IJHCUM

Tehran Municipality

ISSN 2476-4698

Quarterly Publication

International Journal of Human Capital in Urban Management

Volume 10, Number 2, Spring 2025

Indexed by Scopus

International Journal of Human Capital in Urban Managemet (IJHCUM)

Indexed by Scopus

(QUARTERLY PUBLICATION)

Publisher
Tehran Urban Research and Planning Center:
Tehran Municipality,
Tehran, Iran
Email: publisher@ijhcum.net
ijhcum@gmail.com

Editor in Chief
Professor A. Gholipour
University of Tehran,
Tehran, Iran
Email: agholiporut.ac.ir

Managing & Handling Editor
Dr. M. Khodadi
Tehran Municipality
Email: ijhcum@gmail.com

Page Designer
A. Rezaei Soltanabadi
Imajgaran Danesh
ardavanre@gmail.com

Editorial Contact Information
IJHCUM Journal, Khayyam St.,
Building No. 2, Tehran Municipality,
Tehran 1114676111 Iran
Phone: +9821-96015406
Fax: + 9821- 22392096
Emails:
editor@ijhcum.com
ijhcum@gmail .com
Website: https://www.ijhcum.net

Printed at
Tehran Urban Research & Planning
Publication Center

Editorial Board

Publication authorization is certified by the Ministry of Cultural and Islamic Guidance; No. 77163; 14 March 2016

Urban Sustainability is Based on Human Capital

Circulation: 200

*p*ISSN 2476-4698 *e*ISSN 2476-4701

Aims and Scope

International Journal of Human Capital in Urban Management (IJHCUM) aims to offer an outlook on the utilization of human capital in urban management based on existing urban and metropolitan problems. The journal expects to eventually turn into a convergence point as a reference available to professionals, managers and researchers in the field of urban management. Topics of interest include but are not limited to the following disciplines: Human Capital in Urban Management; Urban architecture, design, development and planning; Urban communications and services; Urban civil engineering and related management issues; Urban economics, administrative and financial management; Urban transportation systems and traffic management; Urban social and cultural welfare; Urban ecology and related; environmental concerns; Urban Health, Safety and Environment; Sustainable urban infrastructure.

Vision and Mission

International Journal of Human Capital in Urban Management (IJHCUM) is an open access, peer-reviewed journal affiliated with Municipality of Tehran focusing on employment and allocation of human capital for urban management, including urban multidisciplinary themes. IJHCUM is an integral partner with the scientific and technical communities, delivering superior Information products and services that foster communication, build insights and enables individual and collective advancement in urban management. Providing human capital information to the general public administration with description of contemporary advances in urban issues to be used in improving protection and management.

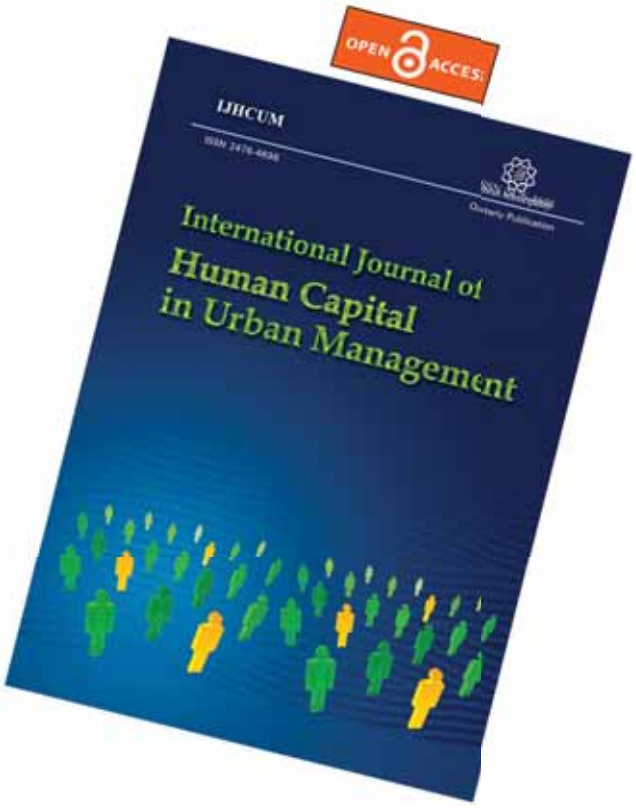
International Journal of Human Capital in Urban Management (IJHCUM)

Editor-in-Chief
E. Sheikh, Ph.D.

pISSN 2476-4698
eISSN 2476-4701

QUARTERLY FULL OPEN ACCESS PEER REVIEWED PUBLICATION

Journal Abbreviation: Int. J. Hum. Cap. Urban Manage.



CALL FOR PAPERS

Publication benefits in
International Journal of
Human Capital in Urban Management

- *Quarterly Publication journal*
- *Online submission and reviewing*
- *Online status inquiry*
- *Double blind peer reviewing*
- *Rapid evaluation and publication*
- *Immediate publication on the net*
- *Open access to all PDF full text of published articles*
- *No pay charge for publication*

Indexed by Scopus

Municipality of Tehran
Tehran Urban Research & Planning Center

www.ijhcum.net

ijhcum@gmail.com
editor@ijhcum.net
publisher@ijhcum.net

Tel.: +9821- 9601 5406
Fax: +9821- 2224 6104

International Journal of Human Capital in Urban Management

CONTENTS

Volume 10, Number 2, Spring (2025)

COVERING LETTER

Subject: **Submission of manuscript**

Dear Editor,

I would like to submit the following manuscript for possible evaluation

Manuscript Title:

Running Title (Short title):

Main Subjects:

Name and address of corresponding author:

Telephone #

Fax #

Email:

I affirm that the manuscript has been prepared in accordance with International Journal of Human Capital in Urban Management guide for authors.

I have read the manuscript and I hereby affirm that the content of this manuscript or a major portion thereof has not been published in a refereed journal, and it is not being submitted fully or partially for publication elsewhere. The manuscript has been read and approved by all listed authors.

The source(s) of financial support of study (if any):

Type of Manuscript (check one):

- ☐ Original research paper
- ☐ Case report
- ☐ Research note
- ☐ Short communication
- ☐ Review paper

Name:

Corresponding Author Signature:

Date:

Int. J. Hum. Capital Urban Manage., 10(2): 199-214, Spring 2025

International Journal of Human Capital in Urban Management
(IJHCUM)

Homepage: http://www.ijhcum.net/

ORIGINAL RESEARCH PAPER

Modeling the cooling effect of urban green infrastructures with an ecosystem services approach (case study: Tehran metropolis)

S. Malekzadeh[1], H.R Jafari[1*], R. Nazari[2], T. Blaschke[3], A. Hof [4], M. Karimi[5]

[1] *Department of Planning, Environmental Management and HSE, Alborz Campus, University of Tehran, Iran*

[2] *Department of Civil, Construction, and Environmental Engineering, University of Alabama at Birmingham, Birmingham, AL, USA*

[3] *Department of Geoinformatics, University of Salzburg, Austria*

[4] *Department of Environment and Biodiversity, University of Salzburg, Austria*

[5] *Department of Environmental Health Science, University of Alabama at Birmingham, Birmingham, AL, USA*

ARTICLE INFO

Article History:
Received 05 July 2024
Revised 15 September 2024
Accepted 06 October 2024

Keywords:
Ecosystem service modeling
Urban heat management
Urban microclimate
Urban resilience
Remote sensing

ABSTRACT

BACKGROUND AND OBJECTIVES: The heating of inner cities is an immense global phenomenon, and urban green spaces are crucial in mitigating this predicament. This study evaluates the cooling effects of urban green infrastructures in a dry region, specifically the Middle East by analyzing Tehran, a metropolis severely impacted by urban heating. We use advanced methodologies to estimate regulating ecosystem services.

METHODS: This research employed a multi-stage methodology utilizing satellite data and in-situ measurements. Land use/land cover maps of Tehran were generated using Landsat imagery from Thematic Mapper (2002), Enhanced Thematic Mapper Plus (2012), and Operational Land Imager (2022), processed with geometric and radiometric corrections in ENVI 5.3. A supervised classification via the Super Vector Machine algorithm identified four land use categories: built-up areas, barren lands, green spaces, and water bodies. The cooling effects of these land uses, analyzed using the InVEST ecosystem service software, were assessed over the 2002-2022 period, incorporating variables such as evapotranspiration, temperature, and shading effects.

FINDINGS: The results showed a decline in green spaces from 13.1% in 2002 to 11.9% in 2012 and 11.8% in 2022, with a projected further decline to 11.7% by 2032. The reduction rate was significant in the first decade, with a loss of 717 hectares, compared to 14 hectares in the second decade. An additional reduction of 66 hectares is predicted over the next decade. The Urban Heat Mitigation Index was highest in the green District 22 with values of 0.91, 0.79, and 0.66, respectively, and lowest in District 10 with values of 0.22, 0.21, and 0.19. Projections for 2032 suggest that District 22 will maintain the highest cooling capacity at 0.65, while District 10 will remain the lowest at 0.19.

CONCLUSION: This study highlights the critical relationship between urban development and green infrastructure. It particularly underscores the importance of preserving green infrastructure as a means to mitigate urban heat, with a focus on its influence on Tehran's microclimate and overall environmental quality. The findings indicate a worrying decline in green spaces, posing significant challenges for urban environmental management. This persistent loss of natural areas undermines ecological stability and urban resilience, especially in terms of heat mitigation and quality of life. Additionally, the uneven distribution of green spaces exacerbates vulnerability in specific Districts, emphasizing the pressing need for sustainable urban planning in Tehran. This study assessed past and future changes to provide valuable insights for urban decision-makers and managers.

DOI: 10.22034/IJHCUM.2025.02.01

NUMBER OF REFERENCES	NUMBER OF FIGURES	NUMBER OF TABLES
50	8	4

*Corresponding Author:
Email: *hjafari@ut.ac.ir*
Phone: +989121002700
ORCID: 0000-0002-8465-6052

Note: Discussion period for this manuscript open until July 1, 2025 on IJHCUM website at the "Show Article.

INTRODUCTION

The process of urbanization has increased public health risks associated with urban heat, risks that are poised to intensify in the coming decades as a result of climate change. Composing with historical records, analysis of future climate data reveals a nuanced picture of future warming. These changes are characterized by variability in both temporal and spatial dimensions, with extremes expected to become more pronounced in the future (Nice *et al.*, 2024). Urban Heat Islands (UHIs) were initially thought to be moderated either by radiative fluxes of sensible and latent heat at night or by vegetation cover and cooling properties. The first characteristic pertains to the urban environment and the associated increase in air temperature, while the latter relates to vegetative surfaces and their cooling attributes (Lin *et al.*, 2017). The UHI phenomenon leads to detrimental impacts in densely populated urban areas, resulting in increased rates of emergency hospital admissions and heat-related illnesses. The examination of UHI effects and temperature fluctuations has gained increased significance amidst the ongoing escalation of global temperatures (Karimi *et al.*, 2024). The development and intensity of the UHI phenomenon are influenced by a complex interplay of factors. These include diminished longwave radiation dissipation, enhanced shortwave radiation reflections between urban structures, increased sensible heat retention within the urban environment, reduced evapotranspiration due to sparse vegetation relative to rural areas, contributions from anthropogenic heat sources, and the impact of air pollution (Oke *et al.*, 1991). While the Surface Urban Heat Island (SUHI) effect is inherently tied to urban surface temperatures and is connected to the UHI effect through its modulation of air temperatures in the lowest atmospheric layers (Voogt and Oke, 2003), it exhibits distinct characteristics due to the influence of air advection (Wang *et al.*, 2020) and tends to be more pronounced during daytime hours (Roth *et al.*,1989). In a study conducted by Feizizadeh and Blaschke (2013) investigating the relationship between UHIs, land use/land cover (LU/LC), and air pollution, the findings underscore that Land Surface Temperature (LST) is significantly influenced by LU/LC characteristics. The study further reveals that UHIs exhibit close associations with both LST and LU/LC. Specifically, LST shows heightened sensitivity to vegetated areas and moisture, resulting in lower temperatures observed around water bodies and green spaces. Conversely, higher temperatures are prevalent in areas characterized by construction and industrial activities, often situated away from the city center. Although the results reveal a strong correlation between UHIs and air pollution, spatial analysis highlights distinct spatial patterns for air pollution in comparison to UHIs. A study investigating UHIs and Urban Heat Waves (UHWs) utilized the MODIS (Moderate-resolution Imaging Spectroradiometer) land surface temperature product to characterize UHI and UHW phenomena across nine major global regions from 2003 to 2020. The findings indicated that a 10% increase in urban built-up density resulted in a rise in LST ranging from 0.20°C to 0.95°C, an increase in the frequency of hot days from 0.59% to 7.17%, and a growth in the number of heat waves from 0.08% to 0.95% (Wei *et al.*, 2021). In urban planning, the mitigation of excessive heat primarily focuses on regulating the microclimate at the pedestrian or building level (Erell, 2008). This approach is particularly relevant to street-level or localized areas (micro-scale) (Norton *et al.*, 2015). While pedestrian-scale interventions are mostly about creating outdoor spaces that provide thermal comfort for individuals, building-scale measures focus on actions that lead to energy savings in buildings. In a comprehensive review spanning the years 1987 to 2017, 146 studies were meticulously examined. These studies focused on the physically based numerical modeling of urban air temperature reduction, specifically analyzing the impact of green-blue infrastructure and reflective materials. The review synthesized key insights and observations, providing valuable recommendations for the optimal design and effective communication of urban heat mitigation simulation studies (Krayenhoff *et al.*, 2021). There are several approaches to mitigating the (S)UHI effect. Incorporating green infrastructure into urban planning as a strategy to counteract (S)UHI provides an opportunity to enhance ecosystem services, which refer to the benefits that humans obtain from natural systems (Leemans and Groot, 2003). These benefits, which encompass both biophysical and economic dimensions (Cortinovis and Geneletti, 2019), can be evaluated through various methods, including air temperature measurements (Bowler *et al.*, 2010), remote sensing analysis of LST data (Zhou *et al.*, 2018), or simulations of the urban thermal environment (Tsoka *et al.*, 2020). Implementing

these strategies necessitates considerable academic expertise, which is often lacking in many urban planning sectors (Bherwani *et al*., 2020; Norton *et al*., 2015). A promising development addressing this gap is the Urban Cooling model, specifically designed for the straightforward evaluation of vegetation's capacity to mitigate UHI. This model is part of the InVEST (Integrated Valuation of Ecosystem Services and Trade-offs) suite, a comprehensive collection of ecosystem service modeling tools developed by the Natural Capital Project (Sharp *et al*., 2020). The Urban Cooling model computes the Heat Mitigation Index (HMI) by considering factors such as vegetation evapotranspiration, the cooling influence of large urban parks, and the albedo associated with the Land Cover (LC) map. This index serves as a basis for estimating the average cooling effect on air temperature and the corresponding economic valuation of vegetation's cooling benefits. Consequently, the accuracy of the model's output is vital for subsequent evaluations. The concept of 'urban cooling' emerged as a response to the significant and adverse impacts of urban heat islands, aiming to mitigate these effects through strategic planning and design. According to global statistics from the United Nations (2019), over 54 percent of the world's population resides in urban areas, with this figure projected to reach 66 percent by 2050. Rapid urbanization has driven changes in land use, an increase in motor vehicle numbers, and the proliferation of high-rise buildings, all of which exacerbate urban heat. These factors underscore the pronounced impact of urban heat islands on city surfaces compared to suburban areas. Therefore, strategies aimed at reducing the negative effects of heat islands, collectively referred to as 'urban cooling,' have become increasingly critical (Du *et al*., 2016). The concept of 'urban cooling' offers a promising approach to mitigating urban heat islands, contributing to the development of sustainable urban environments, and providing long-term solutions for managing urban heat (Rehan, 2016). Fahad *et al*. (2021) investigated thermal comfort and air quality indices by examining large-scale meteorological observations, including temperature, wind speed, solar radiation, and relative humidity, to derive the Universal Thermal Climate Index (UTCI) at hourly intervals along with the Air Quality Index (AQI) derived from Environmental Protection Agency (EPA) observation stations. For investigation on occupational heat exposure, Sabrin *et al*. (2021) examined the frequency of heat days exceeding 90°F (32.2°C) heat-index levels within their research area. They analyzed heat-related injuries and illnesses to determine their incidence rate spanning the years 2015 to 2019. Furthermore, the study observed the characteristics of these incidents, their monthly occurrence, and how their incidence trend correlated with the average air temperature. The statistical analysis findings in a study unveiled intriguing insights into urban cooling strategies. Specifically, it was observed that green roofs outperform cool roofs in terms of cooling the roof area, whereas cool facades exhibit superior cooling capabilities compared to green facades. Furthermore, when considering single mitigation strategies, cool pavements emerged as the most promising option for reducing canopy air temperature significantly (Zhu *et al*., 2021). The outcomes of research undertaken in 2022 shed light on the efficacy of integrated mitigation strategies in urban settings. Specifically, interventions such as enhancing vegetation cover and adjusting albedo levels on horizontal surfaces demonstrated substantial potential in ameliorating urban heat, particularly in low-density urban configurations (Pezzuto *et al*., 2022). In a study carried out in 2023, an ecological network framework was introduced to pinpoint pivotal patches and cooling corridors. Leveraging surface temperature inversion data, Morphological Spatial Pattern Analysis (MSPA), and landscape connectivity indices, the research identified heat island and cold island patches with significant ecological value, laying the groundwork for constructing the network (Luo *et al*., 2023). Another study demonstrated the efficacy of cool materials and rooftop vegetation in mitigating urban heat. These interventions not only lower building cooling needs but also have the potential to counteract the summertime heat island effect when combined. The findings underscore the diverse strategies available for heat mitigation and provide valuable insights into associated costs and benefits for addressing urban heating and cooling demands (Khan *et al*., 2023). The cooling effectiveness of trees is predominantly influenced by the interconnectedness of urban morphology, tree characteristics, and, notably, the prevailing climatic conditions. Recent research has uncovered that urban trees exert substantial cooling effects in hot climates due to their presence at lower latitudes. Moreover, they effectively block solar

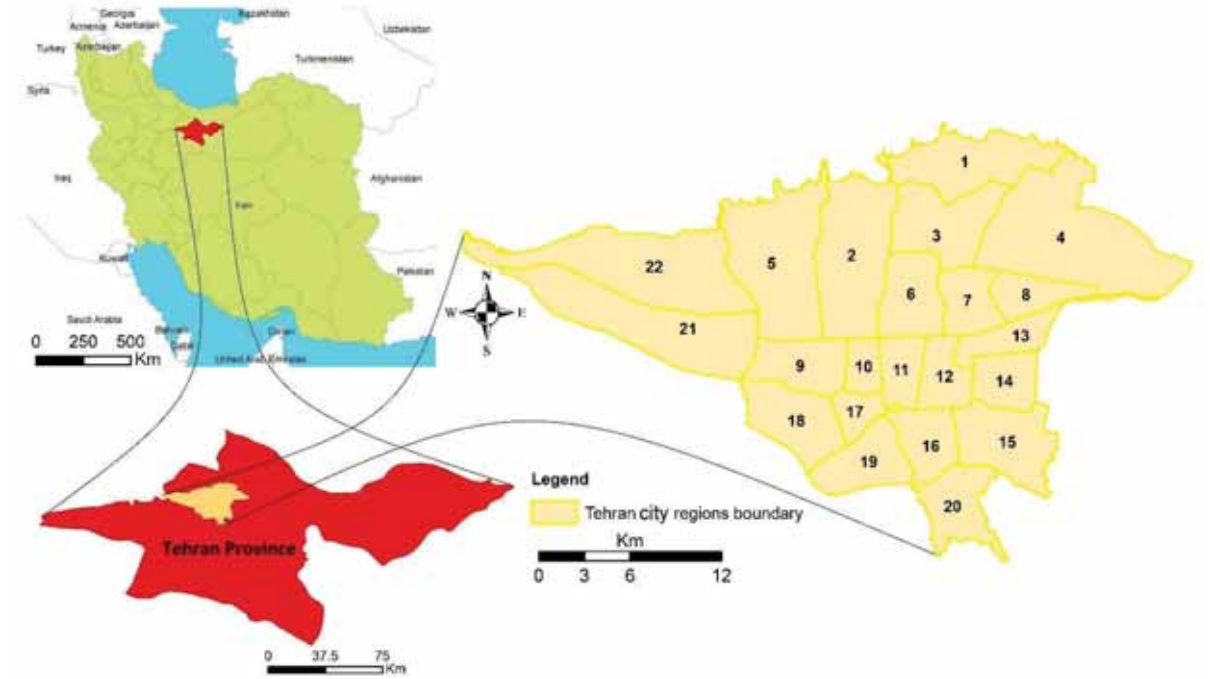


Fig. 1: Geographical location of the study area

radiation and facilitate significant transportation cooling. The cooling impact of trees exhibits a nonlinear escalation, correlating with higher Leaf Area Index (LAI), Leaf Area Density (LAD), tree canopy coverage, and, conversely, a reduced Sky View Factor (SVF) (Li *et al*., 2024). Understanding the cooling contribution of urban greenery is essential for informing urban policy and planning endeavors. The Urban Cooling model gauges the reduction in air temperature due to vegetation, leveraging four key predictors: shading, evapotranspiration, albedo, and building density (Hamel *et al*., 2023). In the current context of climate change and urban expansion, urban heating and its management have become global issues, prompting extensive efforts to develop effective solutions. One of the most important approaches involves using urban green spaces, which, with optimal planning, can significantly mitigate urban heating effects (Bowler *et al*., 2010). The effectiveness of this approach depends on understanding the structural framework and functional components of green spaces (Zhou *et al*., 2018). To achieve this, the study focuses on monitoring the spatial structure and changes in urban green spaces to assess their cooling impact on the urban environment quantitatively. The final platform is the InVEST software, with input parameters prepared using remote sensing techniques, Geographic Information Systems (GISs), and statistical methods. This research aims to analyze the structure and quantify the cooling effects of green spaces in urban environments. This study presents a novel application of the InVEST model to assess the long-term cooling effects of urban green spaces in a dry, Middle Eastern metropolis. Unlike previous studies, it integrates both satellite data and in-situ measurements, offering an accurate and comprehensive assessment of green infrastructure's role in mitigating urban heat in Tehran over a 20-year period, with projections for future urban planning. The present research was conducted in the Tehran metropolis in 2023.

MATERIALS AND METHODS

Study area

The Tehran metropolis, covering an area of approximately 733 km², is situated on the southern slopes of the central Alborz Mountain range. Geographically, it spans between latitudes 35° 35′ N to 35° 51′ N and longitudes 51° 4′ E to 51° 33′ E. The city is bordered by the plains of Varamin and Shahriar to the south and southwest, while mountains surround

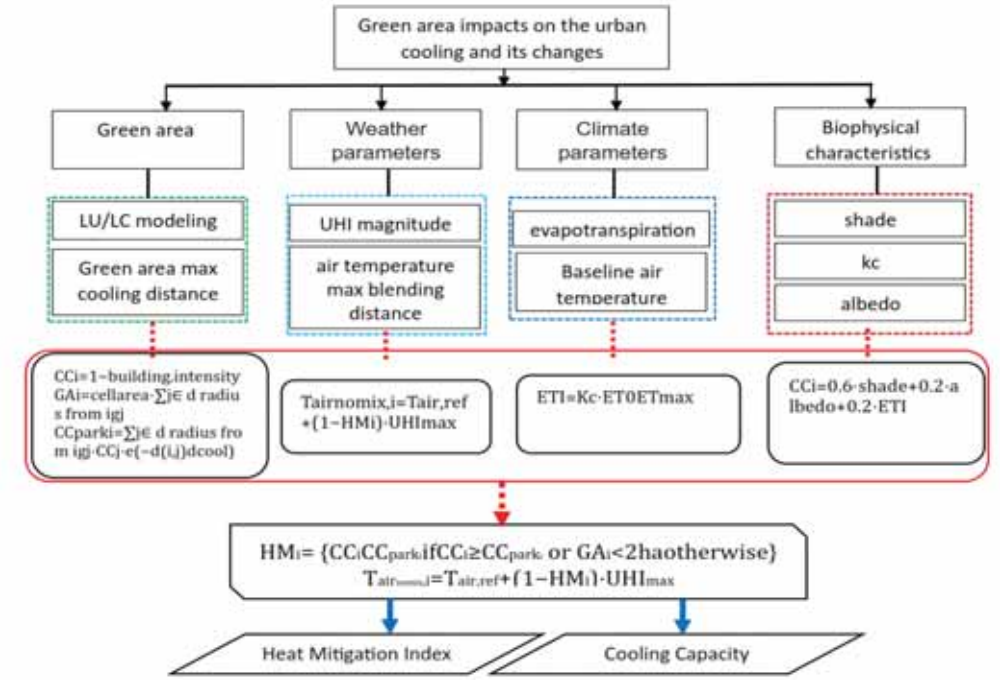


Fig. 2: Flowchart of the research methodology

it to the north and east (Zarandi *et al.*, 2021). Elevation within the metropolis ranges from 900 to 1800 meters above sea level, decreasing from north to south, which results in distinct microclimates across different areas of Tehran (Alibakhshi *et al.*, 2020). Fig. 1 illustrates the geographic location of the Tehran metropolis. Based on the most recent official census conducted in 2016, Tehran's population stood at 8.6 million (Iran Statistical Center, 2016). Furthermore, according to the annual population projection report by the Management and Planning Organization of Tehran Province, the population of Tehran was predicted to reach approximately 9.1 million by 2024 (Management and planning organization, 2024).

Research methodology

This research is conducted based on the stages and phases outlined briefly in Fig. 2.

Preparation of Land Use/Land Cover map

To generate the land use/land cover (LU/LC) map of Tehran for the study period spanning 2002 to 2022, Landsat satellite imagery from various sensors was utilized: Thematic Mapper (TM) for 2002, Enhanced Thematic Mapper Plus (ETM+) for 2012, and Operational Land Imager (OLI) for 2022. These images were acquired and downloaded from the United States Geological Survey (USGS) website (Table 1). In the pre-processing phase within the ENVI 5.3 software environment, geometric corrections (Chavez, 1988) and radiometric corrections (USGS Landsat User Services, 2016) were applied to the satellite images (balist *et al.*, 2022a). In the next step, unsupervised classification was carried out for all the existing LU/LC classes in the study area. To increase the accuracy of the classification process in this study, index-based classification was performed using the Normalized Difference Vegetation Index (NDVI) to extract the Regions of Interest (RoI) from the structural components. Using the prepared RoIs, supervised classification was performed based on the Supper Vector Machine (SVM) algorithm in the ENVI 5.3 software environment. In this step, four land use types were identified in the landscape of the city of Tehran: built-up areas (man-made), barren lands, green areas, and water bodies. Then, using Google Earth images, GPS points, and existing LU/LC maps of the study area, the accuracy of the classified images was assessed, including the examination of the overall accuracy and the Kappa coefficient

Table 1: Specifications of the images used in land use/land cover map preparation

Year	Satellite	Sensor	Resolution	Date	Row/column
2002	4-5	TM	30*30 meter	July 26, 2002	164/35
2012	7	ETM+	30*30 meter	July 14, 2012	164/35
2022	8	OLI	30*30 meter	July 17, 2022	164/35

values. Kappa coefficient values above 80% indicate a generally good agreement between the classification and the existing LU/LC classes on the ground (balist *et al*., 2022b).

InVEST urban cooling model

Cooling capacity index

The InVEST model initially computes the cooling capacity index for each pixel by evaluating local shading, evapotranspiration, and albedo. This approach is informed by the indicators proposed by Zardo *et al*., (2017) and Kunapo *et al*., (2018), with the addition of albedo as a crucial factor in heat reduction. The shading factor (shade) represents the proportion of tree canopy (for trees > 2 meters) related to each LU/LC class, with a value between 0 and 1. The Evapotranspiration Index (ETI) indicates the potential normal evapotranspiration, which refers to the evaporation and transpiration from plants (or evaporation from the soil for areas without vegetation) and is calculated by multiplying the reference evapotranspiration (ET_0, provided by the user) for each pixel by the crop coefficient (K_c), associated with the land use/land cover (LU/LC) type of the pixel. This is then divided by the maximum value of raster ET0 in the specified area, referred to as ET_{max}, as Eq. 1:

$$ETI = \frac{k_c . ET_0}{ET_{max}} \quad (1)$$

The albedo factor, which ranges from 0 to 1, represents the fraction of solar radiation reflected by a given LU/LC type (Phelan *et al*., 2015). This model combines the three factors (shade, albedo factor, and ETI) in the Cooling Capacity (CC) index as Eq. 2:

$$\text{CCi} = 0.6 \cdot \text{shade} + 0.2 \cdot \text{albedo} + 0.2 \cdot \text{ETI} \quad (2)$$

The default weighting values (0.6; 0.2; 0.2) are based on empirical data, reflecting a greater influence of shading compared to evapotranspiration. For example, Zardo et *al*., (2017) reported that in areas smaller than two hectares, evapotranspiration was assigned a weight of 0.2, while shading received a weight of 0.8. In contrast, for areas larger than two hectares, the weights were adjusted to 0.6 for evapotranspiration and 0.4 for shading. Besides, the model can incorporate another factor, Intensity (building intensity), which accounts for the vertical dimension of built infrastructure. Building intensity is a crucial predictor of nighttime temperature as the heat stored in buildings during the day is released at night. To predict nighttime temperatures accurately, users must provide the building intensity coefficient for each land use type in the Biophysical Table (Table 3), and the model modifies Eq. 2 as Eq. 3:

$$\text{CCi} = 1\text{-building intensity} \quad (3)$$

The urban cooling index (Impact of large green spaces)

To assess the cooling effect of large green spaces (greater than 2 hectares) on their surrounding areas (Zardo *et al*., 2017; McDonald *et al*., 2016), the model computes the Urban Cooling Index (UCI). When a large green space does not impact a particular pixel, the UCI is equivalent to the Cooling Capacity (CC) of that pixel. If the large green space does influence the pixel, the UCI is adjusted based on the weighted average distance between the pixel and the CC values of the nearby large green spaces. To achieve this, the model first computes the green area values within the cooling search distance (d_{cool}) around each pixel (GA_i) and the cooling capacity provided by each park (CC_{parki}) as Eqs. 4 and 5:

$$GA_i = \text{cell area} \cdot \Sigma_{j \in d \text{ radius from } i} g_j \quad (4)$$

$$\text{CC}_{\text{Parki}} = \Sigma_{j \in d \text{ radius from } i} g_j \cdot CC_j \cdot \text{e}^{-\frac{\text{d(i.j)}}{d_{cool}}} \quad (5)$$

If the cell area is in hectares per cell, then if pixel j is a green space, g_j is equal to one; otherwise, it is zero. $d_{(i,j)}$ is the distance between pixels i and j, d_{cool} is the distance through which a green space has a cooling effect, and CC_{parki} is the weighted average

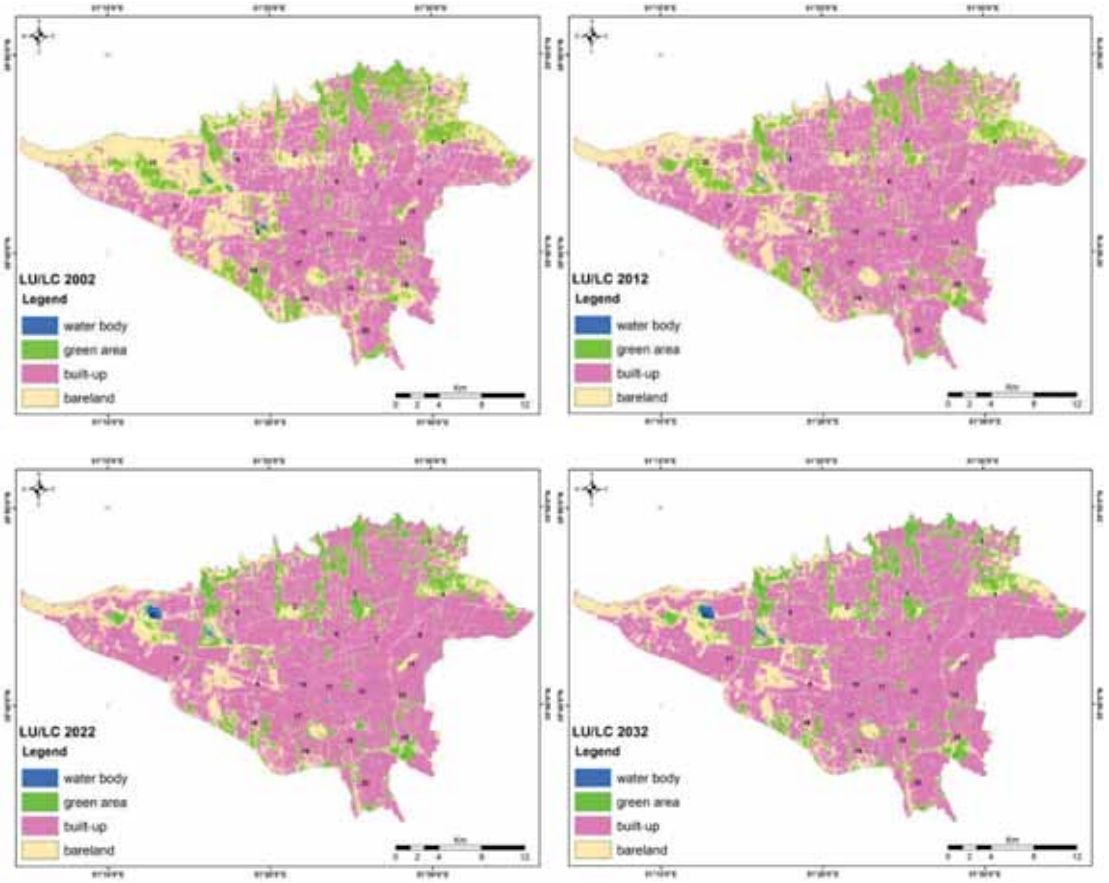


Fig. 3: Land use maps of Tehran city from 2002 to 2032

distance of the CC values from the green spaces. The LU/LC classified as "green area" is determined by the user with the "green_area" parameter in the biophysical table (Tables 2 and 3). Then, the HM index is calculated as Eq. 6:

$$HM_i = \begin{cases} \dfrac{CC_i}{CC_{parki}} & \text{if } CC_i \geq CC_{parki} \text{ or } GA_i < 2\text{ha} \\ Otherwise \end{cases} \quad (6)$$

Estimation of air temperature

For estimating heat reduction at the urban level, this model (at the city scale) utilizes the UHI index, referred to as UHI_{max}. The UHI size is defined for a specific period (e.g., current or future weather) and time (e.g., nighttime or daytime temperature). The choice of period and time influences the assessment of services. The air temperature without air mixing ($T_{airnomix}$) for each pixel is calculated as Eq. 7:

$$T\text{air nomix}.i = T_{air.ref} + (1 - HM_i) \cdot UHI_{max} \quad (7)$$

Where $T_{air,ref}$ is the reference rural air temperature, and UHI_{max} represents the magnitude or scale of the UHI effect for the city. Due to air mixing, this temperature is spatially reduced. The actual air temperature (with mixing), T_{air}, is obtained from $T_{air\ nomix}$ using a Gaussian kernel function with a core radius $_r$ defined by the user. For each region of interest (represented as a vector GIS layer provided by the user), the mean temperature and temperature anomaly ($T_{air,i} - T_{air,ref}$) are calculated.

Urban cooling capacity

Urban cooling capacity refers to the ability of green spaces within urban areas to mitigate and reduce the local urban heat island effect and overall thermal comfort in urban environments.

RESULTS AND DISCUSSION

Land use/Land cover

This section presents the results related to the production of the land use/land cover layer for 3 past periods (2002, 2012, and 2022) and one future period in the city of Tehran (Fig. 3).

As shown in Table 2, green space land use in 2002 accounted for 13.1% of the total land use in the Tehran metropolitan area. However, it decreased to 11.9% in 2012 and 11.8% in 2022, with a projected reduction to 11.7% by 2032. The decrease in green space area was higher in the first half of the study period than in the second half. Over the initial 10 years, 717 hectares of green spaces were reduced, while in the subsequent 10 years, only 14 hectares were lost. A further reduction of 66 hectares is predicted for the next 10 years. Barren lands have also decreased during this period under study. These lands were previously classified as areas with poor or no vegetation cover among other land uses, mainly located on the city's outskirts. With the increase in urban construction, these lands are considered the most important source of land for construction, so during the first 10 years of the study period, 4,072 hectares of these lands underwent land use change. In the next 10 years, 4,319 hectares, and in the next 10 years, 247 hectares of these lands will change. The built-up areas, designated as human-made land use, have been a major factor in land use changes in urban areas, particularly in Tehran. During the first 10-year period, these areas expanded by 4849 hectares, followed by an increase of 4209 hectares in the subsequent 10 years. It can be argued that, apart from a small portion of land use changes in Tehran allocated to blue bodies, the rest of the changes have been from primarily barren lands and green spaces, especially orchards, to built-up areas (Table 2).

Urban green infrastructure cooling model by InVEST

The inputs for the urban green infrastructure cooling model include the land use/land cover map, reference evapotranspiration map, biophysical table, baseline temperature, urban heat island magnitude, maximum air mixing distance, and maximum green space cooling distance.

Biophysical table

A table containing the model-related information for each land use/land cover class is required. All classes in the map must have corresponding values in this table. The table columns are as follows:

Land Use/Land Cover Code: The LU/LC codes must match the 'value' column in the land cover raster map and have valid, sequential, and unique values (Table 3).

Shade:

A value between 0 and 1 represents the tree cover ratio (0 for no trees; 1 for full tree cover with trees taller than 2 meters).

Evapotranspiration coefficient:

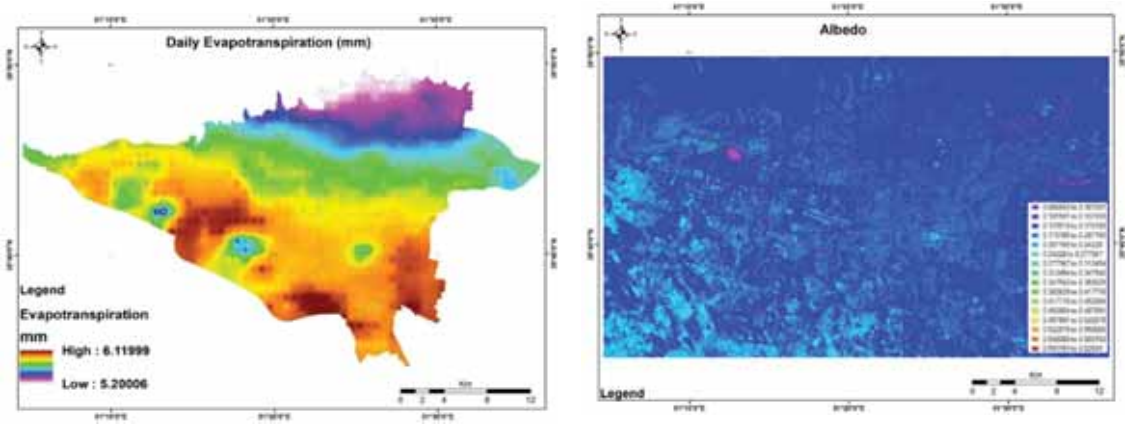
The evapotranspiration coefficient for vegetation cover, along with the evaporation coefficient for other land uses, ranges from 0 to 1. This study draws on findings from research titled 'Calculating the

Table 2: Land use changes in Tehran city from 2002 to 2032

Land Use/Land Cover	2002 ha	%	2012 ha	%	2022 ha	%	2032	%
Water Bodies	104	0.17	43	0.07	168	0.27	182	0/29
Green Areas	8012	13.1	7295	11.9	7281	11.8	7215	11.7
Built-Up Area	30668	49.9	35517	57.8	39726	64.7	40024	65.2
Bare land	22560	36.7	18488	30.1	14169	23.1	13922	22.7
Sum	61345	100	61345	100	61345	100	61345	100

Table 3: Biophysical Table

LU/LC code	Shade	Kc	Albedo	Green_area	Building_intensity
1	0	0.1	0.08	0	0
2	1	0.75	0.15	1	0
3	0	0.1	0.27	0	0.7
4	0	0.5	0.21	0	0



(a) (b)

Fig. 4: Evapotranspiration (a) and Albedo (b) Map of Tehran Metropolis

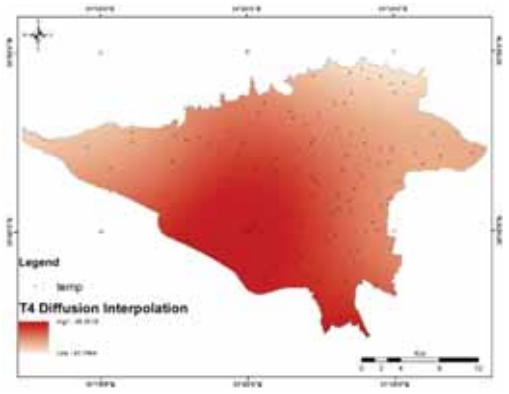


Fig. 5: Map of Collected Temperatures from Various Points in Tehran Metropolis

Water Requirements of Urban Green Spaces Using the California Method' (Babaeian *et al*., 2020). In this research, the evapotranspiration coefficient was calculated for different types of green spaces in District 4 of the Tehran metropolis, the average of which has been used for the entire green space of Tehran in this study. Data from FAO and other relevant studies were employed for different land uses (Table 3).

Albedo:

A value between 0 and 1 represents the solar radiation ratio directly reflected by land use/land cover type. To calculate the albedo for each land use, the albedo map of Tehran city was derived from satellite images using the following formula (Eq. 8):

$$\text{Albedo} = \frac{\left((0.356 \cdot B1) + (0.130 \cdot B2) + (0.373 \cdot B3) + (0.085 \cdot B4) + (0.072 \cdot B5) - 0.018\right)}{1.016} \quad (8)$$

The map was then prepared, and albedo values were extracted for different land uses (Fig. 5).

Green Area:

A value of 0 or 1, where 1 signifies that the land use/land cover is designated as a green area (green areas with an area greater than 2 hectares have additional cooling effects), and 0 signifies that the LU/LC is not considered a green area.

Building density:

A decimal value between 0 and 1 is calculated

by dividing the building area by the land area and normalized between 0 and 1. For this index, the number of floors in Tehran is considered to be 3, and the land area for each building is 200 square meters with a total built-up area of 300 square meters (3 floors of 100 square meters each); therefore, the value of this index is taken as 0.70.

Reference Evapotranspiration map:

This map is generated using meteorological data from Tehran weather stations (Fig. 4).

Maximum cooling distance of green spaces:

The distance (in meters) within which large urban parks (greater than 2 hectares) have a cooling effect.

Reference air temperature (Tref):

The reference ambient temperature (where the urban heat island effect is not observed) for the specified period. This temperature can be either nighttime or daytime temperature for a specific date or an average over several consecutive days. Considering the measurement from various points across Tehran city and averaging based on the surface temperature map derived from sample points (Fig. 5), this index is set at 40 degrees Celsius.

The value of the urban heat island effect:

The value of the Urban Heat Island effect (UHImax) is measured in degrees Celsius, representing the difference between the surrounding reference temperature and the maximum observed temperature within the city. Based on various observational data and research in this field, the UHImax is considered 4 degrees Celsius.

The maximum distance of air temperature mixing:

The search radius (measured in meters) used in the moving average to calculate air temperature mixing is set at 700 meters in this study.

Model output results

At this stage, the model's output results are presented and explained.

Heat Mitigation Index (HMI)

This index indicates the cooling effect of green spaces on the surrounding environment in Fig. 7, the map of the HMI for Tehran from 2002 to 2032 is depicted. This index ranges from 0.1 to 1.0, where moving closer to 1.0 signifies a greater cooling effect of green spaces. This index illustrates the presence of green spaces in different areas and their impact on urban cooling.

In Fig. 6, the trend of changes in HMI is illustrated. This index indicates a decrease in the cooling effect of green spaces over time. It reflects the reduction in green spaces and the increase in construction activities in various areas. Table 4 shows the characteristics of the cooling model from 2002 to 2032 by Districts (Tehran metropolis is divided into 22 Districts).

Additionally, in Fig. 7, the average cooling capacity from 2002 to 2032 is depicted. The highest capacity in 2002 is recorded for District 22 at 0.91, while District 10 at 0.22 has the lowest capacity. In 2012, the highest capacity is observed for District 22 at 0.79, and the lowest for District 10 at 0.21. In 2022, the highest capacity is for District 22 at 0.66, and the lowest for District 10 at 0.19. Finally, in 2032, the highest capacity is for District 22 at 0.65, and the lowest for District 10 at 0.19.

The average cooling capacity

A significant component of the model, calculating the "Heat Mitigation Service Value," is an essential part of the InVEST urban cooling model. Its purpose is to determine the quantity of economic benefits associated with temperature reduction in urban areas, primarily facilitated by the presence of urban green spaces. Fig. 8 depicts comparative maps of the average cooling capacity for 2002, 2012, 2022, and 2032 by Districts. As observed, this capacity has diminished over time.

The study's findings underscore the extensive benefits provided by urban green spaces, particularly in cooling urban environments. Recent research has increasingly highlighted the role of urban green infrastructure (UGI) in mitigating UHI effects and bolstering urban resilience to climate change. Notably, a study by Yan *et al.*, (2021) in Beijing demonstrated significant cooling effects from vegetative green spaces, affirming the effectiveness of UGI in improving thermal conditions and enhancing urban quality of life. Similarly, research by Mughal *et al.*, (2020) in Singapore emphasized the vital role of green roofs and vertical green systems in moderating urban microclimates and reducing energy consumption

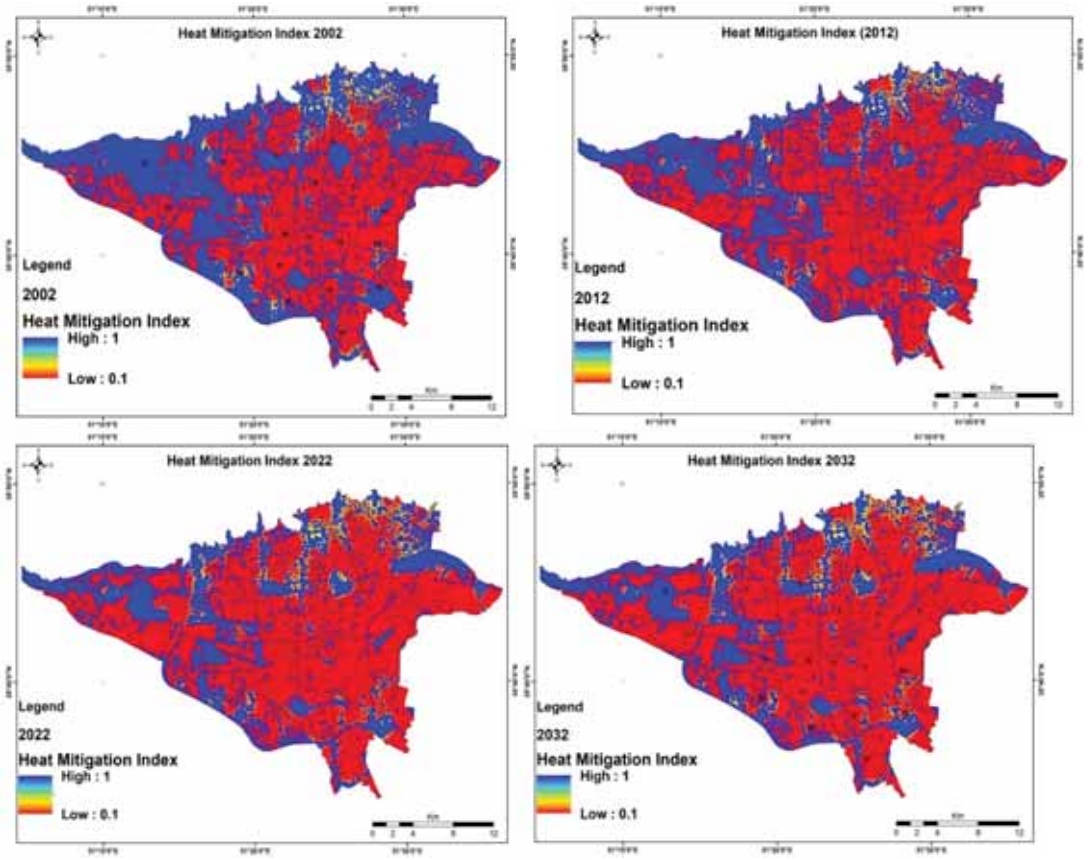


Fig. 6: Heat Mitigation Index Maps of the Tehran metropolis from 2002 to 2032

Table 4: Average cooling capacity from 2002 to 2032 by Districts

year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
2002	0.7	0.49	0.5	0.6	0.62	0.41	0.33	0.26	0.58	0.22	0.3	0.3	0.36	0.28	0.45	0.43	0.24	0.55	0.65	0.39	0.53	0.91
2012	0.54	0.43	0.44	0.53	0.54	0.39	0.29	0.27	0.51	0.21	0.27	0.28	0.34	0.26	0.4	0.38	0.22	0.47	0.54	0.31	0.44	0.79
2022	0.46	0.41	0.39	0.43	0.49	0.32	0.24	0.21	0.4	0.19	0.23	0.21	0.29	0.24	0.37	0.33	0.22	0.43	0.5	0.3	0.36	0.66
2032	0.45	0.41	0.39	0.43	0.48	0.32	0.24	0.21	0.4	0.19	0.22	0.21	0.28	0.23	0.37	0.33	0.21	0.42	0.51	0.3	0.35	0.65

for buildings, demonstrating the various benefits of UGI across different urban domains. Based on the simplifications provided above, the model presents several constraints summarized as follows:

1. Weighting and calculation of the Heat Mitigation Index: Empirical weights derived from a limited number of case studies have been used to calculate this index. These weights include 0.6 for shade,

0.2 for albedo, and 0.2 for evapotranspiration. This weighting stage involves significant uncertainties, as examined by Zardo *et al*. (2017). To describe and reduce this uncertainty, users can test the model's sensitivity to these parameters or conduct empirical studies to provide insights into the relative effects of these parameters.

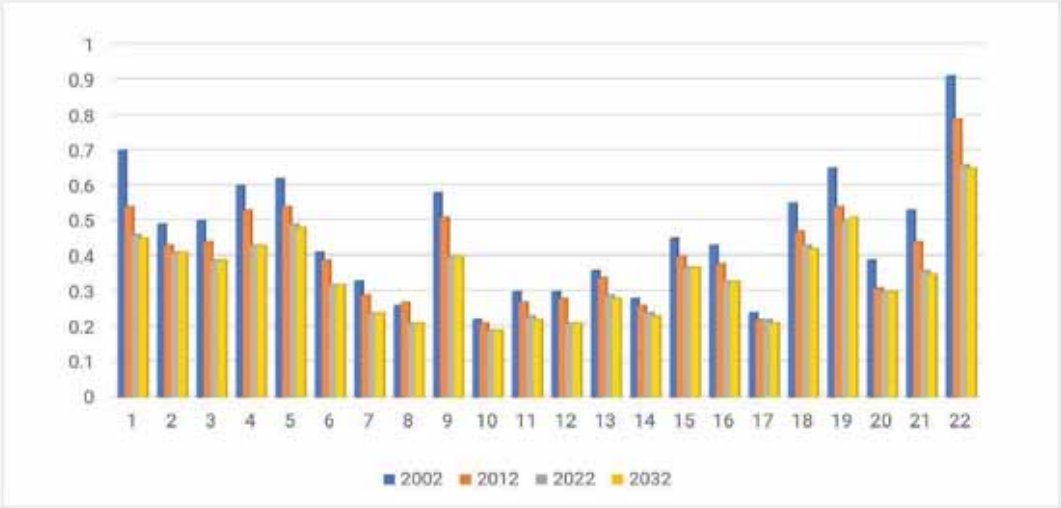


Fig. 7: Average cooling capacity distribution across 22 districts of Tehran in the study years

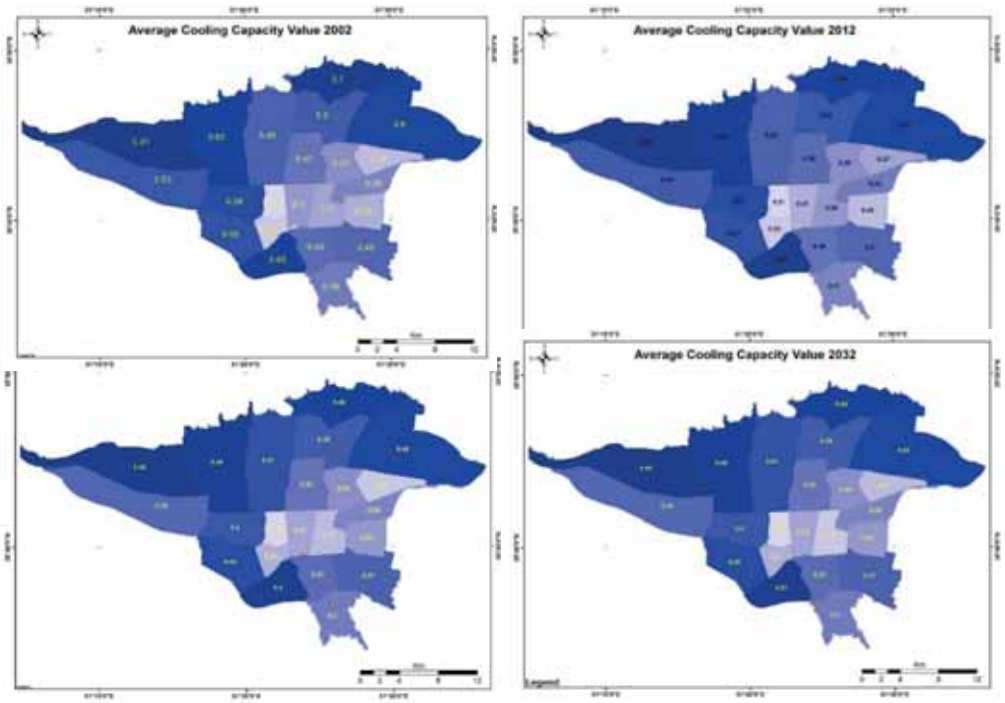


Fig. 8: The maps of Tehran's average cooling capacity values from 2002 to 2032.

2. Large parks and air mixing: These two parameters, namely the impact of large green spaces and air mixing, illustrate their influence on urban cooling (d_{cool}). Extracting the value of these parameters from available sources is challenging as it depends on the properties of vegetation cover, climate (effect of large green spaces), and wind patterns (air mixing), Similar to Cooling capacity. Users can identify and reduce these uncertainties by testing the model's sensitivity to these parameters and comparing the spatial patterns of estimated temperatures by the model with observed or modeled data (Bartesaghi-Koc *et al*., 2018; Deilami *et al*., 2018). Enhancing and strategically designing green and blue spaces can foster nature-based urban heat mitigation strategies that promote sustainable urban development. A study conducted in Wuhan, China, utilized quantitative methods to assess the impact of changes in blue-green spaces on heat mitigation benefits. Through spatial analysis techniques, the study elucidated the correlation between heat reduction effects and the spatial patterns of urban blue-green infrastructure (Hu *et al*., 2023). Modeling this index (UMI) demonstrates that green infrastructures can significantly impact public health, identifying risky areas for citizens (for citizen health) in urban settings. Gasparrini *et al*., (2015) analyze the increase in heat-related mortality across 384 cities in 13 countries.

The results of this study provide critical insights for urban planners and policymakers in the Tehran metropolis. The projected decline in green spaces, coupled with the significant variability in cooling capacity across districts, underscores the need for strategic urban planning interventions. For example, expanding green infrastructure in districts with lower cooling capacity (e.g., District 10) can help mitigate urban heat and improve thermal comfort for residents. The reduction of green spaces and their associated cooling effects poses a risk to public health, particularly during heat waves, which are predicted to increase in frequency and intensity due to climate change. By providing district-level projections, this study can guide targeted efforts to reduce heat stress and heat-related illnesses in vulnerable areas.

CONCLUSIONS

This study provides a novel contribution to the field by applying the InVEST urban cooling model to an arid, rapidly urbanizing context like Tehran metropolis. It highlights the critical relationship between urban green infrastructure and cooling capacity, using multi-temporal satellite data and advanced land-use classification techniques. The findings deepen our understanding of how green spaces influence urban microclimates and inform models predicting future heat mitigation. From a practical standpoint, the results can inform urban planning and environmental management in Tehran metropolis and other cities facing similar challenges. The district-level analysis of cooling capacity highlights areas in need of green infrastructure expansion, while the model's projections can guide long-term urban resilience planning. Furthermore, the study offers valuable insights for reducing heat-related health risks, particularly in densely populated districts with lower green space availability. Further research could focus on integrating additional environmental factors, such as air pollution and water availability, into the urban cooling model. Investigating the social and economic benefits of green infrastructure, including its impact on property values, public health, and community well-being, would provide a more comprehensive view of the ecosystem services provided by urban green spaces. This study has several limitations. The empirical weights used in the model (e.g., for shading and evapotranspiration) are based on previous studies and may not fully capture the complexity of Tehran's microclimate. Additionally, while satellite data provides valuable insights, in-situ measurements of temperature and humidity would enhance the accuracy of future models. The absence of data on socio-economic factors, such as population density and land use policies, also limits the scope of the research.

AUTHOR CONTRIBUTION

S. Malekzadeh performed the conceptualization and literature review, compiled the data, manuscript preparation (Writing – original draft), Methodology, Software, and edited references. H.R Jafaria, R. Nazarib, T. Blaschkec, A. Hof d, and M. Karimie performed Supervision, Validation, Investigation, and Review and Editing of the manuscript.

ACKNOWLEDGEMENT

The current study is a part of the author's doctoral thesis at Tehran University. The authors express their gratitude and appreciation for the support of

this university and also the University of Alabama (USA) and the University of Salzburg (Austria) for the cooperation in carrying out this research.

CONFLICT OF INTEREST

The authors state that they have no possible conflict of interest regarding the publication of this work. Additionally, the authors have also fully observed all ethical difficulties, such as informed consent, data fabrication or falsification, misconduct, plagiarism, duplicate publishing or submission, and redundancy.

OPEN ACCESS

PUBLISHER NOTE

Tehran Urban Research & Planning Centre (TURPC) takes a neutral position about claims on disputed territories, place names, international boundaries, jurisdiction in published maps, and institutional affiliations. TURPC is committed to retracting a paper after its publication if it becomes apparent that there are serious problems in its content in terms of research and publication ethics **(**https://www.ijhcum.net/journal/process?ethics**).**

ABBREVIATIONS

AQI	Air Quality Index
CC	Cooling Capacity
EPA	Environmental Protection Agency
ETI	Evapotranspiration Index
ETM+	Enhanced Thematic Mapper Plus
GIS	Geographic Information System
HMI	Heat Mitigation Index
InVEST	Integrated Valuation of Ecosystem Services and Trade-offs
LAD	Leaf Area Density
LAI	Leaf Area Index
LST	Land Surface Temperature
LU/LC	Land Use/Land Cover
MODIS	Moderate-resolution Imaging Spectroradiometer
MSPA	Morphological Spatial Pattern Analysis
OLI	Operational Land Imager
RoI	Regions of Interest
SUHI	Surface Urban Heat Island
SVF	Sky View Factor
SVM	Supper Vector Machine
TM	Thematic Mapper
UCI	Urban Cooling Index
UGI	Urban Green Infrastructure
UHI	Urban Heat Island
UHW	Urban Heat Wave
USGS	United States Geological Survey
UTCI	Universal Thermal Climate Index

REFERENCES

Alibakhshi, Z.; Ahmadi, M.; Farajzadeh Asl, M., (2020). Modeling biophysical variables and land surface temperature using the GWR model: case study—Tehran and its satellite cities. J. Indian Soc. Remot. Sens., 48(1): 59-70 **(12 pages).**

Babaeian, I.; Ansari Ghojghar, M.; Pourgholam-Amiji, M.; Parsi, E., (2020). Calculate the water need of urban green space using the california method (case study: region 4 of Tehran municipality). J. Meteorog. Or. (NIVAR), 44(110): 131-145 **(16 pages).** (In Persian)

Balist, J.; Malekmohammadi, B.; Jafari, H.R.; Nohegar, A.; Geneletti, D., (2022). Detecting land use and climate impacts on water yield ecosystem service in arid and semi-arid areas. a study in Sirvan River Basin-Iran. Appl. Water SCI., 12: 1-14 **(14 pages)**.

Balist, J.; Malekmohammadi, B.; Jafari, H.R.; Nohegar, A., Geneletti, D., (2022). Modeling the supply, demand, and stress of water resources using ecosystem services concept in Sirvan River Basin (Kurdistan-Iran). Water Supp., 22(3): 2816-2831 **(16 pages)**.

Bartesaghi-Koc, C.; Osmond, P.; and Peters, A., (2018). Evaluating the cooling effects of green infrastructure: a systematic review of methods, indicators and data sources. Solar Energy., 166: 486-508 **(23 pages)**.

Bherwani, H.; Singh, A.; Kumar, R., (2020). Assessment methods of urban microclimate and its parameters: a critical review to take the research from lab to land. Urban Climate., 34: 100690 **(1 page).**

Bowler, D.E.; Buyung-Ali, L.; Knight, T.M.; Pullin, A.S., (2010). Urban greening to cool towns and cities: a systematic review of the empirical evidence. Landscape Urban Plan., 97(3): 147-155 **(9 pages).**

Chavez Jr, P. S., (1988). An improved dark-object subtraction technique for atmospheric scattering correction of multispectral data. Remote Sens. Environ., 24(3): 459-479 **(21 pages).**

Cortinovis, C.; Geneletti, D., (2019). A framework to explore the effects of urban planning decisions on regulating ecosystem services in cities. Ecosyst. Serv., 38: 100946 **(1 page).**

Deilami, K.; Kamruzzaman, M.; Liu, Y., (2018). Urban heat island effect: A systematic review of spatio-temporal factors, data, methods, and mitigation measures. Int. J. Appl. Earth Obs. Geoinformation., 67: 30-42 **(13 pages).**

Du, H.; Song, X.; Jiang, H.; Kan, Z.; Wang, Z.; Cai, Y., (2016). Research on the cooling island effects of water body: a case study of Shanghai, China. Ecol. Indic., 67: 31-38 **(8 pages).**

Erell, E., (2008). The application of urban climate research in the design of cities. Adv. Build. Energy Res., 2(1): 95-121 **(27 pages).**

Fahad, M.G.R.; Karimi, M.; Nazari, R.; Sabrin, S., (2021). Developing a geospatial framework for coupled large scale thermal comfort and air quality indices using high resolution gridded meteorological and station based observations. Sustain. Cities Soc., 74: 103204 **(1 page).**

Feizizadeh, B.; Blaschke, T., (2013). Examining urban heat island relations to land use and air pollution: multiple endmember spectral mixture analysis for thermal remote sensing. IEEE J. of Sel. Top. Appl. Earth Obs. Remote Sens., 6(3): 1749-1756 **(8 pages).**

Gasparrini, A.; Guo, Y.; Hashizume, M.; Lavigne, E.; Zanobetti, A.; Schwartz, J.; Tobias, A.; Tong, S.; Rocklöv, J.; Forsberg, B.; Armstrong, B., (2015). Mortality risk attributable to high and low ambient temperature: a multicountry observational study. Lancet, 386(9991): 369-375 **(7 pages).**

Hamel, P.; Bosch, M.; Tardieu, L.; Lemonsu, A.; de Munck, C.; Nootenboom, C.; Viguié, V.; Lonsdorf, E.; Douglass, J.A.; Sharp, R. P., (2023). Calibrating and validating the InVEST urban cooling model: case studies in France and the United States. EGUsphere., 2023, 1-25 **(25 pages).**

Hu, Y.; Wang, C.; Li, J., (2023). Assessment of heat mitigation services provided by blue and green spaces: an application of the InVEST urban cooling model with scenario analysis in Wuhan, China. Land, 12(5): 963 **(1 page).**

Iran Statistical Center (2016) **(4 pages).** (In Persian)

Karimi, M.; Vant-Hull, B.; Nazari, R.; Mittenzwei, M., Khanbilvardi, R., (2017). Predicting surface temperature variation in urban settings using real-time weather forecasts. Urban Climate., 20: 192-201 **(10 pages).**

Khan, A.; Carlosena, L.; Khorat, S.; Khatun, R.; Das, D.; Doan, Q.V., Hamdi, R.; Aziz, S.M.; Akbari, H.; Santamouris, M.; Niyogi, D., (2023). Urban cooling potential and cost comparison of heat mitigation techniques for their impact on the lower atmosphere. Comput. Urban Sci., 3(1): 26 **(1 page).**

Krayenhoff, E.S.; Broadbent, A.M.; Zhao, L.; Georgescu, M.; Middel, A.; Voogt, J.A.; Martilli, A.; Sailor, D.J.; Erell, E., (2021). Cooling hot cities: a systematic and critical review of the numerical modelling literature. Environ. Res. Lett., 16(5): 053007 **(1 page).**

Kunapo, J.; Fletcher, T.D.; Ladson, A.R.; Cunningham, L.; Burns, M. J., (2018). A spatially explicit framework for climate adaptation. Urban Water J., 15(2): 159-166 **(8 pages).**

Leemans, R.; Groot, R.S.de., (2003). Millennium ecosystem assessment: ecosystems and human well-being:a framework for assessment, Island Press **(245 pages).**

Li, H.; Zhao, Y.; Wang, C.; Ürge-Vorsatz, D.; Carmeliet, J.; Bardhan, R., (2024). Harnessing cooling from urban trees: Interconnecting background climates, urban morphology, and tree traits. EGUsphere, 1-50 **(50 pages).**

Lin, P.; Gou, Z.; Lau, S.S.Y.; Qin, H., (2017). The impact of urban design descriptors on outdoor thermal environment: a literature review. Energies., 10(12): 2151 **(1 page).**

Luo, J.; Fu, H., (2023). Constructing an urban cooling network based on PLUS model: implications for future urban planning. Ecol. Indic., 154: 110887 **(1 page).**

Nice, K.A.; Demuzere, M.; Coutts, A.M.; Tapper, N., (2024). Present day and future urban cooling enabled by integrated water management. Front. Sustain. Cities, 6: 1337449 **(1 page).**

Norton, B.A.; Coutts, A.M.; Livesley, S.J.; Harris, R.J.; Hunter, A.M.; Williams, N.S., (2015). Planning for cooler cities: a framework to prioritise green infrastructure to mitigate high temperatures in urban landscapes. Landscape Urban Plan., 134: 127-138 **(12 pages).**

Management and planning organization., (2024) **(4 pages).** (In Persian)

McDonald, R.; Kroeger, T.; Boucher, T.; Wang LongZhu, W.L.; Salem, R., (2016). Planting healthy air: a global analysis of the role of urban trees in addressing particulate matter pollution and extreme heat. Nature Conservancy **(136 pages).**

Mughal, M.O.; Li, X.X.; Norford, L. K., (2020). Urban heat island mitigation in Singapore: evaluation using WRF/multilayer urban canopy model and local climate zones. Urban Climate, 34: 100714 **(1 page).**

Oke, T.R.; Johnson, G.T.; Steyn, D.G.; Watson, I.D., (1991). Simulation of surface urban heat islands under 'ideal'conditions at night part 2: Diagnosis of causation. Bound-Lay. Meteorol., 56: 339-358 **(20 pages).**

Pezzuto, C.C.; Alchapar, N.L.; Correa, E. N., (2022). Urban cooling technologies potential in high and low buildings densities. Solar Energy Adv., 2: 100022 **(1 page).**

Phelan, P.E.; Kaloush, K.; Miner, M.; Golden, J.; Phelan, B.; Silva III, H.; Taylor, R.A., (2015). Urban heat island: mechanisms, implications, and possible remedies. Ann. Rev. Env.Resour., 40: 285-307 **(23 pages).**

Rehan, R. M., (2016). Cool city as a sustainable example of heat island management case study of the coolest city in the world. HBRC J., 12(2): 191-204 **(14 pages).**

Roth, M.; Oke, T.R.; Emery, W.J., (1989). Satellite-derived urban heat islands from three coastal cities and the utilization of such data in urban climatology. Int. J. Remote Sens., 10(11): 1699-1720 **(22 pages).**

Sabrin, S.; Zech, W.C.; Nazari, R.; Karimi, M., (2021). Understanding

occupational heat exposure in the United States and proposing a quantifying stress index. Int. Arch. Occ. Env. Hea., 94(8): 1983-2000 **(18 pages).**

Sharp, R.; Douglass, J.; Wolny, S.; Arkema, K.; Bernhardt, J.; Bierbower, W.; Chaumont, N.; Denu, D.; Fisher, D.; Glowinski, K.; Griffin, R., (2020). InVEST 3.8.7. post12+ug.gbcad34f , user's guide. The Natural Capital Project, Stanford University. The Nature Conservancy **(308 pages).**

Tsoka, S.; Tsikaloudaki, K.; Theodosiou, T.; Bikas, D., (2020). Urban warming and cities' microclimates: investigation methods and mitigation strategies-a review. Energies, 13(6): 1414**(1 page).**

United Nations, Department of Economic, Social Affairs, Population Division., (2019). World urbanization prospects: the 2018 revision (ST/ESA/SER.A/420). New York: United Nations **(126 pages).**

USGS Landsat User Services., (2016). Landsat 8 (L8) data users handbook. Department of the Interior U.S. Geological Survey **(106 pages).**

Voogt, J.A.; Oke, T.R., (2003). Thermal remote sensing of urban climates. Remote sens. Envir., 86(3): 370-384 **(14 pages).**

Wang, W.; Yao, X.; Shu, J., (2020). Air advection induced differences between canopy and surface heat islands. Sci. Total Envir., 725: 138120 **(1 page).**

Wei, C.; Chen, W.; Lu, Y.; Blaschke, T.; Peng, J.; Xue, D., (2021). Synergies between urban heat island and urban heat wave effects in 9 global mega-regions from 2003 to 2020. Remote Sens., 14(1): 70 **(1 page).**

Yan, L.; Jia, W.; Zhao, S., (2021). The cooling effect of urban green spaces in metacities: a case study of Beijing, China's capital. Remote Sens., 13(22): 4601 **(1 page).**

Zarandi, S.M.; Shahsavani, A.; Nasiri, R.; Pradhan, B., (2021). A hybrid model of environmental impact assessment of PM 2.5 concentration using multi-criteria decision-making (MCDM) and geographical information system (GIS)—a case study. Arab. J. Geosci., 14: 1-20 **(20 pages).**

Zardo, L.; Geneletti, D.; Pérez-Soba, M.; Van Eupen, M., (2017). Estimating the cooling capacity of green infrastructures to support urban planning. Ecosyst. Serv., 26: 225-235 **(11 pages).**

Zhou, D.; Xiao, J.; Bonafoni, S.; Berger, C.; Deilami, K.; Zhou, Y.; Frolking, S.; Yao, R.; Qiao, Z.; Sobrino, J. A., (2018). Satellite remote sensing of surface urban heat islands: Progress, challenges, and perspectives. Remote Sens., 11(1): 48 **(1 page).**

Zhou, W.; Wang, J.; Qian, Y.; Pickett, S.T.; Li, W.; Han, L., (2018). The rapid but "invisible" changes in urban greenspace: a comparative study of nine Chinese cities. Sci. Total Environ., 627: 1572-1584 **(13 pages).**

Zhu, Z.; Zhou, D.; Wang, Y.; Ma, D.; Meng, X., (2021). Assessment of urban surface and canopy cooling strategies in high-rise residential communities. J. Clean. Prod., 288: 125599 **(1 page).**

HOW TO CITE THIS ARTICLE

Malekzadeh, S.; Jafari, H. R.; Nazari, R.; Blaschke, T.; Hof, A.; Karimi, M., (2025). Modeling the cooling effect of urban green infrastructures with an ecosystem services approach (case study: Tehran metropolis). Int. J. Hum. Capital. Urban Manage., 10(2): 199-214.

DOI: 10.22034/IJHCUM.2025.02.01

URL: https://www.ijhcum.net/article_716297.html

Int. J. Hum. Capital Urban Manage., 10(2): 215-228, Spring 2025

International Journal of Human Capital in Urban Management
(IJHCUM)

Homepage: http://www.ijhcum.net/

ORIGINAL RESEARCH PAPER

Socio-economic and Geo-Map analysis of the role of reuse and recycling management in reducing daily waste production

A. Ratnadewati[1], E. Gravitiani[1,*], N. Widiastuti[2]

[1] *Faculty of Economic and Business, Universitas Sebelas Maret, Surakarta, Indonesia*

[2] *STIE Widya Wiwaha, Yogyakarta, Indonesia*

ARTICLE INFO

Article History:
Received 15 June 2024
Revised 07 August 2024
Accepted 17 October 2024

Keywords:
Daily waste production
Waste management
Geo-Map Orange data mining
Socio-economic
Spatial analysis

ABSTRACT

BACKGROUND AND OBJECTIVES: Economic growth accompanied by population growth results in various negative externalities, one of which is excessive waste production. Waste conditions that are not handled properly will cause a domino effect on the balance of the ecosystem and environmental health. One of the factors that caused the high rate of waste production is the quality of the population, the existing condition of the community, the population, and environmental management, especially waste. This study looks at the causes of excessive daily waste production from various aspects from the perspective of social, economic, and spatial conditions. Not only that, the management of reduce, reuse, and recycle waste is also taken into account in the decrease in the amount of daily waste production.

METHODS: This study identifies spatial distribution through a Geo-Map literature analysis with Vosviewer. The study also examines the influence of social, economic, and spatial factors and the existence of reduce, reuse, and recycle waste management sites with daily waste production using Ordinary Least Square Regression and 2022 cross-section data in 34 provinces in Indonesia.

FINDINGS: The results showed that variables with a probability value of $\alpha < 0.05$ for urban population, Area Size, and Life Expectancy had a significant positive influence on daily waste production. In contrast, the average length of schooling has a significant negative effect. In addition, there are also variables with a probability value of $\alpha < 0.10$, namely life expectancy and per capita income, which also have a significant positive effect. However, the existence of Reduce, Reuse, and Recycle Waste Management, shown by a probability value of $\alpha > 0.10$, does not show a significant influence on Daily Waste Production. These factors are also reflected in the spatial distribution of the map.

CONCLUSION: It is concluded that the achievement of goal 12 in the Sustainable Development Goals program will be successful if the community is committed to raising awareness of environmental responsibility. Not only that, major adjustments are needed, including the role of reducing, reusing, and recycling waste management toward responsible consumption and production.

DOI: 10.22034/IJHCUM.2025.02.02

NUMBER OF REFERENCES	NUMBER OF FIGURES	NUMBER OF TABLES
38	11	1

*Corresponding Author:
Email: *evigravitiani_fe@staff.uns.ac.id*
Phone: +62 822-2503-4455
ORCID: 0000-0002-7075-6060

Note: Discussion period for this manuscript open until July 1, 2025 on IJHCUM website at the "Show Article.

INTRODUCTION

The global waste issue remains unresolved and could become increasingly worrying due to uncontrolled waste growth (Jadayil *et al*., 2022; Azzahrah *et al*., 2023; Ho *et al*., 2022; Mahendra, 2017). According to a report entitled What a Waste 2.0 published by the World Bank; the world produces about 2.01 billion tons of solid urban waste yearly. Unfortunately, about 33% of the waste is not managed properly and hurts the environment (Edi *et al*., 2022; Noviyanti, 2019; Saefuddin *et al*., 2019). In the same report, the World Bank also projects that the amount of global waste will increase by 70% by 2050, reaching 3.40 billion tons per year (Kastolani *et al*., 2022; Nouri *et al*., 2021). This is due to rapid urbanization, population growth, and rapid economic development (Kazmi & Chakraborty, 2023). Policies on waste management are also included in the discussion of the United Nations through its sustainable development program, commonly called the 17 (SDGs) (Gricar *et al*., 2023; Petrova, 2023; Retnowati *et al*., 2023). Discussions related to waste are included in the 12th goal of the SDGs, namely responsible production and consumption. To achieve economic growth and sustainable development, communities must realize how important it is to reduce their ecological footprint through changes in the way they produce, consume food, and manage other resources, and waste management is no exception (Imran *et al*., 2024). World Bank data entitled The Atlas of SDGs 2023 states that Indonesia was the 5th largest waste-producing country in the world in 2020, amounting to 65.2 million tons of waste (Bigwanto *et al*., 2024). This is one of the urgent needs that must get special attention from the government. The National Waste Management Information System said that the amount of waste generated in Indonesia fluctuates and tends to increase from 2019 to 2023, as shown in Fig. 1.

The amount of waste produced in 2019 reached 16 million tons of waste every year and increased to 19 million tons of waste in 2020, the highest amount in the last five years. In 2021, the amount of waste in Indonesia was successfully reduced to 13 million tons due to the COVID-19 pandemic. This condition caused several industries to be closed so that waste from production activities was significantly reduced (Krisdhianto *et al*., 2023). However, this did not last long. In 2022, when the COVID-19 pandemic began to subside, waste generation increased to 18 million tons and remained at that number until 2023. These results are also measured through an increase in Daily Waste Production, which is the total amount of waste produced every day for a certain time. Research by Krisdhianto *et al*., (2023) states that the cause of the increase in daily waste production in Indonesia is social and economic factors. The intended social factor consists of several aspects, including the average length of schooling and life expectancy. In contrast, the intended economic factor is the per capita expenditure of the population of an area. Another case is the results of Elyasa (2019), which

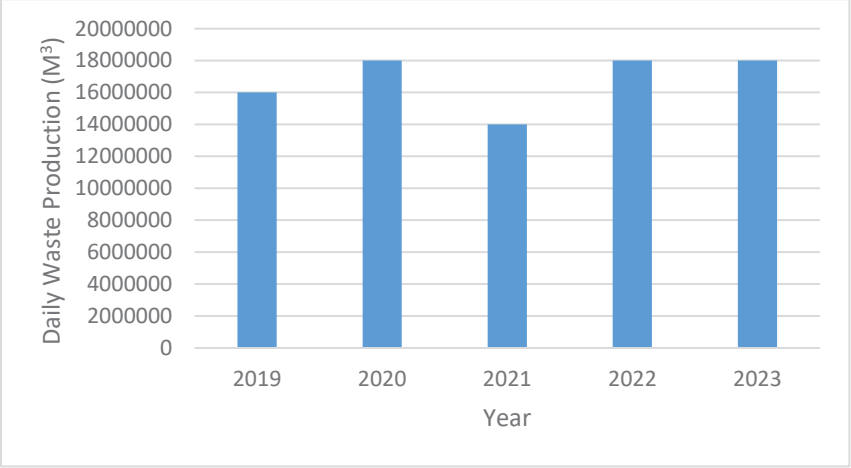


Fig.1: Total waste generation in Indonesia from 2019 to 2023 (Source: Indonesia Waste Management Information System, 2024)

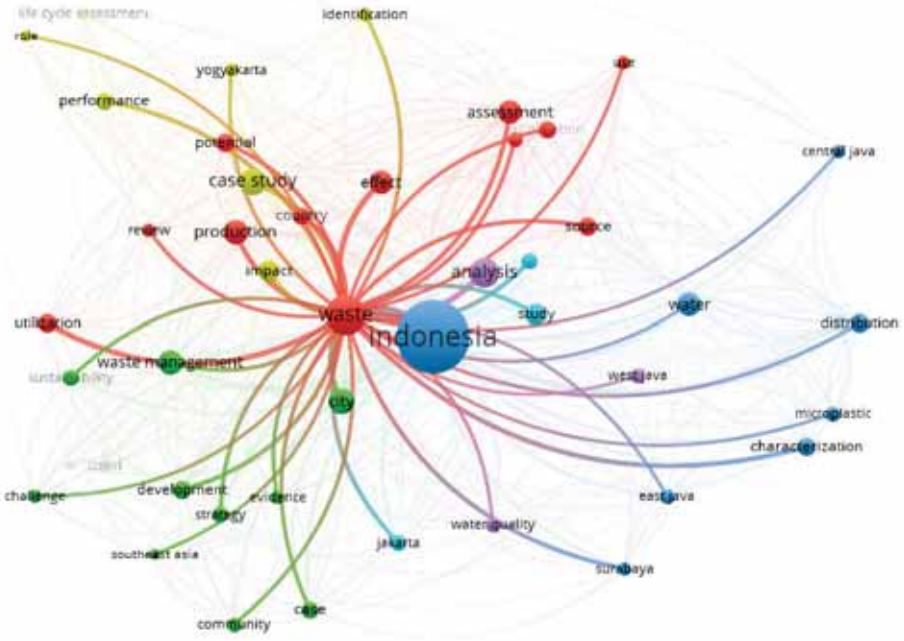


Fig.2: Research and waste generation

state that the number of urban residents is a dominant contributor to the amount of total waste produced. Not only that, but the area also contributes to the amount of daily waste generation. This condition causes the government, through stakeholders and non-governmental organizations, to launch solutions to reduce the amount of waste in Indonesia with the implementation of the Reduce-Reuse-Recycle Waste Management (3RWM) (*Saputra et al., 2024*). 3RWM is a strategy used to manage waste at the communal or regional level, involving active participation from the government and community, with a focus on community empowerment. The program aims to reduce the amount of waste generated to achieve environmental improvement through responsible production and consumption following the 12th goal of SDGs (Stanković *et al*., 2024). The study by Lawa *et al*., (2021) states that 3RWM has not been able to reduce the waste generated due to limited resources and the existence of 3RWM, which is not evenly distributed in each region. This fact is reinforced by data from the Ministry of Environment and Forestry in 2023, namely that the majority of 3RWM is at the sub-district level and not all sub-districts have it (Mustikasari, 2021).

Research on waste generation has been carried out in the last five years, namely, 2019–2024. The majority of research is carried out in major cities in Indonesia, such as Jakarta, Surabaya, Yogyakarta, and cities in Central Java Province, as shown in Fig. 2. However, research related to waste generation and waste management, specifically 3RWM, human development index, and spatial analysis through geographic information, has not been widely carried out, especially in the period 2019-2024, as shown in Fig. 3.

Therefore, this study aims to analyze the influence of social factors, namely average length of schooling and life expectancy, economic factors shown by per capita expenditure, spatial factors in the form of area and number of urban population, and the existence of the number of 3RWM on the amount of daily waste production in 34 provinces in Indonesia (Azzahrah *et al*., 2023). The method used is a mixed method with ordinary least square regression analysis and mapping geographic information using the Geo-Map

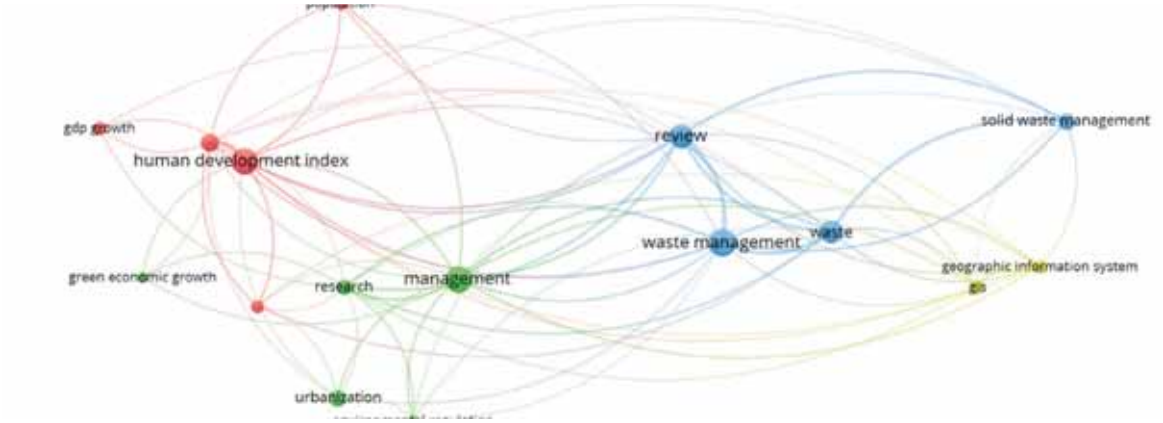


Fig.3: Research on waste generation related to social, economic, and spatial factors.

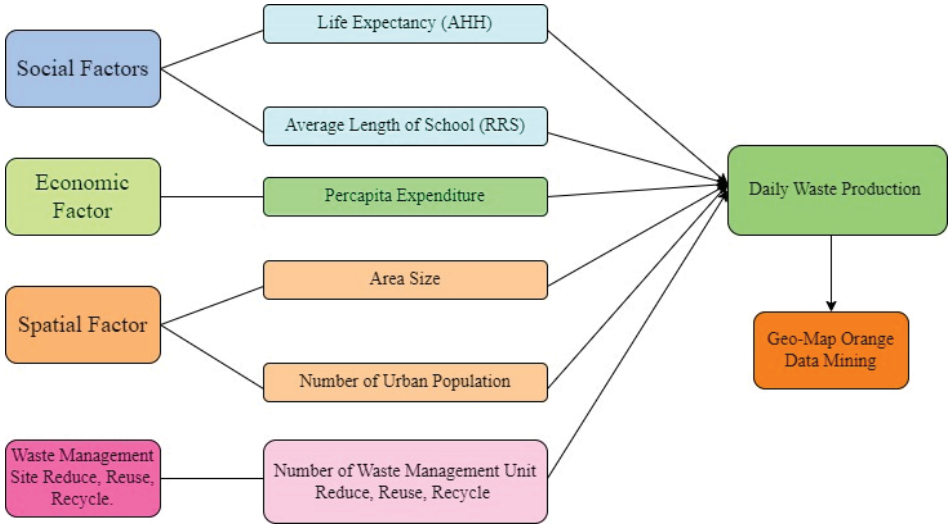


Fig. 4: Research concept

orange data mining tool, which can be seen in the frame of mind in Fig. 4 (*Udin, 2024*). This study is aimed at determining the influence of social factors, economic factors, spatial factors, and the existence of 3RWM on daily waste production in 34 provinces in Indonesia with the last most complete data available, namely in 2022.

MATERIALS AND METHODS

Research type and design

This research uses a mixed method, namely quantitative methods through Ordinary Least Square (OLS) regression, and qualitative elaboration methods, namely mapping using Geo-Map orange data mining. OLS regression is a statistical method used to model the relationship between the dependent variable, which is the variable you want to predict, and one or more independent variables, which are used to predict the dependent variable. The approach is commonly used in statistical analysis (Ariska *et al.*, 2023). OLS regression in this study was used to help analyze the relationship between the dependent variable and the independent variable. The data used is cross-section data from as many as 34 provinces in Indonesia in 2022. The year was chosen based on the latest complete data justification held by the

Indonesian Central Bureau of Statistics before the provinces in Indonesia were divided into 38 provinces. This study used six independent variables, namely per capita expenditure, life expectancy, average length of schooling, number of urban populations, area, and number of 3RWM. At the same time, the dependent variable used is the amount of daily waste production.

Model and Specification

The regression model used in this study is as follows:

$$lnpsh = \alpha + \beta_1 lnpk_1 + \beta_2 lnahh_2 + \beta_3 lnrrls_3 + \beta_4 lnjppk_4 + \beta_5 lnwl_5 + \beta_6 TPS3R_6 + \varepsilon \quad (1)$$

Where =

$lnpsh$ = Daily Waste Production (M^3)
$lnpk$ = per capita expenditure (million rupiah)
$lnrrls$ = Average Length of School (years)
$lnahh$ = Life expectancy (years)
$lnjppk$ = total urban population (million)
$lnwl$ = area per province (m^2)
$TPS3R$ = Number of Waste Management Sites Reduce, Reuse, Recycle (Units)

Spatial analysis: Geo-Map Orange data mining

Spatial analysis is the process of describing and analyzing data that has a geographical position reference (Wyszkowski *et al*., 2023). This study uses the Geo-Map Orange data Mining tool by analyzing latitude and provincial longitude references with criteria according to the variables used (Mahmoudzadeh *et al*., 2024). This is included in the analysis of Geographic Information Systems (GIS), which is a technology that is useful for collecting, storing, managing, analyzing, and visualizing data that has spatial elements.

RESULTS AND DISCUSSION

The amount of daily waste production in Indonesia in 34 provinces in 2022 tends to decrease compared to the previous year. However, the amount of production is not evenly distributed in each province. This can be seen from the results of the mapping analysis using Geo-Map Orange data Mining, which is shown in Fig. 5.

Fig. 5 shows that the majority of areas with high daily waste production in Indonesia are provinces located on the islands of Java, Kalimantan, and Sumatra. The highest amount is in Central Java Province, with total daily waste production reaching 5600.88 m^3 of waste. The area is marked with a yellow dot, while the bright blue dot is an area with total daily waste production reaching 1000-2000 m^3. These areas are South Sumatra, East Java, West Kalimantan,

Fig.5: Map of daily waste production in Indonesia

Central Kalimantan, and South Sulawesi. The majority of waste produced is household waste and waste from the industrial sector. Factors causing the increase in daily waste production also vary, including Socio-economic Factors, Spatial Factors, and the existence of related institutions such as Waste Management Sites, Reduce, Reuse, and Recycle (Almagharb, *2024*). Testing variables that affect daily waste production in Indonesia were tested using cross-section data consisting of 34 provinces in Indonesia in 2022 with six independent variables. The data were then tested using OLS regression, with the results shown in Table 1.

The regression results obtained are displayed in the equation as follows:

$$lnpsh = 12.33 + 0,575lnpk_1 + 10.740lnahh_2 - 5.199lnrrls_3 + 0.688lnjppk_4 + 0.420lnwl_5 - 0.002TPS3R_6 + \varepsilon \quad (2)$$

Table 1 explains that daily waste production in 34 provinces in Indonesia is influenced by several factors: Life Expectancy, Average Length of School, Per Capita Expenditure, Area, and Number of Urban Population. This can be seen from the probability value of each variable, which is not greater than 5% and 10%. However, in the 3RWM variable, it can be seen that the probability value of more than 5% shows the result that 3RWM has no effect, especially for daily waste production in Indonesia. The value of the life expectancy variable coefficient of 10.74 shows that if the life expectancy of the community increases by 1%, the daily waste production will increase by 10.7%. Life expectancy is one of the components used to calculate the human development index (Hasanah, 2021). This indicates that life expectancy has a significant positive effect on daily waste production (Janah *et al.*, 2019). High life expectancy will affect individual productivity. Every individual who can still carry out activities will produce a higher amount of waste. This assumption is supported by research by Purwita *et al.,* (2022), which states that a person's age influences productivity. If someone has a long life supported by a strong body and soul, it will increase the value of productivity. Every activity carried out by humans will cause residues or negative externalities, namely in the form of waste (Koeshendrajana *et al.*, 2017). This fact is also reinforced by mapping analysis through Geo-Map Orange data Mining that can be seen in Fig. 6, which shows that areas with yellow dots have a high life expectancy. Most of these areas are on the island of Java, one of which is the Central Java Province, which also produces daily waste.

The next influential variable is the average length of schooling. Every increase in the average length of schooling in an area will reduce daily waste production by 5.2%. The average length of schooling refers to the number of years spent by individuals completing their formal education. This life expectancy is calculated based on residents aged 25 years and over, assuming that by the age of 25, the education process has been completed (Syabrina & Mustika, 2021). The higher the average length of schooling in a region, the higher the level of literacy related to environmental concerns (Lagis & Matthew, 2023) . So, the community will be more concerned and wise in managing waste. The negative correlation between the average length of schooling and daily waste production is supported by spatial analysis, which can be seen in Fig. 5 and Fig. 7. The Latter shows that areas with younger dot colors signify that they have a higher average level of the length of schooling. As seen in the Yogyakarta Special Region Province, which has an average school rate of 11 years, and Central Java Province, with an average school length of 9 years, in the Yogyakarta Special Region Province, the amount of daily waste production is lower than in Central Java Province.

The third variable that affects daily waste production in Indonesia is per capita expenditure.

Table 1: OLS regression result

Variable	Coefficient	Probability
LnAHH	10.740	0.0869*
LnRRLS	-5.199	0.0128
LnPK	0,575	0.0653*
LnWL	0.420	0.0304
LnJPPK	0.688	0.0040
3RWM	-0.002	0.5526
Adj R-Squared	0.543	

Fig. 6**:** Map of life expectancy in Indonesia

Fig. 7**:** Map of the average length of schools in Indonesia

The value of the variable coefficient is 0.57, indicating that if per capita expenditure increases by 1%, it will increase daily waste production by 0.57%. Per capita expenditure is one aspect that can be used as an indicator of a region's economy. Areas with high per capita expenditure will generally have a high level of population productivity. The intended productivity is the productivity of human resources both in the industrial and industrial sectors. It also has an impact on the surrounding ecosystem, namely negative externalities in the form of daily waste production (Hasanah, 2021). The spatial analysis used in this study also supports the results of OLS regression, which can be seen in Fig. 5 and Fig. 8.

The next factor that affects daily waste production in Indonesia is the spatial factor, namely the area. Area and population, especially urban residents, are closely related to the amount of daily waste production. Urban residents are considered to play a more crucial role as producers of daily waste because the majority of households and industries are in urban areas. This can be seen from the value of the area coefficient of 0.42 and the population coefficient of 0.69. This Figure shows that if an area is 1% larger than the area of other areas, the amount of daily waste production will increase by 0.42%.

In comparison, if the population in the area increases by 1%, it will cause an increase in daily waste production by 0.69%. This fact is following research conducted by Mustikasari (2021), which says that the population and area affect population density, so the resulting side effect is that the denser the population, the higher the waste production. Areas with a large area will have the opportunity to become industrial and residential land (Krisdhianto *et al*., 2023). The analysis then continues with the substantiation of spatial data in the form of mapping, as shown in Fig. 9 and Fig. 10.

Fig. 9 shows that the majority of provinces with a large area are on the island of Kalimantan, namely West Kalimantan and Central Kalimantan. Both provinces produce fairly high amounts of daily waste, as shown in Fig. 5. Still, when viewed from the number of urban residents in Fig. 10, the two provinces are not provinces with high urban populations. According to Ziaulhaq (2022), the majority of waste in the region is not waste from households but comes from industry and

Fig. 8: Map of per capita expenditure in Indonesia

Fig. 9**:** Map of area size in Indonesia

Fig. 10**:** Map of urban population in Indonesia

Fig. 11: Map of the number of 3RWM in Indonesia

plantations, namely oil palm. Another thing is in Fig. 10, which shows that the provinces of West Java, DKI Jakarta, Central Java, and East Java have a high urban population. This amount results in high daily waste production due to community activities. The majority of these provinces are centers of education, offices, and trade, so the population density is high (Mardiansjah, 2018). The government has implemented various solutions to solve the problem of waste generation in Indonesia. One of them is through the 3RWM Site program. 3RWM is a location that receives waste from WPS as well as from households and industries (Clasissa Aulia *et al*., 2021; Nopriani *et al*., 2022; Norken & Harmayani, 2019). The waste is processed to reduce the amount or improve its properties so that only the remnants of waste are then disposed of in the Landfill. The program is a government initiation program that is upstream to downstream and has a joint commitment with the community to realize balance as a form of environmental responsibility (Aziz *et al*., 2021). However, the implementation of 3RWM in reducing waste produced by the community is considered not effective enough. This argument is strengthened by the results of OLS regression in this study; namely, the probability value in the 3RWM variable is more than 10%. Research conducted by (Kurniawan *et al*., 2020) showed that the role of 3RWM has not been effective in reducing waste, especially waste produced by households. Several things cause this condition; namely, there has been no synergy between the community and the government, and facilities are in the form of tools and places that are less crowded. A similar study conducted by Purwita *et al*., (2022) in Kulon Progo, Special Region of Yogyakarta, also said that 3RWM could not be implemented optimally because the comparison of the calculation of TPS 3R land area with waste management area did not follow the criteria of Minister of Public Works No. 03 of 2013. Another thing with Herningrum (Herningrum *et al*., 2022) is that there is a slight difference between 3RWM managed by the government and non-government. The difference lies in the uneven aspects of education related to waste management and the lack of adequate facilities. In addition to infrastructure and human resources, the number

of 3RWM in Indonesia is also not evenly distributed in each province in Indonesia, as shown in Fig. 11.

The majority of areas that have a high number of 3RWM are in Java. This is by areas that have a high amount of waste production. However, in some areas, a high amount of daily waste production is not comparable to the number of 3RWM units provided. Thus, the uneven amount of 3RWM is also one of the causes of unhandled daily waste production.

CONCLUSION

The existence of 3RWM sites in Indonesia is considered unable to reduce the amount of daily waste production. This is due to the lack of synergy between Human Resources (HR) related to the government, facilities that have not been met, and the uneven distribution of 3RWM units in Indonesia. In addition, the amount of daily waste production in Indonesia has a significant positive effect on social factors, namely life expectancy, economic factors represented by per capita expenditure, and spatial factors consisting of area and population. Other social factors, namely the average length of schooling, have a significant negative effect on daily waste production. Therefore, ongoing training and mentoring are needed for the community to be able to make good use of waste at each 3RWM. This aims to improve the management, productivity, and marketing of existing 3RWM production products. Assistance is needed to develop human resources and maintain equipment facilities. The government should also facilitate the socialization of the implementation of community-based waste management, including the provision of facilities, infrastructure, and comparative study opportunities to areas that have succeeded in waste management.

AUTHOR CONTRIBUTIONS

A. Ratnadewati performed data processing and interpretation. E. Gravitiani performed in writing and searching literature. N. Widiastuti performed data interpretation and proofreading.

ACKNOWLEDGEMENT

The authors express gratitude and appreciation to the editor for the opportunity given. In addition, the author also expressed gratitude to the parties involved in writing.

CONFLICT OF INTEREST

The authors declare no potential conflict of interest regarding the publication of this work. In addition, the authors have witnessed ethical issues, including plagiarism, informed consent, misconduct, data fabrication or falsification, double publication and submission, and complete redundancy.

ABBREVIATIONS (NOMENCLATURE)

M^3	Cubic meters
M^2	Square Meters
GIS	Geographic Information Systems
HR	Human Resources
OLS	Ordinary Least Square
3RWM	Reduce-Reuse-Recycle Waste Management
SDGs	Sustainable Development Goals
WPS	Waste Processing Sites

REFERENCES

Abu Jadayil.; W., Qureshi, M. R. N. M.; Ajaj, R.; Aqil, E.; Shawahin, G.; Anver, H.; Aljeawi, S. (2022). An Empirical Investigation on Plastic Waste Issues and Plastic Disposal Strategies to Protect the Environment: A UAE Perspective. Sustainability (Switzerland)., 14(24): 1-22 **(22 pages)**

Almagharbeh, B. K. (2024). The effect of human resource agility on organizational sustainability: Structural equation modeling approach., Int. J. Hum. Capital Urban Manage., 9(1): 177–188 **(11 pages)**

Ariska, A.; Nihayatul Rohmah, A.; Eko Sujianto, A. (2023). Pengaruh Inflasi dan Nilai Tukar (Kurs) Terhadap Pembiayaan Mudharabah Pada Perbankan Syariah di Indonesia. CiDEA Journal., 2(1): 1–12 **(12 pages).**

Aziz, R.; Ruslinda, Y.; Yeni, Y. S.; Dewilda, Y. (2021). Solid Waste Management System Model of Village Tourism Area of Nagari Tuo Pariangan, Indonesia. IOP Conf. Series: Materials Science and Engineering., 1041(1): 012030 **(8 pages)**

Azzahrah, S.; Hastuti, S. H.; Azzahrah, S.; Hastuti, S. H.; Hartono, D.; Moghaddasi, R.; Mohamadinejad, A. (2023). Economic, Social , and Environment Impact of Renewable Energy Investment : Empirical Study of Indonesia., Int.Energy Journal., 23: 55–70 **(16 pages)**

Bigwanto, A.; Widayati, N.; Wibowo, M. A.; Sari, E. M. (2024). Lean Construction: A Sustainability Operation for Government Projects. Sustainability (Switzerland)., 16(8): 1–16 **(16 pages)**

Clasissa Aulia, D.; Kiswanto Situmorang, H.; Fauzy Habiby Prasetya, A.; Fadilla, A.; Safira Nisa, A.; Khoirunnisa, A.; Farhan, D.; Nur, D.; Nindya, aini; Purwantari, H.; Octaviani Dwi Jasmin, I.; Aulia Akbar, J.; Mesrina Cicionta Ginting, N. B.; Fadhilah Lubis, R.; Peningkatan Pengetahuan dan Kesadaran Masyarakat tentang Pengelolaan Sampah dengan Pesan Jepapah (2021). Jurnal Pengabdian Kesehatan Masyarakat (Pengmaskesmas)., 1(1): 62–70 **(8 pages)**

Destiana Purwita, L.; Sari, E. K.; Tirtaweningtyas, S.; Widiarko, P.; Ramadhan, W.; (2022). Proyeksi Pertumbuhan Penduduk dan Kebutuhan Fasilitas Persampahan di Kecamatan Baturaja Timur Kabupaten OKU Projected Population Growth and Waste Facility Needs in Baturaja Timur District, OKU Regency. UEEJ-Unbara Environ. Engineerin. Journal., 03(01): 1-12 **(12 pages)**

Elyasa, M. D. (2019). Analisis Pengaruh Nilai Ipm Dan Jumlah Penduduk Terhadap Timbunan Sampah Di Tpa Se-Provinsi Kepulauan Bangka Belitung: Sebuah Studi Pendahuluan. Jurnal Green Growth dan Manajemen Lingkungan., 8(1): 1–8 **(8 pages)**

Gricar, S.; Šugar, V.; Starc, J. (2023). Interrelationships among Tourism, Economic, and Environmental Time Series—The Case of Slovenia. Sustainability (Switzerland)., 15(19): 1-20 **(20 pages)**

Hasanah, R. (2021). Pengaruh Angka Harapan Hidup, Rata-Rata Lama Sekolah Dan Pengeluaran Perkapita Terhadap Tingkat Kemiskinan Pada Kabupaten / Kota Di Provinsi Jambi. e-Journal Perspektif Ekonomi dan Pembangunan Daerah., 10(3): 223–232 **(10 pages)**

Herningrum, E. G. A. Sunariya, M.I.T.; (2022). Analisis Keefektifitasan Tempat Pengelolaan Sampah Reduce, Reuse, Recycle (TPS3R) Dalam Upaya Mengatasi Sampah Rumah Tangga Di Kota Bekasi Universitas Muhammadiya Surakarta, 1-14**(14 pages)**

Ho, B. Q.; Vu, K.; Nguyen, T.; Le, Q.; Rakholia, R.; Carbajo, R. S. (2022). The Emissions and Measures in Greenhouse Gases Management for Climate Change Mitigation in Developing Countries: A Case of Ho Chi Minh City, Vietnam. International Journal of Environmental Science and Development, Int. J of Environmental Science and Development1., 3(6): 257–263 **(7 pages)**

Imran, M.; Khan, M. K.; Alam, S.; Wahab, S.; Tufail, M. (2024). The implications of the ecological footprint and renewable energy usage on the financial stability of South Asian countries. Financial Innovation., 10 (1): 1–23 **(23 pages)**

Janah, E. Z., Handajani, S. S., Susanti, Y. (2019). Spatial Autoregressive Model Untuk Angka Harapan Hidup Spatial Autoregressive Model For Life Expectancy In Central Java. The 9 th University Research Colloqium 2019 Universitas Muhammadiyah Purworejo., 1(1): 105–113 **(9 pages)**

Kastolani, W.; Warlina, L.; Luckyardi, S.; Oktafiani, D.; Meyer, D. F. (2022). Improving Local Economy Through Integrated Waste Management in Bandung City, Indonesia (Case Study of Sukasari District). J. of Eastern European and Central Asian Research., 9(5): 874–888 **(14 pages)**

Kazmi, R.; Chakraborty, M. (2023). Identification of parameters and indicators for implementing circularity in the construction industry. J. of Engineering and Applied Science., 70(1): 1–27 **(27 pages)**

Koeshendrajana, S.; Wijaya, R. A.; Priyatna, F. N.; Martosuyono, P.; Sukimin, S. (2017). Kajian Eksternalitas Dan Keberlanjutan Perikanan Di Perairan Waduk Jatiluhur. Jurnal Sosial Ekonomi Kelautan Dan Perikanan., 4(2): 137- 156 **(20 pages)**

Krisdhianto, A.; Muyasaroh, S.; Defriatno, M. E.; Sumberagung, D., Pesanggaran, K., Pengolahan, P., Merah, P. (2023). JURNAL BIOSENSE., Analisis Timbulan, Komposisidan Potensi Pengolahan Sampah Kawasan Wisata Pantai Pulau Merah Banyuwangi. J. Biosense., 6(1): 60–72 **(13 pages)**

Abdillah, M.R; Kurniawan, B. (2020). Implementasi Pengelolaan Sampah Berbasis Masyarakat Di Tempat

Pengolahan Sampah Reduce-Reuse-Recycle Lestari Rahayu Desa Karanganyar Kecamatan Gandusari Kabupaten Trenggalek Periode 2019-2020. e-journal unesa., 12(1): 119–134 **(15 pages)**

Lagis, M. A.; Matthew, N. K. (2023). Residents' Willingness To Pay For Healthcare Waste Management Services Fee In Malaysia. J. of Sustain. Science and Management., 18(1): 133–162 **(30 pages)**

Lawa, J. I. J.; Mangangka, I. R.; Riogilang, H.; Belakang, A. L. (2021). Perencanaan Tempat Pengolahan Sampah (TPS) 3R Di Kecamatan Mapanget Kota Manado. TEKNO., 19: 77–89 **(13 pages)**

Mahendra, A. (2017). Analisis Faktor-faktor yang Mempengaruhi Fertilitas di Indonesia. Jurnal Riset Akuntansi & Keuangan., 3(2): 223–242 **(19 pages)**

Mahmoudzadeh, H.; Abedini, A.; Aram, F.; Mosavi, A. (2024). Evaluating urban environmental quality using multi criteria decision making. Heliyon., 10(3): 1-19 **(19 pages)**

Mardiansjah, F. H. (2018). Pertumbuhan Penduduk Perkotaan dan Perkembangan Pola Distribusinya pada Kawasan Metropolitan Surakarta., 6(3): 215–233 **(19 pages)**.

Mustikasari, S. D.; Surabaya, U. N. (2021). Pengaruh Kepadatan Penduduk Terhadap Timbulan Sampah Masyarakat Kecamatan Bojonegoro Kabupaten Bojonegoro Tahun 2017-2020 **(4 pages)**

Nopriani, M.; Fauzi, A. (2022) A Prospective Analysis For Tps 3r Sustainability In Pangkalpinang City. Jurnal Ekonomi Dan Bisnis., 11(1): 1281- 1296 **(15 pages)**

Norken, I. N., & Harmayani, K. D. (2019). Analisis Risiko Pembangunan Dan Pengelolaan Tps 3r (Reduce , Reuse , Recycle) Di Kota Denpasar (Studi Kasus Tps 3r Desa Sanur Kauh) Journal Harian Regional 7(2): 232–243 **(11 pages)**

Nouri, Z. S.; Nouri, J.; Habib, F.; Rafian, M (2021). Environmental management for urban development around river valleys using a conceptual model. Int. J. of Hum. Capital in Urban Management., 6(4): 351–364 **(14 pages)**

Noviyanti, I. K. (2019). Pembuatan Peta Zona Nilai Ekonomi Kawasan Pantai Parangtritis Dan Pantai Kuwaru, Yogyakarta. Seminar Nasional Geomatika., 3: 491-496 **(5 pages)**

Swastika, U.S.; Arifin, Z. (2023). Pengaruh Rata-Rata Lama Sekolah, Umur Harapan Hidup, dan Pengeluaran Perkapita Terhadap Pertumbuhan Ekonomi DKI Jakarta., Jurnal Ilmu Ekonomi., 7(3): 449– 464 **(16 pages).**

Petrova, Y. A. (2023). Ecological Intelligence And Youth Value Orientations Towards Innovation In Achieving Sustainable Development Goals. Int. J. of Hum. Capital in Urban Management., 8(2): 291–302 **(12 pages)**.

Retnowati, R., Dewi, I. K., Istiana, R., Puspita, E. (2023). Environmental Responsibility through the Effectiveness of Community Activities in Supporting Sustainable Development Goal Programs. Environ. and Ecology Research 11(6): 904–921 **(18 pages)**.

Saefuddin, A., Mangku, I. W., Siregar, H. (2019). Analisis Kemiskinan menggunakan Model Panel Spasial Statik. MIMBAR., 29(2): 195–203 **(9 pages).**

A.R.P. Saputra. W. Widarta, I. Iswiyanto. (2024).The impact of green training, green reward, and green recruitment on organizational citizenship behavior for environment. Int. J. of Hum. Capital in Urban Management., 9(1): 75–84. **(9 pages)**

Stanković, S., Ilić, B., Rabrenović, M. (2024). Using the Composite EEPSE Green Economy Index to Assess the Progress of Emerging Economies in Achieving the Sustainable Development Goals. Problemy Ekorozwoju., 19(1):78–88 **(9 pages)**

Syabrina, N. P., Mustika, C. (2021). Pengaruh Pertumbuhan Ekonomi, Rata-Rata Lama Sekolah Dan Tingkat Pengangguran Terhadap Tingkat Kemiskinan Di Provinsi Jambi. e-Jurnal Perspektif Ekonomi dan Pembangunan Daerah., 10(1):1–10 **(10 pages)**

Udin, U. (2024). Leadership styles and their associated outcomes: A bibliometric review using VOSviewer. Int. J. of Hum. Capital in Urban Management 8(4): 443–456 **(13 pages)**

Wyszkowski, A., Prus, P., Pawlik, A., Maitah, M. (2023). Zero Waste as a Determinant of Shaping Green Economy Processes on the Example of Communes of Eastern Poland in 2010–2020. Energies 16: 19 **(24 pages)**

Ziaulhaq, W. (2022). Keberadaan Industri Kelapa Sawit terhadap Lingkungan Masyarakat The Presence of the Palm Oil Industry on the Community Environment. Indonesian J. of Agriculture and Environment Analytics., 1(1): 1–12 **(12 pages)**

HOW TO CITE THIS ARTICLE

Ratnadewati, A.; Gravitiani, E.; Widiastuti, N., (2025). Socio-economic and Geo-Map analysis of the role of reuse and recycling management in reducing daily waste production. Int. J. Hum. Capital Urban Manage., 10(2): 215-228.

DOI: 10.22034/IJHCUM.2025.02.02

URL: https://www.ijhcum.net/article_717014.html

Int. J. Hum. Capital Urban Manage., 10(2): 229-250, Spring 2025

International Journal of Human Capital in Urban Management
(IJHCUM)

Homepage: http://www.ijhcum.net/

ORIGINAL RESEARCH PAPER

A model for measuring the Quality of Work-Life

R. Forouzandeh Joonaghani*, I. Raeesi Vanani, S. A. Hosseini

Faculty of Management and Accounting, Allameh Tabataba'i University, Iran

ARTICLE INFO

Article History:
Received 01 July 2024
Revised October 2024
Accepted 05 November 2024

Keywords:
Happiness
Quality of Work-Life
municipal employees
well-being
welfare

ABSTRACT

BACKGROUND AND OBJECTIVES: The Quality of Work-Life is a dynamic construct shaped by various individual, demographic, occupational, organizational, psychological, and social factors. It encompasses job satisfaction, work-life balance, stress management, participation, engagement, and commitment. This study aims to develop a comprehensive Quality of Work-Life model for the employees in the Tehran municipality through the Lens of Job Demands-Resources theory, which posits that job resources can mitigate job demands and enhance employee well-being. The research assesses the current Quality of Work-Life status within this organizational context.

METHODS: In this study, a sequential qualitative-quantitative mixed method was utilized. The qualitative section employed a systematic review, with its findings informing the hypotheses for the quantitative section. The quantitative segment involved survey methodology, with data analysis conducted using SmartPLS and SPSS software. A hybrid cluster-stratified sampling was used. About 1372 employees sent their answers, and after data cleansing, 1343 answers were analyzed and interpreted.

FINDINGS: The results indicate that Organizational Employer Brand (SM = 0.198, $p < 0.05$), Organizational Work-Life Balance (SM = 0.429, $p < 0.05$), Organizational Psychological Atmosphere (SM =-0.151, $p < 0.05$), Salaries and Benefits (SM = 0.133, $p < 0.05$), and Social aspect- Communication with Coworkers (SM = 0.066, $p < 0.05$) have a significant direct effect on Quality of Work-Life and no direct relationship between Job factors and Quality of Work-Life (SM = 0.074, P= 0.068) between Organizational-Physical Conditions and Quality of Work-Life (SM = 0.029, P= 0.344) and between Social aspect- Communication with Managers and Quality of Work-Life (SM =-0.026, P=0.412). Additionally, it is found that Organizational- Physical Conditions (SM = 0.300, $p < 0.05$), Organizational Work-Life Balance (SM = 0.281, $p < 0.05$), Social aspect- Communication with Coworkers (SM = 0.291, $p < 0.05$), and social aspect- Communication with Managers (SM = 0.209, $p < 0.05$) significantly affect Organizational Psychological Atmosphere and indirect effect on Quality of Work-Life.

CONCLUSION: Findings from the Partial Least Squares - Structural Equation Modeling analysis reveal no direct effect of physical conditions, job factors, or communication with managers on the Quality of Work-Life, although indirect relationships were supported. Direct relationships were noted between psychological atmosphere, communication with coworkers, salary, and benefits, organizational branding, and work-life balance with Quality of Work-Life. According to the Job Demands-Resources theory, this study highlights that resources like organizational branding, psychological atmosphere, work-life balance, and communication significantly enhance the Quality of Work-Life in Tehran municipality, illustrating their essential role in promoting employee well-being.

DOI: 10.22034/IJHCUM.2025.02.03

NUMBER OF REFERENCES	NUMBER OF FIGURES	NUMBER OF TABLES
88	6	11

*Corresponding Author:
Email: *Reyhaneforouzandeh@gmail.com*
Phone: 09192127158
ORCID: 0000-0002-0456-6576

Note: Discussion period for this manuscript open until July 1, 2025 on IJHCUM website at the "Show Article.

INTRODUCTION

The issue of improving the Quality of Work-Life (QWL) within the Tehran municipality has emerged due to several concerns, including a decline in employee satisfaction over recent years, a necessity to enhance employees' happiness levels, which is evidenced by a noticeable decrease in enthusiasm for work within the occupational environment, and a prevailing sentiment that ineffective measures and a lack of corrective actions to enhance QWL have led to employee burnout and turnover, resulting in organizational silence. Consequently, the primary research question aimed at addressing these issues is: What is the appropriate model for measuring the QWL in municipalities? In this research, we intend to design a comprehensive model for measuring the QWL in municipalities, however, as the Tehran Municipality is the largest and most capable municipality in Iran, the model is finally used for evaluating the status of QWL in this municipality. The relationship between humans and technology increasingly focuses on promoting human welfare and redefining productivity. In this article, human resources are crucial in addressing pivotal questions related to organizational practices: How can organizations implement initiatives that enhance employee well-being? What practical strategies should be adopted? How can organizations successfully balance personal and professional responsibilities? How can both organizations and individuals facilitate the advancement of these initiatives? Human resources professionals are essential in designing and implementing QWL initiatives, ensuring a balance between personal and professional responsibilities while fostering a culture of well-being and productivity. A critical approach to addressing these concerns is through the concept of QWL, which encompasses various dimensions, reflecting employees' perceptions regarding financial remuneration, workplace safety, working conditions, interpersonal relationships, and the overall significance of work in their lives (Guest, 1979). This study reviews relevant literature while utilizing JD-R theory as a framework, highlighting the need for QWL models to be tailored to the specific requirements of institutions, such as the Tehran Municipality. The urgency for enhanced QWL has become increasingly evident within the Tehran Municipality, as reflected by declining employee satisfaction in recent years. A notable decrease in employee enthusiasm, a perception of ineffective measures, and a lack of corrective actions have contributed to burnout and turnover. This phenomenon has given rise to 'organizational silence,' where employees refrain from expressing their concerns or ideas due to management's perceived lack of response. Consequently, the primary research question arises: What is the appropriate model for measuring QWL in municipalities? This research aims to design a comprehensive QWL assessment model for Tehran Municipality, Iran's largest and most resourceful municipality. Research indicates that QWL is integral to organizational strategies to enhance productivity and improve the complexities associated with quality of life in a competitive environment (Horst *et al.*, 2014). Effective QWL initiatives are linked to improved employee productivity, job satisfaction, mental health, and reduced burnout. For instance, flexible work hours, wellness programs, and opportunities for skill development have proven successful in many organizations (Parakandi *et al.,* 2016, Abdirahman, 2018). Well-implemented QWL programs also promote greater employee satisfaction, engagement, and overall enthusiasm in the workplace. There is a significant interconnection between QWL initiatives and employee engagement. Individuals who experience higher levels of health and well-being demonstrate increased enthusiasm and cooperation compared to their less fortunate counterparts. Additionally, prioritizing wellness programs is crucial for minimizing turnover, as employees are inclined to seek better working conditions even in challenging job markets (Oosthuizen *et al.*, 2016). Research from the Pew Research Center reveals that factors such as inadequate wages, limited advancement opportunities, and a lack of flexibility substantially contribute to employee turnover (Parker *et al.*, 2022). Moreover, a well-structured QWL program is vital for preventing negative consequences such as depression and burnout, which adversely affect employee motivation (Wang *et al.*, 2019). Evidence suggests that effective wellness programs significantly reduce absenteeism. A meta-analysis comprising over 46 studies demonstrates that such programs encourage healthier employee behaviors, aid in stress management, and contribute to lower absenteeism rates (Parks *et al.,* 2008). Emphasizing physical and mental health within QWL initiatives is critical, as healthy employees exhibit lower risk factors and foster

habits that support overall well-being (Greenhaus *et al*., 2003; Parakandi *et al.,* 2016; Kaya *et al*., 2020). Enhancing QWL and overall employee well-being correlates with increased morale and happiness within the workforce. According to Maslow's Hierarchy of Needs, when employees satisfy their fundamental needs, they are more likely to pursue higher-level needs related to self-esteem and creativity (Bibi *et al*., 2022; Arndt *et al.,* 2015). Ultimately, QWL programs significantly enhance productivity, elevate employee satisfaction and engagement, decrease turnover rates, attract and retain talent, and foster overall job security and safety. To strengthen QWL, organizations should prioritize employees' interests and capabilities, cultivate enjoyment in their work, and provide opportunities for skill development through job enrichment and challenges. Actively involving employees in decision-making processes enhances their sense of autonomy, underscoring the critical role of QWL initiatives (Parakandi *et al*., 2016, Pawar, 2013, Heffernan *et al*., 2016, Ho *et al*., 2020, Haider *et al*., 2018, Soomro *et al*., 2018, Cooper *et al*., 2019, Nielsen *et al*., 2017, Sahni,2019, Kim *et al*2017, Zheng *et al*., 2015, Hayat *et al*., 2002, Emre *et al*., 2021). In summary, this article examines the factors influencing QWL through the lens of JD-R theory, emphasizing the importance of tailored approaches to enhance employee well-being, particularly within the context of the Tehran Municipality. By prioritizing QWL initiatives, organizations can foster a more engaged, motivated, and productive workforce.

QWL

The concept of QWL has undergone significant evolution over time. Before 1970, various measures related to QWL were considered, though they did not explicitly use the term itself. The formal introduction of QWL occurred at the International Labor Relations Summit in 1972, where it was defined as a comprehensive approach concerned with worker well-being and organizational effectiveness. The focus during the 1970s was on humanizing the work environment by establishing joint committees to address workplace issues. By the 1980s, discussions increasingly centered on the idea that QWL derived from work conditions that promote individual growth, taking into account income, benefits, and job satisfaction. In the 2000s, the emphasis shifted toward creating safe and satisfying work environments, leading to the contemporary understanding of QWL as an amalgamation of strategies and practices designed to enhance employee quality of life, a concept that is continually evolving and adapting to the needs of the workforce (Zhang *et al*., 2020; Ko *et al*., 2021; Baquero, 2023). As the concept evolved, it transitioned from focusing on objective criteria, such as employment rates and job security, to a greater emphasis on subjective measures like job satisfaction. This shift, noted by scholars like Henry Mintzberg and Stephen Robbins, underscores the significant role of individual perceptions in QWL assessments (Autrata, 2023; de Jong *et al*.,2015). Today, the dynamic nature of QWL necessitates that organizations implement comprehensive programs addressing objective and subjective factors to optimize employee well-being and satisfaction. The evolution of the QWL concept is illustrated in Fig. 1 (Shinde *et al*., 2022; Ko, 2021; Lee *et al*., 2018).

According to research in the field of QWL programs with multiple goals, various perspectives categorize this concept into four main categories. The first category includes articles that present models, theories, and foundational patterns from scholars such as Robbins, Walton, Griffin, Maslow, McClelland, Herzberg, and Alderfer (Walton,1973 & 1979, Danna & Griffin,1999; Trivedi *et al.*, 2019; McClelland, 2019; Herzberg, 1966; Alderfer, 1972, Emre *et al.*, 2021; Fischer *et al.*, 2022). The second category focuses on examining the outcomes and impacts of these programs, including aspects like productivity, performance, job burnout reduction, job satisfaction enhancement, and increased trust and enthusiasm among employees (Shinde *et al*., 2022; Lawler,1982; Carter,1989; Danna & Griffin,1999; Adhikari *et al.*, 2010; Kanten *et al.,* 2012). The third category investigates the components influencing these programs, such as employee rights and benefits, health and safety measures, participation in decision-making processes, safe working conditions, ergonomics, and job variety (Walton,1973 & 1979, Danna & Griffin,1999; Trivedi *et al*,2019; Sirgy *et al.*, 2001; Adhikari *et al.*, 2010; Kanten *et al.,* 2012; Chan *et al.*, 2007; Babu,2022, Ko,2021; Lee *et al*,2018). Lastly, the fourth category addresses the challenges and obstacles in implementing these programs, highlighting issues like discrepancies between managers' and employees' goals, a lack of problem-solving experience, difficulties in achieving broad

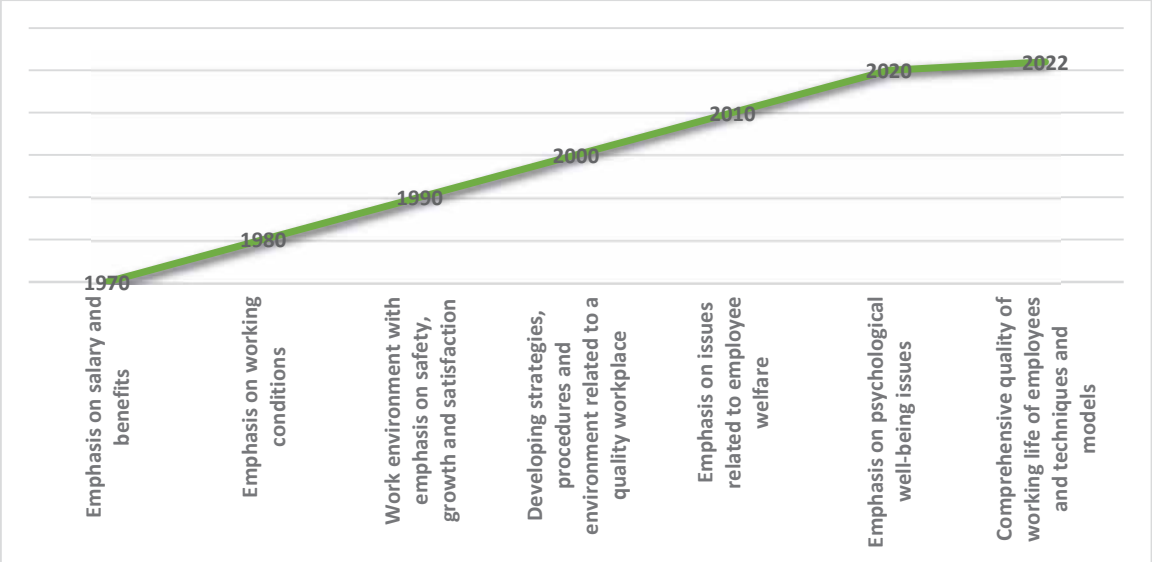


Fig. 1: The evolutionary process of the concept of the QWL of employees

participation, and the inclination of both managers and employees to adhere to traditional management practices (Abdullah *et al.*, 2021; Hsu *et al.*, 2006; Akter *et al.*, 2019; Jayakumar *et al.*, 2019; Gregory *et al*,2009; Majumder *et al.*, 2021; Srivastava *et al.*, 2014; Shinde *et al*., 2022). Based on the discussions during the concept's evolution and the literature review on QWL, it appears that research on QWL with multiple goals has been comprehensive, leading to the identification of distinct categories within the concept. The first category comprises papers that introduce models, theories, and foundational patterns articulated by renowned scholars such as Robbins, Walton, Griffin, Maslow, McClelland, Herzberg, and Alderfer (Walton,1973 & 1979, Danna & Griffin,1999; Trivedi *et al.*, 2019; McClelland, 2019; Herzberg, 1966; Alderfer, 1972, Emre *et al.*, 2021; Fischer *et al.*, 2022). The second category delves into the outcomes and effects of these programs, including productivity, performance, reduction of job burnout, and enhancements in job satisfaction, trust, and enthusiasm (Shinde *et al*.,2022; Lawler,1982; Carter,1989; Danna & Griffin,1999; Adhikari *et al.*, 2010; Kanten *et al*., 2012). The third category explores the components influencing these programs, such as rights and benefits, health and safety, participation in decision-making, safe working conditions, ergonomics, and the variety and richness of jobs (Walton,1973 & 1979, Danna & Griffin, 1999; Trivedi *et al.*, 2019; Sirgy *et al.*, 2001; Adhikari *et al.*,2010; Kanten *et al.*, 2012; Chan *et al.*, 2007; Babu,2022, Ko,2021; Lee *et al.*, 2018). Lastly, the fourth category addresses the obstacles and challenges associated with implementing these programs, providing a comprehensive understanding of the field and strategies for overcoming these hurdles (Abdullah *et al.*,2021; Hsu *et al.*, 2006; Akter *et al.*, 2019; Jayakumar *et al*,2019; Gregory *et al*,2009; Majumder *et al.*,2021; Srivastava *et al.*, 2014; Shinde *et al*., 2022). Perhaps because of the breadth of this concept, it is not easy to address all these categories in a single paper. Therefore, this article focuses on the factors that cause the formation of the QWL program in the organization and examines this concept through the lens of the JD-R theory. QWL is defined in various ways, reflecting diverse perspectives on the issue. Walton identified eight key factors that contribute to QWL, including adequate and fair compensation, safe and healthy working conditions, opportunities for personal and professional growth, job security, social integration within the organization, constitutionalism at work, the interplay between work and quality of life, and the social relevance of work (Walton, 1973 & 1979). Beinum (1974) defined QWL as the degree of excellence achieved through work and working conditions that enhance overall satisfaction

and performance, primarily impacting individuals before influencing organizations (Kumar, 2018). Sirgy *et al.,* (2001) defined QWL as the level of employee satisfaction derived from meeting various needs through workplace resources, activities, and outcomes, identifying seven domains: health and safety, economic and family needs, social needs, esteem needs, actualization needs, knowledge needs, and aesthetic needs. Furthermore, QWL is described as the overall level of satisfaction, motivation, involvement, and commitment that individuals experience concerning their work lives (Srivastava *et al.*, 2014). In this study, according to the reviewed articles and the research objective, the following definition is based on "The QWL is a dynamic process that is influenced by resources such as individual and demographic, occupational, organizational, psychological, social characteristics and work-life balance that results such as job satisfaction, stress management at work, participation, and It affects commitment. In other words, the goal is to reduce job demands and establish a balance between those demands and the available resources, thereby fostering a healthier work environment and enhancing QWL." To determine the range of these resources and measure the concept of QWL, a research survey was conducted in the Municipality of Tehran City, Iran, in 2023.

*Job Demands-Resource (*JD-R*) theory*

The JD-R theory, developed by Bakker and Demerouti in 2001, is a framework that explains how job characteristics influence employee well-being and performance. It categorizes job aspects into two main types. First, job demands: these aspects of the job require sustained effort, such as high workload and time pressure, which can lead to excessive stress and burnout. Second is job resources, these are supportive elements of a job and catalysts for personal growth. They help employees achieve their goals, reduce the impact of demands, and promote personal growth. Examples include social support, autonomy, and development opportunities. The theory posits that balancing job demands and resources determines employee engagement and well-being. When resources are sufficient to meet demands, employees experience higher motivation and job satisfaction. Conversely, high demands with low resources lead to stress and decreased performance. The JD-R theory highlights the importance of fostering a supportive work environment to improve the QWL, enhance engagement, and boost productivity within organizations (Bakker *et al.*, 2014). Collectively, the JD–R theory and model provide an essential framework for organizations aiming for a holistic approach to fostering work engagement and well-being, thereby enhancing QWL (Berthelsen *et al.*, 2018 & Radic *et al.*, 2020). Today, with its seven fundamental tenets (Bakker *et al.*, 2017), the JD-R theory is a vital lens for understanding the QWL. The first tenet, which classifies job characteristics into demands and resources, offers a framework for understanding their contributions to QWL. The second tenet elaborates on how these demands and resources influence health impairment and motivational processes, underscoring their importance in shaping employees' work quality. The third tenet highlights specific work conditions that foster employee flourishing, which is crucial for enhancing QWL. The fourth emphasizes the positive effects of job resources on motivation, particularly under high job demands, which is essential for maintaining work engagement and well-being. The fifth one indicates that personal resources can function similarly to job resources, reinforcing that both significantly improve QWL. The sixth asserts that motivation enhances job performance, while job strain detracts from it, illustrating the direct connection between QWL and productivity. Finally, the seventh tenet posits that motivated employees are more inclined to engage in job crafting behaviors, a hopeful prospect that can boost their job and personal resources and improve their QWL. Finally, as mentioned, through the synthesis of the literature and what we have found through extensive search and analysis, QWL is a broad concept that can be analyzed through a robust and encompassing viewpoint. Therefore, to reach the desired levels of welfare, productivity improvement, happiness, stress reduction, and life well-being, we need to design our model based on the most relevant theories in the field. Accordingly, the authors chose the JD-R theory as the best fit for the model. For making a balance between the job demands and resources needed to conduct the job activities, a model is needed to help the managers create the balance by reducing the negativity and improving the positivity of the work. JD-R helps in creating the balance. Accordingly, the following theoretical illustration sheds light on the

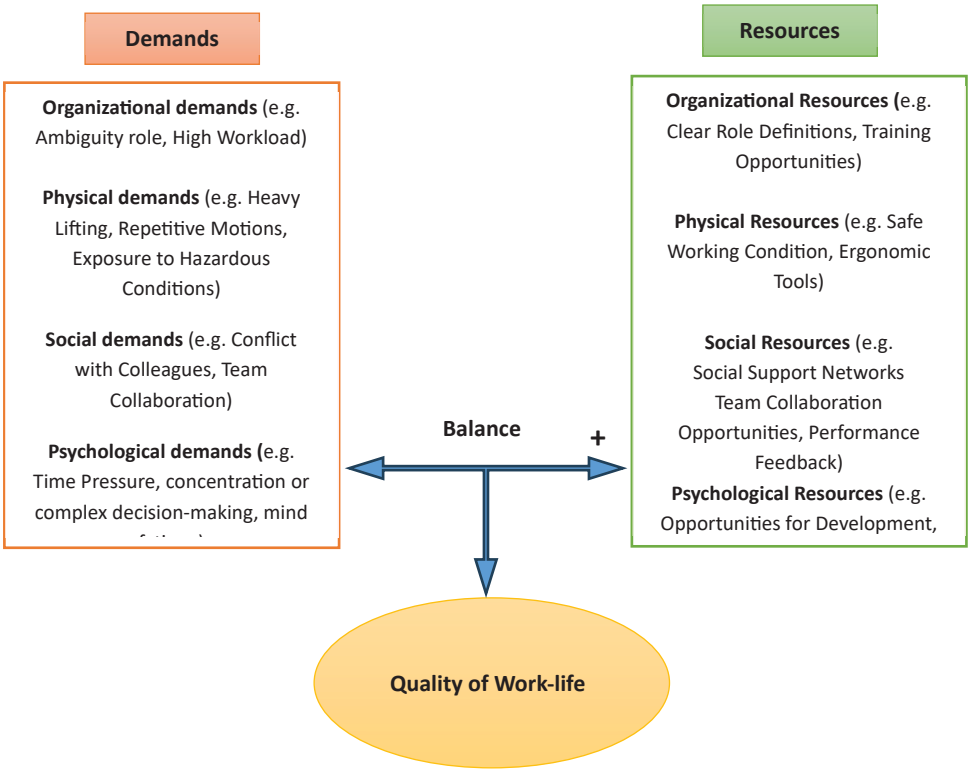


Fig. 2: QWL balance through the lens of JD-R

inter-relationships between the factors affecting the demands as well as influential factors on the resources (Fig. 2). The final Partial Least Squares - Structural Equation Modeling (PLS-SEM) of the current research assists the municipality managers in improving the QWL through the lens of the JD-R theory.

A major factor that we focused on was finding the most important resource in the municipality according to the demand so the managers could initially prioritize the investments in the selected resources. This is also another reason for choosing the mentioned theory. In our research, the concentration is on the resource side of the job. Job factors, salaries and benefits, organizational-physical conditions, and other relevant and emphasized concepts of the theory are extracted and utilized in our conceptual model, which is presented in the next section.

MATERIALS AND METHODS

Survey design and data collection

Since the main purpose of this research is to investigate and measure the QWL of Tehran Municipality employees and it is a practical-developmental purpose, a mixed method has been chosen for the research in this method. Mixed methods research is an approach that combines both quantitative (numerical) and qualitative (descriptive) research methods within a single study. Systematic review has been used in the qualitative part and survey research has been used in the quantitative part of the method. In terms of the method of document data collection, the developmental part is systematic and in the practical part, the data collected in Tehran Municipality has been used. In the current research, an attempt has been made to review the concept of the QWL of employees with a focus on Tehran municipality and propose a model for it with a systematic review from 2013 to 2023. According to (Fink *et al*., 2005), it is recorded to identify, evaluate, and interpret the documents.

Qualitative part - Systematic review of research background

The literature review often pursues two main

goals: firstly, it summarizes current studies by identifying patterns, topics, and issues, and secondly, it helps to identify the conceptual content of a specific field and plays a role in the development of theory. To examine the patterns and targeted coding, the output of the systematic method has been used as an input for the qualitative method of thematic analysis to extract the main sub-themes and finally draw the model of the QWL of the employees. The following steps of a systematic review are described in order (Nagendrababu *et al*., 2020). As shown in Fig. 3, to review the literature, the seven stages of the systematic review of Scaringella and Radziwon were used, and the following steps were followed in this method (Scaringella *et al*., 2018).

In this study, the steps are as follows:

Steps 1 and 2: Initial database search and setting of the systematic review protocol

In this step, according to the specific approach of the current research to the QWL, keywords were selected in three general categories as described in Table 1. The first category of keywords, mentioned under the title of type 1 terms, is aimed at modeling and similar and related words. The term type 2 is related to the keyword QWL. Type 3 terms are related to keywords related to employees so that the research focuses on the quality-of-life models of employees, and the extracted articles have specific content. Finally, Type 4 was assigned to studies related to municipalities. However, due to the research limitations, keywords and the specialized search field were generally selected to obtain the maximum possible output. Also, Scopus and Web of Science databases were chosen as reference databases for the research because of the comprehensiveness of the resources and content.

The broad literature has been investigated through a comprehensive search of published articles in highly ranked journals indexed by Scopus and Web of Science. It is worth mentioning that to achieve a manageable and, at the same time, representative sample of documents, the entry and exit criteria of the Systematic Literature Review (research protocol) were set as described in Table 2. The selected entry criteria for the search are based on the filtering and classification options presented in international databases like ScienceDirect. Based on the opinion of (Webster *et al*., 2002), high-quality contributions are mainly found in authoritative sources such as academic journals and conferences. Therefore, the current research focuses on articles with a high-level impact factor.

Method and qualitative criteria for selection and

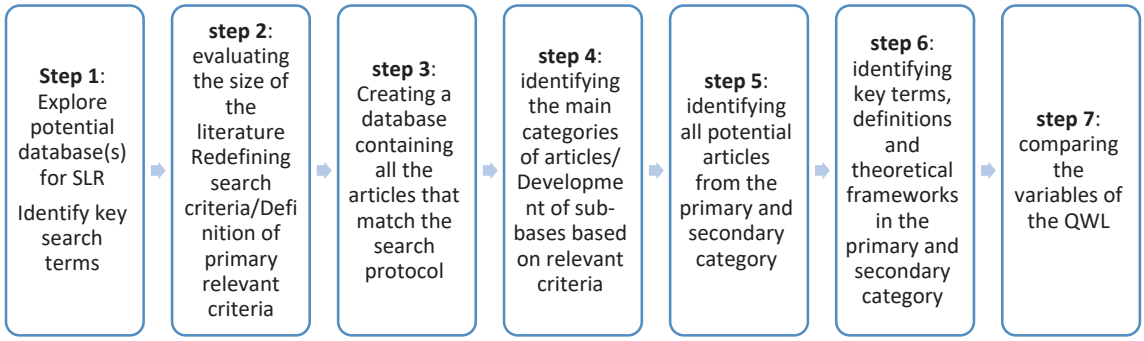


Fig. 3: Systematic review steps (Scaringella *et al*., 2018)

Table 1: Keywords of a systematic review of QWL

	Type 1	Type 2	Type 3	Type 4
Keywords	Model	Happiness	Human resource	Municipality
	Framework	Work-life balance	Employee	-
	Profile	QWL	-	-
	-	Welfare	-	-
	-	Well-being	-	-

Table 2: Systematic Literature Review protocol of employees QWL

	Inclusion Criteria	Non-inclusion Criteria
Period	2013 -2024	Before 2013
Language	English & Persian	Except for English and Persian
Type of Document	Articles	Notes, books, theses, as well as less relevant articles in the industry and internet resources
Search Type	Topic & Titles	-

Table 3: Method and qualitative criteria for selection and exclusion of systematic review articles on QWL

Selection Method	Refinement of articles in three stages: 1- Checking the titles of articles and removing articles. 2- Examining the abstract and keywords of the selected articles of the first stage Qualitative evaluation of the selected articles of the second stage (matching between the problem, methodology, and conclusion)
Focus Criteria	Priority is given to articles that deal with the development of the QWL model Preference should be given to articles with multiple references (if there are many sources) and a high impact factor.

exclusion of systematic review articles on QWL as described in the following Table 3:

Steps 3-5: Article content evaluation, article selection, and tracking references

The selection of articles was a meticulous process, following a three-stage selection model (title, abstract, text). The process is shown in Fig. 4

Step 6: Content analysis and coding of concepts

The critical factors are identified at this stage, and content information is analyzed. Finally, based on the 81 articles, Identification of crucial QWL invariants. After coding the articles, 611 codes were identified and categorized into 173 primary codes. 74 titles were re-categorized based on the principal axes, and coding was finalized in 8 concepts, including Work, Occupational, psychological, social, Organizational, Individual and demographic, Human resources policies, and Organizational ecosystem factors. For coding the concepts, the authors first reviewed the characteristics, abstracts, outcomes, results, and discussion of the articles. The detailed latent concepts for the factors affecting the QWL were extracted from the relevant paragraphs and phrases of the literature as primary codes. Similar concepts were categorized together as high-level axial codes. Finally, the axial codes were integrated into selective coding. A sample of the extracted codes is presented in Table 4:

Step 7: Exploratory Factor Analysis (EFA): Extracting relevant factors of the QWL of employees

In this stage, the final analysis and review of the codes and categories were conducted, a questionnaire was prepared and distributed to create a consensus among the experts, and based on the results, SPSS software and EFA were used. EFA is a statistical technique used to identify the underlying structure of a set of variables. It aims to discover relationships between observed variables and constructs that may explain these relationships. Before conducting the EFA, the set of variables extracted from the literature was delivered to a group of 12 experts who had the relevant proficiency in the field. Their expertise was mostly concentrated on human resources management, municipality activities, and QWL. The initial questionnaire was distributed, evaluated, and approved by the experts in terms of content and the provided structure of the questions. After the initial evaluation, EFA is typically used to reduce data to a smaller set of summary variables and examine the underlying structure of the concepts. In this research, several EFA methods (Principal Component Analysis, Principal Axis Factoring, Maximum Likelihood) were applied to find the best number of factors affecting the QWL, extracted from the initial variables. For conducting the EFA, the questionnaire was distributed among 69 supervisors, managers, and experts who were working in the fields of human capital management, working life improvement, HR planning, and relevant fields of expertise. After choosing the Principal Component Analysis as the best algorithm, the varimax rotation method is used for extracting the factors that are described in the next section.

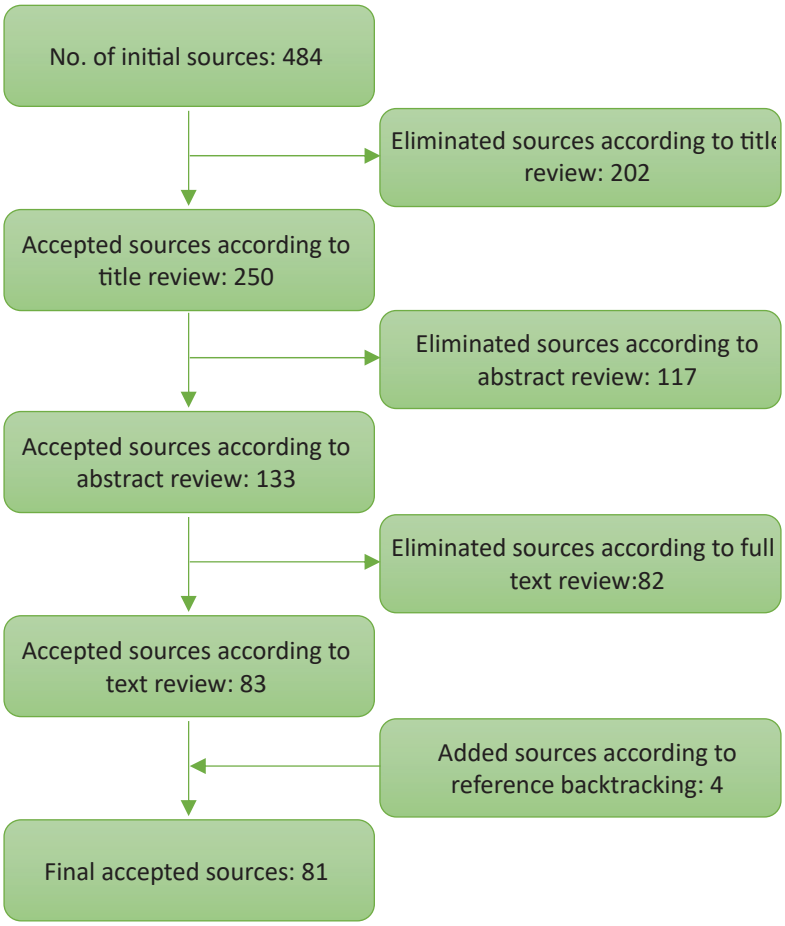


Fig. 4: The process of selecting articles for a systematic review of QWL

Varimax rotation:

Commonly used in EFA, this is an orthogonal rotation method that simplifies the correlation matrix by creating new variables that are linear combinations of the original variables. Varimax rotation aims to achieve a simple structure in which each factor has a high loading on only one or two variables, making it easier to interpret the factors. In this Kaiser-Meyer-Olkin (KMO) test, the number is 0.97, which indicates suitable data for conducting the exploratory factor analysis test. Based on the above method, the dimensions of the questionnaire to model the QWL of Tehran municipality employees, it was discovered to be somewhat different from the proposed model resulting from the analysis of themes, and some dimensions have been divided into smaller dimensions, which are further described as these dimensions and their names. It is shown in the following Table 5.

According to the exploratory factor analysis results, 8 factors were selected and extracted from the final rotation matrix based on the highest factor loadings. Afterward, the selected factors were provided to experts in the field to approve the inter-relationships among them. The Partial Least Squares (PLS) is used for this purpose, and its results are explained in the next sections. Based on the results of the factor analysis and synthesizing the factors with the relevant literature, the following hypotheses are designed and evaluated using PLS:

- *H1: Organizational Psychological Atmosphere (OPA) has a significant positive effect on QWL.*
- *H2: Job Factor (JF) has a significant positive effect on QWL.*

Table 4: Content Analysis and Coding of QWL Concept

Primary codes	Axial Coding	Selective Coding
meaningfulness Meaningful work Professional challenges	Task Identity	
Applying all the potentials in the job Job complexity Number of tasks	Skill Variety	*Job Factor (JF)*
Feedback Mastery of the environment	feedback	
Independence and freedom	Autonomy	
Compensation for services and financial benefits Compensation for services and benefits - economic needs	Compensation-financial	
Compensation for services and benefits - non-financial rewards	Compensation-non-financial	
Compensation and benefits - fair wages	fair wages	*Salaries and Benefits Factor (SBF)*
Benefits - On-site health care Advantages - car cleaning services Support for employees' families Shorter working hours Time flexibility Continuous growth opportunity	Benefits	
self-esteem Individual resilience self-efficacy cheerfulness Sacrifice hope positivity Fulfilling other community obligations	Personality and individual behaviors	*Organizational Psychological Atmosphere (OPA)*
The degree of freedom in expressing opinions Participation through comments	Freedom in expressing opinions	
Organizational spirituality Organizational virtue	Organizational spirituality	
Employer brand Proud of the organization Proud of the products Proud of the organization's services in the community	Employer brand	*Organizational Employer Brand (OEB)*
Corporate social responsibility	Corporate social responsibility	
Number of working hours Number of working hours per week Job sharing Intensive work week	Quantity at work	*Organizational Work-Life Balance (OWLB)*
The amount of free time	Quantity at leisure time	
Type of office Layout	Office	
safety equipment Light Sound Temperature physical conditions	safety physical conditions	*Organizational-Physical Conditions (OPC)*
Trust in colleagues	Trust coworkers	
Teamwork Commitment to teamwork	Teamwork	*Social aspect - Communication with Coworkers (SCC)*
The level of participation of colleagues The level of communication with colleagues	Quantity of communication with coworkers	
The level of communication with managers	Quantity of communication with manager	*Social aspect - Communication with Managers (SCM)*
manager support Manager availability	manager support	
Trust to manager	Trust (manager)	

Table 5: KMO and bartlett's test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.969
Bartlett's Test of Sphericity	Approx. Chi-Square	48078.624
	Sig.	.000

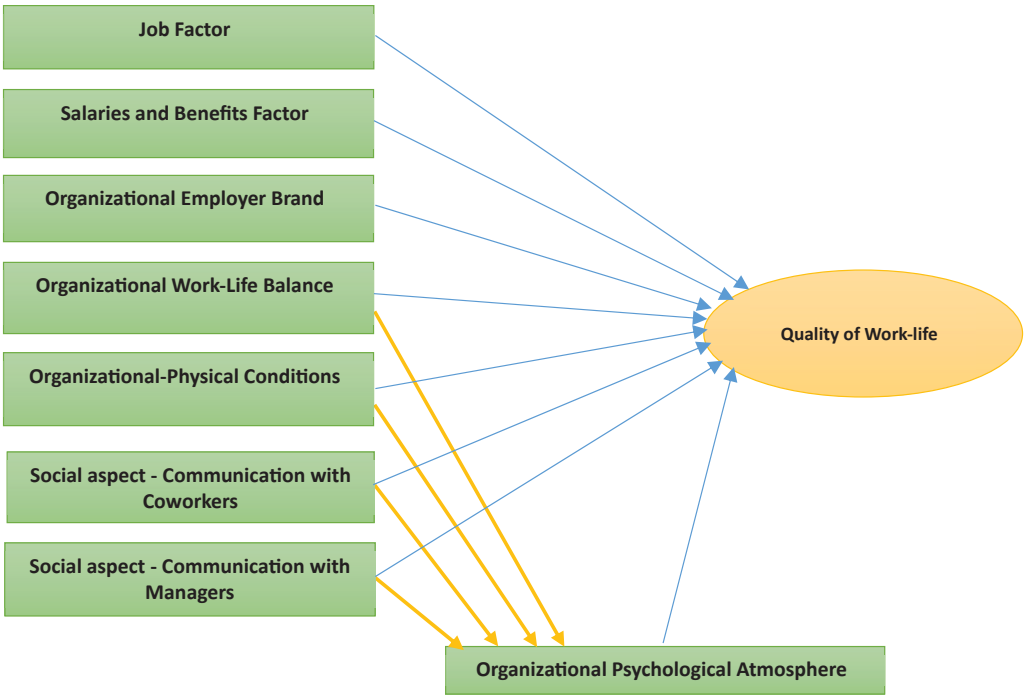


Fig. 5: Conceptual model of QWL

• *H3: Salaries and Benefits Factor (SBF) has a significant positive effect on QWL.*

• *H4: Organizational Employer Brand (OEB) has a significant positive effect on QWL.*

• *H5: Organizational Work-Life Balance (OWLB) has a significant positive effect on QWL.*

• *H6: Organizational-Physical Conditions (OPC) have a significant positive effect on QWL.*

• *H7: Social aspect - Communication with Coworkers (SCC) has a significant positive effect on QWL.*

• *H8: Social aspect - Communication with Managers (SCM) has a significant positive effect on QWL.*

Also, based on the studies, we found that there are inter-relationships among some of the factors extracted in the EFA phase through a deep analysis of the relevant literature. These relationships have an indirect impact on the QWL of employees:

• *H9: Organizational-Physical Conditions (OPC) have a significant positive effect on OPA.*

• *H10: Organizational Work-Life Balance (OWLB) has a significant positive effect on OPA.*

• *H11: Social aspect - Communication with Coworkers (SCC) has a significant positive effect on OPA.*

• *H12: Social aspect - Communication with Managers (SCM) has a significant positive effect on OPA.*

Fig. 5 is drawn based on hypotheses extracted from this stage, as well as the literature review and JD-R theory. As indicated in this figure and based on JD-R theory, demands can take various forms, including physical demands such as heavy lifting or prolonged standing, psychological demands like excessive workloads and emotional labor, social demands involving challenging interactions with colleagues or clients, and organizational demands

related to role ambiguity or insufficient management support. Such job demands are viewed as potential stressors that may lead to adverse outcomes, such as burnout and diminished well-being, resulting in low QWL. However, the JD-R model asserts that job resources—such as social support, autonomy, and opportunities for professional development—play a crucial role in mitigating these effects and enhancing QWL. The interaction and balance between job demands and resources is critical; high job resources can buffer the negative impacts of high job demands, leading to improved employee QWL.

Next, the quantitative section presents the hypotheses derived from the qualitative section of the test and the results.

Quantitative part - survey research method

In this part, the survey research method is used. In this part, the output of the systematic method is used as the input of the quantitative part. In this section, the steps are as follows:

Preparing the PLS questionnaire for QWL

Based on the codes as variables extracted from the systematic review, also illustrated as factors of the EFA, a questionnaire was prepared to measure the QWL in the Tehran Municipality. This questionnaire had 18 demographic questions and 56 questions related to different aspects of the QWL of Tehran Municipalities derived from the previous analysis. Demographic characteristics including age, gender, level of education, physical health, marital status, number of children, residential area, residential status, approximate commuting time, vehicle, ease of access to the workplace, nature of the job, position, type of employment, place of service, work experience, amount of salary, and benefits.

Distribution and collection of data

Sampling

This study uses the departmental divisions of the Tehran municipality as the basic criteria for evenly distributing the questionnaire to the relevant experts in the field, a large entity comprising vice-chairs, general offices, autonomous bodies, and various subsidiaries. A hybrid cluster-stratified sampling method was utilized. With the research objective being the assessment of Employee QWL using the human capital approach, data from statistical populations across different areas (deputies) and their subsets, regional municipalities, independent bodies, and enterprises as distinct clusters were collected. Moreover, employee and laborer categories within the municipal staff served as strata for stratified sampling classification. Based on what was described in this sampling, an online questionnaire was sent to all expert personnel, and 1372 people answered in 12 clusters and two classes of workers and employees (The response rate was 74%). The findings indicate that among the total sample, **454** respondents (**33%**) are women, **911** (**66.3%**) are men, and eight people (0.5%) chose "I don't want to answer." Additionally, the distribution of work experience reveals that individuals with less than ten years of experience constituted **267** respondents (19.7%), and those with 10-20 years and over 20 years of experience accounted for **789** (58.2%) and **300** (22.1%) respondents, respectively. In terms of age, 39 (8.2%) people are 30 and under **30 years old, 503 (6.36%) are between 31 and 40, 644 (9.46%) are between 40 and 50, and the rest** are 187 (6.13%) people over 51 years old. In terms of educational level, 628 (7.45%) have a bachelor's degree and below, 651 (4.47%) have a master's degree, and 94 (8.6%) have a Ph.D. and above.

Measures

The proposed model consists of 8 constructs, namely OPA, JF, SB, OEB, SCC, OWLB, OPC, and SCM, which are measured by the items mentioned in Table 6. An example item is "I have satisfactory job autonomy in doing my duties". JF is assessed using 8 items, and the other constructs are shown in Table 6. The survey comprises 56 question items extracted from the previous steps of research, and respondents provided ratings using a 5-point Likert scale. The scale ranges from 1, representing "strongly disagree," to 5, indicating "strongly agree." As mentioned, the technique used for data analysis is PLS-SEM with Smart-PLS 3.0. The SmartPLS software is acknowledged as a fitting choice for implementing PLS-SEM, as outlined by Sarstedt *et al.*, (2014). PLS-SEM is commonly endorsed within the realm of business management research (Hair *et al.*, 2019) to investigate and validate intricate interconnections.

RESULTS AND DISCUSSION

The structural model evaluation in this study,

Table 6: Labeling and categorizing the final factors for PLS-SEM

Factors	abbreviation	Items	Codes	Examples
Demographic factors	DE	18	D1-D18	
Organizational Psychological Atmosphere	OPA	15	OPA1,OPA2,OPA3,OPA4,OPA5 ,OPA6,OPA7,OPA8,OPA9,OPA 10,OPA11,OPA12,OPA13,OPA 14,OPA15	The organization has programs that keep positivity alive in employees.
Job factors	JF	8	J1,J2, J3, J4, J5, J6 J7, J8	I have satisfactory job autonomy in doing duties
Salaries and benefits factors	SB	4	SB1, SB2,SB3,SB4	I am satisfied with my current salary in the organization.
Organization - employer brand	OEB	7	OEB1, OEB2, OEB3,OEB4,OEB5,OEB6,OEB7	I feel satisfied with the image of the organization in society.
Social aspect - communication with coworkers	SCC	4	SCC1,SCC2, SCC3, SCC4	The level of communication with colleagues at my workplace is satisfactory.
Organizational work-life balance	OWLB	4	OWLB1, OWLB2, OWLB3, OWLB4	I am satisfied with my work and rest time.
Organizational - physical conditions	OPC	3	OPC1,OPC2,OPC3	I feel satisfied with the layout and physical conditions of my workspace.
Social aspect - communication with managers	SCM	3	SCM1, SCM2, SCM3	The level of communication with managers at my workplace is satisfactory.
Quality of Work Life	QWL	8	QL1, QL2, QL3, QL4, QL5, QL6, QL7, QL8	I have enough money to meet my personal needs. I have enough energy to do daily tasks.

conducted using SmartPLS 3.0 software, has yielded significant findings. Notably, due to low loadings (<0.5 as per Table 7), three items (J6, OEB1, OEB2) have been excluded. This underscores the importance of factor loadings within the 0.40 to 0.70 range, which may be eliminated for model enhancement (Hair *et al*., 2019). Table 7 shows Cronbach's alpha, composite reliability, and AVE values for Job factors (0.884,0.909,0.590), Organization - employer brand (0.855,0.899, 0.644), Organizational work-life balance (0.850, 0.900, 0.693), Organizational - physical conditions (0.822,0.894, 0.737), Organizational Psychological Atmosphere (0.953, 0.958, 0.603), Salaries and benefits (0.869, 0.910, 0.717), Social aspect - communication with managers (0.818, 0.889, 0.727), Social aspect - communication with coworkers (0.830, 0.886, 0.661), QWL (0.831, 0.870, 0.458), indicating internal consistency reliability and convergent validity of scale items.

The assessment of discriminant validity in this study, employing the Fornell-Larcker criterion and HTMT, has yielded reassuring results. The Cornell-Larcker results in Table 8 demonstrate the square root of AVE exceeding the correlation value between constructs, while HTMT values for J, OEB, OWLB, OPC, OPA, SB, SCM, SCC, and QL do not surpass 0.90. This validates the measurement model's discriminant validity (Gold *et al*., 2001) and underscores the robustness of our study.

The results from PLS-SEM analysis in Fig. 6 and Table 9 reveal no direct relationship between JF and QWL (SM = 0.074, SD = 0.040, t-statistic = 1.828, P= 0.068) between OPC and QWL (SM = 0.029, SD **= 0.031, t-statistic = 0.946, P= 0.344) and between SCM and QWL (SM = -0.026, SD = 0.031, t-statistic = 0.821, P=0.412). Thus, H2, H6, and H8 have to be rejected. Furthermore, the results indicate that** OEB(SM = 0.198, SD = 0.036, t-statistic = 5.502, P= 0.000), OWLB(SM = 0.429, SD = 0.027, t-statistic = 16.113, P= 0.000), OPA(SM = -0.151, SD = 0.048, t-statistic = 3.104, P= 0.002), SB(SM = 0.133, SD = 0.033, **t-statistic = 4.076, P= 0.000), and SCC(SM = 0.066, SD = 0.033, t-statistic = 1.965, P= 0.049) have** a significant direct effect on QWL. Hence, H1, H3, H4, H5, and H7 are confirmed and supported by the data. Additionally, it is found that OPC (SM = 0.300, SD = 0.021, t-statistic = 14.434, P= 0.000), OWLB ((SM = 0.281, SD = 0.020, t-statistic = 13.938, P= 0.000), SCC (SM = 0.291, SD = 0.021, t-statistic = 13.579, P= 0.000) and SCM (SM = 0.209, SD = 0.021, t-statistic

Table 7: Measurement model

Variables	Items	Outer Loadings	Cronbach's Alpha	Composite Reliability	AVE
Job factors	J1	0.722	0.884	0.909	0.590
	J2	0.794			
	J3	0.813			
	J4	0.800			
	J5	0.728			
	J7	0.694			
	J8	0.816			
Organization - employer brand	OEB3	0.842	0.855	0.899	0.644
	OEB4	0.586			
	OEB5	0.815			
	OEB6	0.861			
	OEB7	0.873			
Organizational work-life balance	OWLB1	0.741	0.850	0.900	0.693
	OWLB2	0.869			
	OWLB3	0.875			
	OWLB4	0.838			
Organizational - physical conditions	OPC1	0.823	0.822	0.894	0.737
	OPC2	0.906			
	OPC3	0.845			
Organizational Psychological Atmosphere	OPA1	0.733	0.953	0.958	0.603
	OPA2	0.737			
	OPA3	0.712			
	OPA4	0.759			
	OPA5	0.795			
	OPA6	0.829			
	OPA7	0.784			
	OPA8	0.833			
	OPA9	0.821			
	OPA10	0.804			
	OPA11	0.784			
	OPA12	0.732			
	OPA13	0.787			
	OPA14	0.701			
	OPA15	0.816			
Salaries and benefits	SB1	0.853	0.869	0.910	0.717
	SB2	0.872			
	SB3	0.808			
	SB4	0.854			
Social aspect - communication with managers	SCM1	0.836	0.818	0.889	0.727
	SCM2	0.852			
	SCM3	0.870			
Social aspect - communication with coworkers	SCC1	0.770	0.830	0.886	0.661
	SCC2	0.822			
	SCC3	0.830			
	SCC4	0.828			
Quality of Work-Life	QL1	0.738	0.831	0.870	0.458
	QL2	0.702			
	QL3	0.766			
	QL4	0.731			
	QL5	0.643			
	QL6	0.589			
	QL7	0.656			
	QL8	0.559			

Table 8: Discriminant validity

Fornell-Larcker Criterion								
	JF	OWLB	OEB	OPC	OPA	QWL	SCC	SCM
JF	0.768							
OWLB	0.513	0.832						
OEB	0.685	0.470	0.802					
OPC	0.566	0.452	0.505	0.859				
OPA	0.771	0.583	0.712	0.635	0.776			
QWL	0.418	0.563	0.452	0.351	0.428	0.676		
SCC	0.555	0.329	0.539	0.416	0.629	0.305	0.813	
SCM	0.573	0.343	0.450	0.418	0.599	0.258	0.576	0.853
SB	0.495	0.524	0.529	0.503	0.655	0.425	0.348	0.340
Heterotrait-Monotrait Ratio (HTMT)								
OWLB	0.582							
OEB	0.771	0.548						
OPC	0.653	0.537	0.598					
OPA	0.832	0.647	0.787	0.711				
QWL	0.468	0.643	0.524	0.402	0.458			
SCC	0.638	0.387	0.627	0.500	0.695	0.367		
SCM	0.651	0.395	0.515	0.491	0.648	0.295	0.671	
SB	0.558	0.607	0.613	0.592	0.720	0.452	0.407	0.392

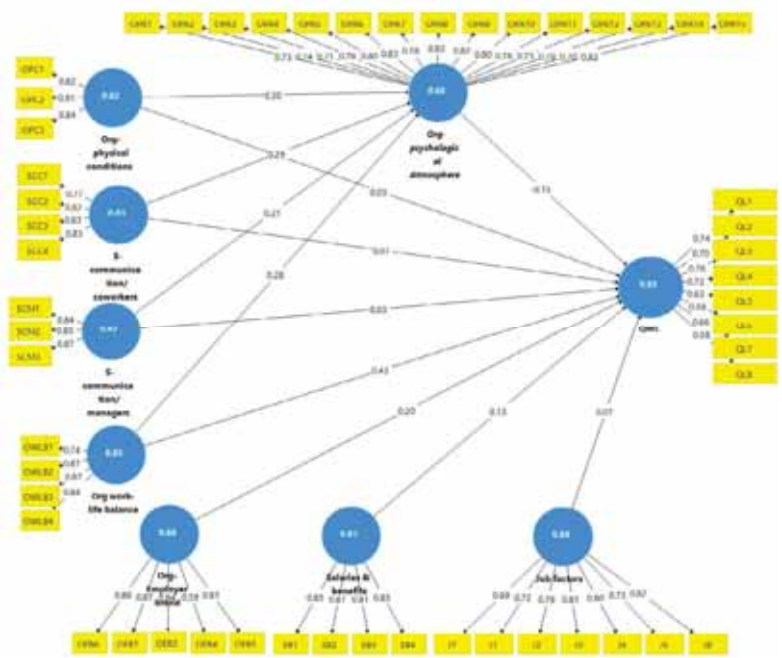


Fig. 6: PLS-SEM results

Table 9: Path coefficients

	Original Sample (O)	Sample Mean (SM)	Standard Deviation (STDEV)	T Statistics	P Values	Decision
Direct effect						
Job factors -> QWL	0.072	0.074	0.040	1.828	0.068	Rejected
Org work-life balance -> Org-psychological atmosphere	0.281	0.281	0.020	13.938	0.000	Supported
Org work-life balance -> QWL	0.429	0.429	0.027	16.113	0.000	Supported
Org-Employer brand -> QWL	0.196	0.198	0.036	5.502	0.000	Supported
Org-physical conditions -> Org-psychological atmosphere	0.300	0.300	0.021	14.434	0.000	Supported
Org-physical conditions -> QWL	0.029	0.029	0.031	0.946	0.344	Rejected
Org-psychological atmosphere -> QWL	-0.148	-0.151	0.048	3.104	0.002	Supported
S- communication/coworkers -> Org-psychological atmosphere	0.291	0.291	0.021	13.579	0.000	Supported
S- communication/coworkers -> QWL	0.065	0.066	0.033	1.965	0.049	Supported
S- communication/managers -> Org-psychological atmosphere	0.209	0.209	0.021	10.061	0.000	Supported
S- communication/managers -> QWL	-0.026	-0.026	0.031	0.821	0.412	Rejected
Salaries & benefits -> QWL	0.133	0.133	0.033	4.076	0.000	Supported
Indirect effect						
Org work-life balance -> Org-psychological atmosphere -> QWL	-0.042	-0.042	0.014	3.043	0.002	Supported
Org-physical conditions -> Org-psychological atmosphere -> QWL	-0.044	-0.045	0.015	3.005	0.003	Supported
S- communication/coworkers -> Org-psychological atmosphere -> QWL	-0.043	-0.044	0.014	3.026	0.002	Supported
S- communication/managers -> Org-psychological atmosphere -> QWL	-0.031	-0.032	0.011	2.940	0.003	Supported

= 10.061, P= 0.000) significantly affect OPA. Hence, H9, H10, H11, and H12 are confirmed and supported by the data. Based on the findings of this study, it has been shown that the quality of employees' working lives is directly affected by work-life balance, the organization's Employer brand, Organizational Psychological Atmosphere, communication with coworkers, and Salaries and benefits. Also, the organization's work-life balance, physical conditions, communication with coworkers, and communication with managers affect the psychological atmosphere of the organization.

In addition to path coefficients, the Goodness of Fit measures also approve the validity of the model as provided in Table 10:

The qualitative and quantitative aspects of work and organization influence employees' quality of life. One of the integral aspects of the QWL is work-life balance (Parakandi *et al.*, 2016; Kaya *et al.*, 2020), which is also strongly confirmed in this study. Organizational Work-Life Balance (OWLB) is a deliberate organizational initiative designed to minimize the work-life conflict of employees and enable them to be more effective in their work and other roles. In recent years, companies have become increasingly aware of the need to embrace the concept of work-life balance as an essential tool to facilitate sustainable human resources, which is crucial to attracting and retaining talent (Bhende *et al.*, 2020; Szücs *et al.*, 2011; Fontinha *et al.*, 2019; Bhola *et al.*,

Table 10: Goodness of fit index

Fit Index	Value	Interpretation
Standardized Root Mean Square Residual (SRMR)	0.064	Good fit (≤ 0.08)
Distance Unweighted Least Squares (d_ULS)	5.950	Indicates a strong fit; lower values preferred
Discrepancy Goodness-of-Fit (d_G)	1.224	Reasonable fit
Chi-Square	9,626.642	Significant at p < 0.01; indicates model fit
Normed Fit Index (NFI)	0.800	Acceptable fit

Table 11: Desirability levels of QWL in Tehran Municipality

Variables	Mean	Mean Std. Error	Desirability level
SB	1/93	0/02	Low Desirability
OPA	2/41	0/02	Relatively Desirable
OWLB	2/46	0/02	Relatively Desirable
OPC	2/65	0/03	Relatively Desirable
JF	3/00	0/02	Relatively Desirable
OEB	3/11	0/02	Acceptable Desirability
SCC	3/37	0/02	Acceptable Desirability
SCM	3/54	0/03	Acceptable Desirability
QWL	2/88	0/02	Relatively Desirable

2016). Another qualitative factor is the Organizational psychological conditions of the organization (OPA), which directly and indirectly affect the quality of employees' working lives (Teles *et al.*, 2014; Zhang *et al.*, 2020; Rathi, 2011; Allameh *et al.*, 2018; Salehi *et al.*, 2020). Therefore, in this field, the organization can take various measures to increase the morale of the employees. Creating a sense of positivity and hope in personnel, an atmosphere of respect among people, a balance in freedom of expression, the number of rules and regulations and norms, reducing discrimination and creating organizational justice, and training and developing soft skills in the organization can improve the organizational atmosphere and increase quality. It can also help people's lives. Organizational Employee Brand (OEB), a concept that can improve the organizational and individual identity of people through the organization, can be another influential factor strongly confirmed in this research (Parvar *et al.*, 2013). Communication and the social dimension of the organization (SCM, SCC) (Parvar *et al*,2013; Jiang *et al.*, 2017; Wright *et al.*,2014) is one of the most essential and vital factors in creating a favorable psychological atmosphere and a high QWL that organizations must pay enough attention to in the organization. In a communication atmosphere where unresolved conflicts between employees and managers increase, burnout and fatigue from work, the rate of absenteeism increases (Md-Sidin *et al.,* 2010; Omar *et al*,2015; Rice *et .al*, 1992), and the performance and productivity of people decrease. Organizational - Physical Conditions (OPC) (Walton,1973, Puciato *et al.*, 2017, Platts *et al.*, 2013; McFarland, 2017) are another influential factor in the quality of employees' working lives. This was not directly confirmed in this study but indirectly through the Organizational Psychological Atmosphere (OPA) on the QWL. It is practical. Finally, one of the most critical dimensions in this model is salary and benefits, or in other words, service compensation (Lewis *et al*,2001; Srivastava *et al*,2014; Swamy,2013; Swamy *et al*,2015), which is quantitatively one of the factors affecting the QWL of employees during different decades, which has a more prominent place in the early models of this concept. It has had, and it has also been confirmed in this model.

Therefore, based on the findings from analyzing the relationships among various organizational factors, QWL can be effectively interpreted through the JD-R theory. This theory posits that job characteristics can be categorized into demands and resources, which interact to influence employee well-being and performance. In this study, organizational work-life balance emerged as a significant

resource that positively impacts the organizational psychological atmosphere and QWL, underscoring its motivational potential. Conversely, while job factors and organizational physical conditions were hypothesized to contribute positively to QWL, the results indicated that their direct effects were not statistically significant, suggesting that these factors may not function as adequate resources in this context. Additionally, the negative relationship between the organizational psychological atmosphere and QWL highlights the complexity of how demands can lead to strain when resources are insufficient. The supportive roles of communication with coworkers and managers not only emphasize the importance of social resources in fostering a positive work environment but also highlight their significant role in organizational settings. Overall, this analysis illustrates how the JD-R framework can elucidate the dynamics between job demands and resources, providing valuable insights for enhancing employee well-being in organizational settings. Using the model of the QWL of employees, the average response to the items of each dimension has been measured among the employees of Tehran Municipality, and the results are described in Table 11. As it is apparent in Table 11, based on the 5-point Likert spectrum from low desirability to high desirability, the items are respectively unfavorable (0-1), low desirability (1.1-2), relatively favorable (2.1-3), desirability It is acceptable (3.1-4) and desirable (4.1-5). In the Tehran Municipality, the quality of life of employees, as revealed by the collected data, follows a clear order of desirability. This order, from low to high, includes salary and benefits (SB), Organizational Psychological Atmosphere (OPA), Organizational Work-Life Balance (OWLB), Organizational - Physical Conditions (OPC), Job Factor (JF), Organizational - Employer Brand (OEB), Social aspect - Communication with Coworkers (SCC), and social aspect - Communication with Managers (SCM).

Analyzing the factors influencing employee perceptions, we find a nuanced landscape of strengths and weaknesses across different dimensions. The Salaries and Benefits Factor received a low desirability rating, indicating that employees perceive this aspect as inadequate, which may hinder overall job satisfaction and motivation. This underscores the need for immediate attention and improvement in this area. On the other hand, factors such as the Organizational Psychological Atmosphere, Organizational Work-Life Balance, and Organizational-Physical Conditions were rated as relatively desirable, suggesting that while these areas are viewed positively, there is still room for improvement. The Job Factor emerged as a relatively desirable attribute, reflecting a balanced view of job demands and resources. Furthermore, the Organizational Employer Brand and social communication aspects—specifically with coworkers and managers—were rated as acceptable in desirability, indicating that while these factors contribute to a supportive work environment, they may not fully meet employee expectations. Overall, the findings highlight critical areas for organizational development, particularly in enhancing salaries and benefits to bolster employee satisfaction while maintaining the positive aspects of workplace culture and conditions.

CONCLUSION

The study has established that QWL are related by psychological factors, work-life balance, salaries and wages, physical conditions and safe environment, job factors, employer brand, social dimension—communication with colleagues, and communication with managers, however, all sizes of QWL are not uniformly related. The results of this research have been discussed and investigated to improve employees' quality of life. The concept of employees' QWL is comprehensive, and many organizational measures can be influenced by or affect it. On the other hand, one sector that can improve the QWL of employees in organizations and vice versa is the policies that direct the functions of human resources. Based on the findings of the qualitative section, 18 demographic characteristics have been examined in this model, and using the statistical findings in this organization, to set the letters, guidelines, strategies, and human resources policies, These items should include education level, place of service, amount of salary and benefits, gender, organizational position, type of employment, number of children, ease of access to the workplace, work experience, age, residence status, marital status, approximate commuting time, nature of the job, residential area, vehicle, and physical health should be given sufficient attention. In the QWL of Tehran municipality employees, factors such as psychological factors, work-life balance, salaries and

wages, physical conditions and safe environment, job factors, employer brand, social dimension—communication with colleagues, and communication with superiors are completely controlled. It is an organization, and by making positive changes in this field, the organization can bring good results to the QWL of Tehran Municipality employees. Factors related to extra-organizational factors, including personal and economic factors, are less within the organization's authority. However, in many cases, they have a significant impact on the quality of life of employees. For this type of dissatisfaction in the organization, people's expectations should be kept at the level of awareness. The issue was pointed out to people in meetings, meetings, and many cases in the organization, and people should know that the quality of life at the personal level and national decisions also influence the quality of their work life. Analyzing Tehran Municipality's work environment through the JD-R theory, a significant and widely accepted framework in organizational psychology, reveals critical insights into employee satisfaction and performance. The data indicates a low desirability for the Salaries and Benefits Factor, which may contribute to decreased employee motivation, highlighting a significant job demand that is not adequately met. In contrast, factors such as organizational psychological atmosphere and work-life balance are rated relatively desirable, suggesting they serve as essential job resources that positively influence the QWL. The supported relationships between organizational work-life balance and the organizational psychological atmosphere and QWL underscore the importance of providing resources that enhance employee engagement and mitigate stress. Furthermore, while organizational and physical conditions were found to have a supportive effect on the psychological atmosphere, their direct impact on QWL was insignificant, indicating that simply improving physical conditions may only suffice if addressing other underlying demands. The findings also emphasize the role of social communication, particularly with coworkers, as a vital resource that fosters a positive psychological atmosphere and contributes to QWL. Overall, this analysis highlights the necessity for the Tehran Municipality to strategically enhance job resources while addressing unmet demands to improve employee well-being and organizational effectiveness. There are also some limitations to the research. Researchers of the current study had to focus on the available literature as well as the opinions of the accessible experts in the field. Another point to notice is the accessibility to the Tehran Minimality, the largest municipality of Iran for testing the status of QWL. Other municipalities in the country can also be evaluated based on the current model as future research endeavors. An important future research suggestion will be to share and discuss the findings of this research with the authorities and managers of the Tehran Municipality as well as other municipalities to concentrate and invest in the most relevant factors and indicators influencing the QWL.

AUTHOR CONTRIBUTIONS

R. Forouzandeh Joonaghani conducted the literature review, data collection, and data analysis, and outlined the research findings. I. Raeesi Vanani screened and analyzed the gathered data, discussion, and conclusion. A. Hosseini contributed to the review, synthesis of the findings, and final conclusion.

ACKNOWLEDGEMENT

The authors wish to express their sincere gratitude to all those who contributed to the success of this research. Special thanks are extended to the research participants for their time and valuable insights, without which this work would not have been possible. Additionally, we would like to acknowledge the support of the Tehran Municipality, whose resources and support were crucial in completing this work.

CONFLICT OF INTEREST

The authors declare no potential conflict of interest regarding the publication of this work. In addition, the ethical issues including plagiarism, informed consent, misconduct, data fabrication and, or falsification, double publication and, or submission, and redundancy have been completely witnessed by the authors.

PUBLISHER NOTE

Tehran Urban Research & Planning Centre (TURPC) takes a neutral position about claims on disputed territories, place names, international boundaries, jurisdiction in published maps, and institutional affiliations. TURPC is committed to retracting a paper after its publication if it becomes apparent that there are serious problems in its content, in terms of research and publication ethics (https://www.ijhcum.net/journal/process?ethics).

ABBREVIATIONS

AVE	Average Variance Extracted
d_G	Discrepancy Goodness-of-Fit
d_ULS	Distance Unweighted Least Squares
DE	Demographic factors
JD-R	Job Demands-Resource
JF	Job Factors
KMO	Kaiser-Meyer-Olkin
NFI	Normed Fit Index
O	Original Sample
OEB	Organizational Employer Brand
OPA	Organizational Psychological Atmosphere
OPC	Organizational - Physical Conditions
OWLB	Organizational Work-Life Balance
P L S - SEM	Partial Least Squares - Structural Equation Modeling
QWL	Quality of Work-Life
SB	Salaries and Benefits Factors
SCC	Social aspect - Communication with Coworkers
SCM	Social aspect - Communication with Managers
SD	Standard Deviation
SM	Sample Mean
SRMR	Standardized Root Mean Square Residual

REFERENCES

Abdirahman, H. I. H.; Najeemdeen, I. S.; Abidemi, B. T.; Ahmad, R. B. (2018). The relationship between job satisfaction, work-life balance and organizational commitment on employee performance. Acad. J. Econ. Stud., 4(3): 12-17 **(6 Pages)**

Abdullah, N. A. C.; Zakaria, N.; Zahoor, N. (2021). Developments in Quality of Work-Life Research and Directions for Future Research. Sage Open., 11(4): 21582440211059177 **(18 Pages)**

Adhikari, D. R.; Gautam, D. K. (2010). Labor legislations for improving quality of work life in Nepal. Int. J. Law Manag., 52(1): 40-53 **(14 Pages)**

Akter, N.; Akter, M. K.; Turale, S. O. U. T. H. (2019). Barriers to quality of work life among Bangladeshi nurses: a qualitative study. Int. Nurs. Rev., 66(3): 396-403 **(7 Pages)**

Alderfer, C. P. (1972). Existence, relatedness, and growth: Human needs in organizational settings. J. Appl. Behav. Sci., Free Press. **(16 Pages)**

Allameh, S. M.; Hosseini, S. H.; Mahabadi, M. N.; Samadi, A. (2018). The effect of psychological capital on quality of life, given the mediating role of social capital and quality of work life. Int. J. Bus. Innov. Res., 17(2): 210-225 **(16 Pages)**

Arndt, A. D.; Singhapakdi, A.; Tam, V. (2015). Consumers as employees: The impact of social responsibility on quality of work life among Australian engineers. Soc. Responsib. J., 11(1): 98-108 **(11 Pages)**

Autrata, O.; Scheu, B. (2023). Subjective quality of life and social work: Social Widerspiegelung as a basis. Springer Nature. **(234 Pages)**

Azeem, S. M.; & Akhtar, N. (2014). The influence of work life balance and job satisfaction on organizational commitment of healthcare employees. Int. J. Hum. Resour. Stud., 4(2): 18 **(8 Pages)**

Babu, P. F. (2022) Quality of work life in textile industry a study on public private cooperative sectors of Rayalaseema region Andhra Pradesh India. Int. J. Manag. Bus. Stud., **(17 Pages)**

Bakker, A. B., Demerouti, E. (2014). Job demands–resources theory. Wellbeing: A complete reference guide., 1-28 **(28 Pages)**

Bakker, A. B., Demerouti, E. (2017). Job demands–resources theory: Taking stock and looking forward. Journal of occupational health psychology., 22(3), 273 **(15 Pages)**

Baquero, A. (2023). Authentic Leadership, Employee Work Engagement, Trust in the Leader, and Workplace Well-Being: A Moderated Mediation Model. Psychol. Res. Behav. Manag., 1403-1424 **(22 Pages)**

Berthelsen, H., Hakanen, J. J., Westerlund, H. (2018). Copenhagen psychosocial questionnaire-a validation study using the job demand-resources model. PloS one., 13(4): e0196450 **(9 Pages)**

Bhende, P., Mekoth; N., Ingalhalli, V.; Reddy, Y. V. (2020). Quality of work life and work–life balance. J. Hum. Values., 26(3): 256-265 **(10 Pages)**

Bhola, D. J.; Nigade, J. (2016). Relationship between work life balance, quality of work life and quality of life of women working in service industry. Prav. Manag. Rev., 15(1): 30-45 **(16 Pages)**

Bibi, S.; Khan, A.; Hayat, H.; Panniello, U.; Alam, M.; Farid, T. (2022). Do hotel employees really care for corporate social responsibility

(CSR): a happiness approach to employee innovativeness. Curr. Issues Tourism., 25(4): 541-558 **(18 Pages)**

Carter, C. G. (1989). Factors Related to Organizational Turnover Intentions of Louisiana Cooperative Extension Service Agents, Qual. Life. **(20 Pages)**

Chan, K. W.; Wyatt, T. A. (2007). Quality of work life: A study of employees in Shanghai, China. Asia Pac. Bus. Rev., 13(4): 501-517 **(17 Pages)**

Cooper, B.; Wang; J.; Bartram, T.; Cooke, F. L. (2019). Well-being-oriented human resource management practices and employee performance in the Chinese banking sector: The role of social climate and resilience. Hum. Resour. Manag., 58(1): 85-97 **(13 Pages)**

Dahiya, R. (2020). Does virtue in the organisation affect happiness of employees? INT. J. INDIAN. CULT. BU., 21(4): 459-477 **(19 Pages)**

Danna, K.; Griffin, R. W. (1999). Health and well-being in the workplace: A review and synthesis of the literature. J. Manag., 25(3): 357-384 **(28 Pages)**

de Jong, M.; de Boer, A. G.; Tamminga, S. J.; Frings-Dresen, M. H. (2015). Quality of working life issues of employees with a chronic physical disease: a systematic review. J. Occup. Rehabil., 25: 182-196 **(15 Pages)**

Elizur, D.; S. Shye: 1990, 'Quality of work life and its relation to quality of life', Appl. Psychol. Int. Rev. 39(3): pp. 275–291 **(17 Pages)**

Emre, O.; De Spiegeleare, S. (2021). The role of work–life balance and autonomy in the relationship between commuting, employee commitment and well-being. Int. J. Hum. Resour. Manag., 32(11): 2443-2467 **(25 Pages)**

Fink, R.; Thompson, C. J.; Bonnes, D. (2005). Overcoming barriers and promoting the use of research in practice. JONA: J. Nurs. Admin., 35(3): 121-129 **(9 Pages)**

Fischer, V.; O'Mara, S. M. (2022). Neural, psychological, and social foundations of collective memory: implications for common mnemonic processes, agency, and identity. Brain Res. J., 274(1): 1-30 **(30 Pages)**

Fontinha, R.; Easton, S.; Van Laar, D. (2019). Overtime and quality of working life in academics and nonacademics: The role of perceived work-life balance. Int. J. Stress Manag., 26(2): 173 **(39 Pages)**

Greenhaus, J. H.; Collins, K. M.; Shaw, J. D. (2003). The relation between work–family balance and quality of life. J. Vocat. Behav., 63(3): 510-531 **(22 Pages)**

Gregory, A.; Milner, S. E. (2009). Work-life balance: a matter of choice? Gend. Work Organ., 16(1): **(13 Pages)**

Guest, R. H. (1979). Quality of work life, learning from Tarrytown (pp. 76-87). Harvard University Graduate School of Business Administration, Harv. Bus. Rev **(11 Pages)**

Haider, S.; Jabeen, S.; Ahmad, J. (2018). Moderated mediation between work life balance and employee job performance: The role of psychological wellbeing and satisfaction with coworkers. Rev. Psicol. Trab. las Organ., 34(1): 29-37 **(9 Pages)**

Hair, J.F.; Risher, J.J.; Sarstedt, M.; Ringle, C.M., (2019). When to use and how to report the results of PLS-SEM. Eur. Bus. Rev., 31(1): 2-24 **(23 Pages)**

Hayat, A.; Afshari, L. (2022). CSR and employee well-being in hospitality industry: A mediation model of job satisfaction and affective commitment. J. Hosp. Tour. Manag., 51: 387-396 **(10 Pages)**

Heffernan, M.; Dundon, T. (2016). Cross-level effects of high-performance work systems (HPWS) and employee well-being: the mediating effect of organisational justice. Hum. Resour. Manag. J., 26(2)., 211-231 **(21 Pages)**

Herzberg, F. I. (1966). Work and the Nature of Man.

Ho, H.; Kuvaas, B. (2020). Human resource management systems, employee well-being, and firm performance from the mutual gains and critical perspectives: The well-being paradox. Hum. Resour. Manag., 59(3): 235-253 **(19 Pages)**

Horst, D. J.; Broday, E. E.; Bondarick, R.; Serpe, L. F.; Pilatti, L. A. (2014). Quality of Work Life and productivity: An overview of the conceptual framework. Int. J. Manag. Stud. (IJMSR)., 2(5): 87-98 **(12 Pages)**

Hsu, M. Y.; Kernohan, G. (2006). Dimensions of hospital nurses' quality of working life. J. Adv. Nurs., 54(1): 120-131 **(12 Pages)**

Jayakumar, A.; Kalaiselvi, K. (2012). Quality of work life-an overview. IJMFS & MR., 1(10): 140-151 **(12 Pages)**

Jiang, H.; Men, R. L. (2017). Creating an engaged workforce: The impact of authentic leadership, transparent organizational communication, and work-life enrichment. J. Commun. Res., 44(2): 225-243 **(19 Pages)**

Kanten, S.; Sadullah, O. (2012). Empirical research on relationship quality of work life and work engagement. Procedia. Soc. Behav. Sci., 62: 360-366 **(7 Pages)**

Kaya, B.; Karatepe, O. M. (2020). Attitudinal and behavioral outcomes of work-life balance among hotel employees: The mediating role of psychological contract breach. J. Hosp. Tour. Manag., 42: 199-209 **(11 Pages)**

Kim, J. S.; Ryu, S. (2017). Employee satisfaction with work-life balance policies and organizational commitment: A Philippine study. PUBLIC. ADMIN. DEVELOP., 37(4): 260-276 **(17 Pages)**

Ko, M. C. (2021). An examination of the links between organizational social capital and employee well-being: Focusing on the mediating role of quality of work life. Rev. Public Pers. Adm., 41(1): 163-193 **(31 Pages)**

Kumar, K. (2018). Impact of Quality of Work Life on Employees of Foundry Industries in Belagavi. RRIJM, 3(12): 49-52 **(4 Pages)**

Lawler, E. E. (1982). Strategies for improving the quality of work life. Am. Psychol., 37(5): 486 **(7 Pages)**

Lee, D. J.; Yu, G. B.; Sirgy, M. J.; Singhapakdi, A.; Lucianetti, L. (2018). The effects of explicit and implicit ethics institutionalization on employee life satisfaction and happiness: The mediating effects of employee experiences in work life and moderating effects of work–family life conflict. J. Bus. Ethics, 147: 855-874 **(20 Pages)**

Levine, M. F.; Taylor, J. C.; Davis, L. E. (1984). Defining Quality of Work Life. Hum. Relat., 37(1): 81-104 **(24 Pages)**

Lewis, D.; Brazil, K.; Krueger, P.; Lohfeld, L.; Tjam, E. (2001). Extrinsic and intrinsic determinants of quality of work life. Leadersh. Health Serv., 14(2): 9-15 **(7 Pages)**

Majumder, S.; Biswas, D. (2021). Fundamentals, present and future perspectives of quality of work life. In Proceeding of First Doctoral Symposium on Natural Computing Research: DSNCR 2020 (pp. 271-279). Springer Sing. **(9 Pages)**

McClelland, D. C. (2019). The achievement motive in economic growth. In *the gap between rich and poor* (pp. 53-69). Routledge. **(17 Pages)**

McFarland, A. L. (2017). The relationship between the use of green spaces and public gardens in the work place on mental well-being, quality of life, and job satisfaction for employees and volunteers. HortTechnology., 27(2): 187-198 **(12 Pages)**

Md-Sidin, S.; Sambasivan, M.; Ismail, I. (2010). Relationship between work-family conflict and quality of life: An investigation into the role of social support. J. Manag. Psychol., 25(1): 58-81 **(24 Pages)**

Nadler, D. A.; Lawler 3rd, E. E. (1983). Quality of work life: perspectives and directions. Organ. Dyn., 11(3), 20-30. **(11 Pages)**

Nagendrababu, V.; Dilokthornsakul, P.; Jinatongthai, P.; Veettil, S. K.; Pulikkotil, S. J.; Duncan, H. F.; Dummer, P. M. H. (2020). Glossary for systematic reviews and meta-analyses. Int. Endod. J., 53(2), 232-249. **(18 Pages)**

Nielsen, K.; Nielsen, M. B.; Ogbonnaya, C.; Känsälä, M.; Saari, E.; Isaksson, K. (2017). Workplace resources to improve both employee well-being and performance: A systematic review and meta-analysis. Work Stress, 31(2): 101-120 **(20 Pages)**

Omar, M. K.; Mohd, I. H.; Ariffin, M. S. (2015). Workload, role conflict and work-life balance among employees of an enforcement agency in Malaysia. Int. J. Bus., Econ. Law., 8(2): 52-57 **(6 Pages)**

Oosthuizen, R. M.; Coetzee, M.; Munro, Z. (2016). Work-life balance, job satisfaction and turnover intention amongst information technology employees. South. Afr. Bus. Rev., 20(1): 446-467 **(22 Pages)**

Parakandi, M.; Behery, M. (2016). Sustainable human resources: Examining the status of organizational work–life balance practices in the United Arab Emirates. Renew. Sustain. Energy Rev., 55: 1370-1379 **(10 Pages)**

Parvar, M. R. F.; Allameh, S. M.; Ansari, R. (2013). Effect of quality of work life on organizational commitment by SEM (case study: OICO company). Int. J. Acad. Res. Business Social Sci. J., 3(10): 135 **(10 Pages)**

Pawar, B. S. (2013). A proposed model of organizational behavior aspects for employee performance and well-being. APPL. RES. QUAL. LIFE., 8: 339-359 **(21 Pages)**

Platts, L. G.; Netuveli, G.; Webb; E., Zins, M.; Goldberg; M., Blane, D.; Wahrendorf, M. (2013). Physical occupational exposures during working life and quality of life after labour market exit: results from the GAZEL study. Aging. Ment. Health., 17(6): 697-706 **(10 Pages)**

Puciato, D.; Borysiuk, Z.; Rozpara, M. (2017). Quality of life and physical activity in an older working-age population. Clin. Interv. Aging., 1627-1634 **(8 Pages)**

Radic, A., Arjona-Fuentes, J. M., Ariza-Montes, A., Han, H., Law, R. (2020). Job demands–job resources (JD-R) model, work engagement, and well-being of cruise ship employees. International Journal of Hospitality Management, 88, 102518. **(9 Pages)**

Rathi, N. (2009). Relationship of Quality of Work Life with Employees' Psychological Well-Being. International journal of business insights & transformation, 3(1):1-4 **(4 Pages)**

Rathi, N.; Rastogi, R.; Rangnekar, S. (2011). Quality of work life, organisational commitment, and psychological well-being. A study of the Indian employees. Int. J. Contemp. Bus. Stud., 2(4): 2156-7506 **(13 Pages)**

Rice, R. W.; Frone, M. R.; McFarlin, D. B. (1992). Work—nonwork conflict and the perceived quality of life. J. Organ. Behav., 13(2): 155-168 **(14 Pages)**

Sahni, J. (2019). Role of quality of work life in determining employee engagement and organizational commitment in telecom industry. Int. J. Qual. Res., 13(2): 285 **(16 Pages)**

Salehi, M.; Seyyed, F.; Farhangdoust, S. (2020). The impact of personal characteristics, quality of working life and psychological well-being on job burnout among Iranian external auditors. Int. J. Organ. Theory Behav., 23(3): 189-205 **(17 Pages)**

Sarstedt, M.; Ringle, C.M.; Smith, D.; Reams, R.; Hair, J.F., (2014). Partial least squares structural equation modeling (PLS-SEM): A useful tool for family business researchers. J. Fam. Bus. Strategy., 5(1): 105-115 **(11 Pages)**

Scaringella, L.; Radziwon, A. (2018). Innovation, entrepreneurial, knowledge, and business ecosystems: Old wine in new bottles? Technol. Forecast. Soc. Change., 136: 59-87 **(29 Pages)**

Shinde, G. R.; Majumder; S., Bhapkar, H. R.; Mahalle, P. N. (2022). Quality of Work-Life During Pandemic. Springer Sing **(127pages)**

Sirgy, M. J.; Efraty, D.; Siegel, P.; Lee, D. J. (2001). A new measure of quality of work life (QWL) based on need satisfaction and spillover theories. Soc. Indic. Res., 55: 241-302 **(62 Pages)**

Soomro, A. A.; Breitenecker, R. J.; Shah, S. A. M. (2018). Relation of work-life balance, work-family conflict, and family-work conflict with the employee performance-moderating role of job satisfaction. South Asian J. Bus. Stud., 7(1): 129-146 **(18 Pages)**

Srivastava, S.; Kanpur, R. (2014). A study on quality of work life: key elements & It's Implications. IOSR J. Bus. Manag, 16(3): 54-59 **(6 Pages)**

Swamy, D. R. (2013). Quality of work life of employees in private technical institutions. Int. J. Qual. Res., 7(3): 3-14 **(12 Pages)**

Swamy, D. R.; Nanjundeswaraswamy, T. S.; Rashmi, S. (2015). Quality of work life: scale development and validation. Int. J. Caring Sci., 8(2): 281 **(20 Pages)**

Szücs, S.; Drobnič, S.; den Dulk, L.; Verwiebe, R. (2011). Quality of life and satisfaction with the work-life balance. In Quality of life and work in Europe: Theory, practice and policy (pp. 95-117). London: Palgrave Macmillan UK. **(22 Pages)**

Teles, M. A. B.; Barbosa, M. R.; Vargas, A. M. D.; Gomes, V. E.; e Ferreira, E. F.; Martins, A. M. E. D. B. L.; Ferreira, R. C. (2014). Psychosocial work conditions and quality of life among primary health care employees: a cross-sectional study. Health Qual. Life Outcomes., 12: 1-12 **(13 Pages)**

Trivedi, A. J.; Mehta, A. (2019). Maslow's hierarchy of needs-theory of human motivation. IJRSML., 7(6): 38-41 **(4 Pages)**

Walton, R. E. (1973). Quality of working life: what is it. MIT Sloan Manag. Rev., 15(1): 11-21 **(11 Pages)**

Wang, Q. Q.; Lv, W. J., Qian, R. L.; Zhang, Y. H. (2019). Job burnout and Quality of Work Life among Chinese nurses: A cross-sectional study. J. Nurs. Manag., 27(8): 1835-1844 **(10 Pages)**

Webster, J.; Watson, R. T. (2002). Analyzing the past to prepare for the future: Writing a literature review. MIS quarterly, xiii-xxii **(12 Pages)**

Wright, K. B.; Abendschein, B.; Wombacher, K.; O'Connor, M.; Hoffman, M.; Dempsey, M.; ... Shelton, A. (2014). Work-related communication technology use outside of regular work hours and work life conflict: The influence of communication technologies on perceived work life conflict, burnout, job satisfaction, and turnover intentions. Manag. Commun. Q., 28(4): 507-530 **(24 Pages)**

Zhang, X.; Lin, Z.; Liu, Y.; Chen, X.; Liu, D. M. (2020). How do human resource management practices affect employee well-being? A mediated moderation model. Empl. Relat., 42(4): 903-919 **(17 Pages)**

Zheng, X.; Zhu, W.; Zhao, H.; Zhang, C. (2015). Employee well-being in organizations: Theoretical model, scale development, and cross-cultural validation. J. Organ. Behav., 36(5): 621-644 **(24 Pages)**

HOW TO CITE THIS ARTICLE

Forouzandeh Joonaghani, R.; Hosseini, S. A.; Raeesi Vanani, I., (2025). A model for measuring the Quality of Work-Life. Int. J. Hum. Capital Urban Manage., 10(2): 229-250.

DOI: 10.22034/IJHCUM.2025.02.03

URL: https://www.ijhcum.net/article_717814.html

Int. J. Hum. Capital Urban Manage., 10(2): 251-268, Spring 2025

International Journal of Human Capital in Urban Management
(IJHCUM)

Homepage: http://www.ijhcum.net/

ORIGINAL RESEARCH PAPER

Navigating urban gridlock: A study of traffic congestion and sustainable mobility solutions in the urban center

D. V. Ogunkan[1,*], E. O. Olaleye[2], O. P. Akinpelu[1], I. O. Oyeleye[3]

[1] *Department of Urban and Regional Planning, Bells University of Technology, Ota, Nigeria*
[2] *Department of Community and Regional Planning, Alabama A&M University, Normal, AL, USA*
[3] *Department of Tourism Studies, Osun State University, Osogbo, Nigeria*

ARTICLE INFO

Article History:
Received 05 August 2024
Revised 10 October 2024
Accepted 02 November 2024

Keywords:
Traffic congestion
Land use
Road capacities
Traffic composition
Commuters

ABSTRACT

BACKGROUND AND OBJECTIVES: Traffic congestion, a prevalent global issue, has entrenched itself as a persistent problem, posing substantial challenges for residents and commuters, especially in developing nations. This study addresses this concern by delving into the intensity, patterns, and traffic characteristics within selected road corridors in the Abeokuta metropolis, Nigeria.

METHODS: Data on road types and land use were systematically gathered through structured observations using a pre-designed checklist. Traffic counts were conducted to capture characteristics during the morning and evening peak periods. Traffic volume and capacity were measured in "vehicles per hour" (vph) and Passenger Car Units per hour (PCU/hr). To analyze the data, a chi-square test was used to examine differences in traffic volume between the peak hours, while Analysis of Variance was applied to assess variations in traffic composition across the studied road corridors.

FINDINGS: The study's findings spotlight Sapo-Ijaye-Iyana Mortuary, recording the highest daily peak traffic volume at 2315 vph, with cars dominating at 4444 vph. Buses emerged as the most impactful vehicle class, influencing 4872 PCU/hr. The Chi-square test indicates no significant differences in vph between morning and evening peaks (x=0.822604; p=0.84405). Correspondingly, the Analysis of Variance results (f=3.3106; p=1.0000) suggest that traffic composition did not significantly differ across the surveyed roads.

CONCLUSION: Based on the study's findings, it is recommended to enhance road capacities by upgrading infrastructure to accommodate both current and future transportation needs. Additionally, the development of alternative traffic routes, such as rail lines, is suggested to ease the movement of heavy-duty trucks and reduce road congestion. Adopting intelligent transportation systems is also encouraged to improve traffic management and optimize transportation efficiency.

DOI: 10.22034/IJHCUM.2025.02.04

NUMBER OF REFERENCES	NUMBER OF FIGURES	NUMBER OF TABLES
60	5	8

*Corresponding Author:
Email: *ogunkansvictor@yahoo.com*
Phone: +2348034866541
ORCID: 0000-0003-2681-1023

Note: Discussion period for this manuscript open until July 1, 2025 on IJHCUM website at the "Show Article.

INTRODUCTION

Cities represent focal points of intensified economic activities, characterized by a dense accretion of various industries and services. This economic saturation, in turn, gives rise to intricate spatial structures that rely heavily on efficient transport networks for their functionality and development (Wegener, 2021). In essence, cities and their transport systems operate in a symbiotic relationship, a fact emphasized by scholars who have likened transportation to "the veins and arteries of urban areas" (Berry & Hurton, 1970), the "maker and breaker of cities" (Ogunsanya, 2002 cited in Olawepo, 2015), and the "backbone of the urban economy" (Harriet *et al.*, 2013). However, the recent trajectory of unchecked urbanization and rampant population growth has strained the delicate equilibrium between transportation and cities. The consequence of this strain is notably evident in traffic congestion. This pervasive issue has become a global concern, transcending the developmental stages of countries and posing a significant threat to the quality of urban life. Traffic congestion describes traffic volume or modal split that creates a demand for space that overwhelms the existing road capacity (Rahman *et. al.*, 2022; Afrin & Yodo, 2020). Rapid motorization growth without corresponding enhancements in road networks, infrastructure, and traffic management techniques is a common precursor to congestion (Arti *et al.*, 2022), turning it into a global challenge associated with urban centers worldwide. While some developed nations have made strides in managing traffic congestion, the problem persists largely unsolved in underdeveloped regions, manifesting particularly acutely in countries like Nigeria. In Nigeria, the challenge is exacerbated by factors such as inadequate transportation and traffic facilities, poor driving habits, poor road intersections, poor road network, insufficient road capacity, lack of parking facilities financial constraints, lack of planning data, suboptimal political decisions among many others (Abuh & John, 2023; Irunokhai *et al.*, 2020). In the contemporary context, traffic congestion has permeated virtually every urban landscape in Nigeria, as indicated by various studies (Salisu *et al.*, 2024), Akanmu, Fasina & Sanni, 2020; Ajala, 2019). The issue has evolved into an intractable challenge in the urban centers of Nigeria, fueled by factors such as a burgeoning population, increased household incomes leading to heightened car usage, suboptimal land-use planning, and inefficiencies in transport planning and design (Aderamo & Atomode, 2012). Strikingly, traffic congestion has been speciously characterized as a reflection of urban development (Ajala, 2019) and a symbol of growth in the urban economy (Harriet *et al.*, 2013). However, the actual impact of congestion is nothing short of devastating, manifesting predominantly in recurring queues, time wastage, and other adverse traffic externalities, especially during peak hours (Aderamo & Atomode, 2012). This depiction accurately mirrors the situation in specific corridors and intersections within Abeokuta, the administrative headquarters of Ogun state. The traffic congestion in Abeokuta has become an entrenched problem, causing considerable hardship for residents and commuters, especially along critical corridors such as Adatan-Car-wash-Asero, Panseke-Adigbe, Kuto-Isabo, and Sapon-Ijaye-Iyana Mortuary road. This study, therefore, aims to examine the intensity, patterns, and characteristics of traffic congestion in those specified corridors. The overarching goal is to recommend measures that can effectively address the recurrent traffic gridlock along these corridors, thereby contributing to a more efficient and sustainable urban transportation system in Abeokuta.

Literature review

Definition issues of traffic congestion

Traffic congestion poses a persistent challenge in urban areas globally, exerting significant impacts on economic productivity, air quality, and overall quality of life (Li, 2023; Vichiensan *et al.*, 2021; Rossi *et al.*, 2020). Despite its widespread occurrence, the absence of a universally accepted definition has hindered effective efforts to address this multifaceted issue. Thus, it is imperative to examine the elusive nature of a standardized definition for traffic congestion, exploring diverse perspectives, measurement methodologies, and the consequential implications of this definitional ambiguity. Numerous studies underscore the intricate challenge of defining traffic congestion, resulting in varying interpretations across disciplines and geographic regions (Andreas *et al.*, 2023; Mehdi *et al.*, 2022; Afrin & Yodo, 2020). Some scholars (Al-Turki *et al.*, 2021; Drličiak *et al.*, 2020; Abdulsattar *et al.*, 2020) emphasize the multifaceted nature of congestion, highlighting the intricate interplay among factors such as traffic volume, density, and infrastructure capacity. In contrast, others (Zhu *et*

al., 2023; Droj *et al*., 2021; Acheampong, 2020) argue for the adoption of a multi-scalar concept of urban spatial structure, providing valuable insights into the complex interactions between urban elements and their influence on congestion. These divergent conceptualizations contribute significantly to the ongoing challenge of establishing a standardized definition. The methodologies employed in defining and measuring traffic congestion exhibit noteworthy diversity. Traditional traffic flow models, as proposed by Verhoef *et al.*, (1997) and adopted by various scholars (Karbasi *et al*., 2022; Parisi *et al*., 2021), often rely on observable variables such as speed and density. However, limitations in these models capturing the dynamic nature of congestion have prompted the exploration of emerging technologies. Researchers like Li *et al.*, (2023), Wang *et al*. (2022), and Jiao & Wang (2022) leverage GPS data and real-time monitoring to redefine congestion, emphasizing the necessity for continuous adaptation to evolving urban dynamics. Despite the innovative promise, integrating qualitative approaches, as undertaken by Ambühl *et al.* (2023) and Xie *et al.*, (2020), introduces subjectivity to the definition, posing challenges for standardization. The absence of a standardized definition carries profound implications for both research and policy. Policymakers encounter difficulties formulating effective interventions when the understanding of congestion varies widely. Furthermore, research comparisons become challenging due to inconsistencies in definitions, limiting the generalizability of findings. The economic, social, and environmental impacts of congestion necessitate a cohesive and universally applicable understanding to guide evidence-based decision-making. This review underscores the challenges in achieving a universally accepted definition of traffic congestion. The diversity in conceptualizations and methodologies, coupled with the profound implications of ambiguity, emphasizes the need for collaborative efforts in developing standardized frameworks. As we move forward, research and policy initiatives must navigate this complexity to effectively address the global challenge of urban congestion, emphasizing adaptability and inclusivity in the pursuit of a universally applicable definition.

Studies on traffic congestion in Nigeria

The literature extensively discusses the causes, effects, and remedies for traffic congestion across various regions in Nigeria. Abuh & John (2023) investigate traffic congestion in Abuja, utilizing Geographic Information System (GIS) techniques to map congestion areas, identify causes, and explore solutions. The study, based on random sampling and structured questionnaires, identifies excess taxis as the primary cause and proposes road maintenance and the completion of the Apo-Karshi road as key solutions. Otto & Ogboda (2022) observe a surge in motor vehicles on Port Harcourt Road, leading to significant traffic issues. The study focuses on the Garrison intersection, proposing sustainable improvements based on a comprehensive traffic study using the Relative Importance Index (R.I.I). The identified causes include inadequate bus stop capacity, poor traffic control, and insufficient road capacity. Remedial measures involve enhancing the intersection with U-turns, pedestrian crossing facilities, and off-road bus stop bays.

Salisu *et al.*, (2020) examine persistent traffic congestion issues in Ibadan, emphasizing ineffective traditional measures and negative motorist attitudes. The study explores Intelligent Transport Systems (ITS) as a solution, highlighting faulty intersections and an excess of traffic officers as significant contributors to congestion. The findings suggest a clear necessity and willingness to adopt ITS in Ibadan, with recommendations aiming to enhance traffic flow in Nigerian cities. Irunokhai *et al*., (2020) argue that population increase exacerbates traffic congestion, leading to the selection of Sango T junction in Ibadan for investigation. The study, employing direct observation and time countdown methods, determines the morning as the peak traffic period. Although the average waiting time in the evening is higher, there isn't a significant difference in traffic flow between peak and off-peak periods. In Ogun State, despite a few outdated studies (Ajala, 2019; Olagunju, 2015; Raji & Muse, 2009), there is a lack of serious research attention on traffic congestion in Abeokuta, the administrative headquarters. This gap exists despite its economic importance, substantial population growth, and proximity to Lagos, the commercial hub of Nigeria.

Causes of traffic congestion in Nigeria

Traffic congestion in Nigeria is primarily caused by poor road infrastructure, indiscriminate parking, and high vehicle density. Many of the roads in the country are in poor condition, characterized by potholes and inadequate drainage systems, which slow down the

Fig. 1: The study area: Abeokuta metropolis (source: Google Maps, 2024)

movement of vehicles and cause frequent traffic jams (Aderamo & Atomode, 2012). Indiscriminate parking further worsens the situation, as vehicles parked along roadsides reduce the available space for moving traffic, leading to congestion (Ajala, 2019).

The number of vehicles on Nigerian roads has also increased significantly, surpassing the capacity of the existing road infrastructure. This imbalance between vehicle numbers and road capacity exacerbates congestion (Olawale, 2020). In addition, ineffective traffic management and the absence of proper traffic signals contribute to the problem, with traffic officers often struggling to manage the flow of vehicles effectively (Olagunju, 2015). Street trading and commercial activities along major roads also obstruct traffic, as vendors and buyers often spill onto the streets, leaving less space for vehicles (Global Journals, 2018). Rapid urbanization has led to an increased demand for road space, but many cities have not expanded their road networks to match the growing population (Olawale, 2020). Furthermore, deficiencies in the public transport system, such as inadequate and poorly managed services, force more people to rely on private vehicles, increasing traffic volumes (Ajala, 2019). Cultural factors, including driving behaviors like aggressive driving and a disregard for traffic rules, also contribute to the worsening traffic situation (Olagunju, 2015). The effects of traffic congestion in Nigeria are far-reaching. Economically, it leads to a loss of productive time and increased fuel consumption. Environmentally, the idling of vehicles during traffic jams contributes to increased emissions and air pollution (Olawale, 2020, Olagunju, 2015;. Health-wise, prolonged exposure to congested traffic conditions can lead to elevated stress levels and respiratory issues (Onyeneke, 2018). To address these issues, various remedies have been proposed. Improving road infrastructure through regular maintenance and expansion of road networks is essential. More effective traffic management systems, along with better training for traffic officers, are also necessary to manage traffic flow efficiently. Developing efficient and reliable public transport systems can help reduce the reliance on private vehicles (Aderamo & Atomode, 2012)., alleviating congestion. Additionally, enforcing laws to prevent street trading on major roads and educating drivers about the importance of adhering to traffic rules can help reduce congestion and improve traffic flow in Nigeria.

The study area

The study area is Abeokuta, the administrative headquarters of Ogun State. Abeokuta became the state capital of Ogun State in 1976. Abeokuta lies within the southwestern part of Nigeria on Longitude 3.33°E and latitude 7.17°N (see Fig. 1). It is within 70 15′ North of the Equator and Longitude 50 05′ East of the Greenwich Meridian. Abeokuta, being sandwiched between Lagos and Ibadan, the two important cities in the Southwestern part of Nigeria, is about 103 km to the former and 79 km to the latter.

MATERIALS AND METHODS

Data types and sources

The data required for this study were sourced from primary sources, encompassing the following:

1. *Corridor types and associated land uses* (Commercial, residential, industrial, institutional, markets, retailing shops, etc.) obtained through direct observation.

2. *Traffic characteristics*: Including traffic volume, composition, variations, and operating capacity, sourced through manual traffic count.

Data collection

In this study, a systematic approach to data collection was adopted to ensure accuracy and consistency in gathering essential information related to road types, intersections, and land uses. The researchers designed a comprehensive checklist that allowed for the standardized collection of data on various road and intersection configurations, including dual and single carriageways, as well as different intersection types such as two-legged, three-legged, and four-legged intersections. Additionally, the checklist categorized land use types into key categories like commercial, industrial, residential, institutional, motor parks, and retail shops. This standardized tool ensured that data could be collected uniformly across all observed locations. To assist in the data collection process, a team of six trained assistants was employed. Each assistant underwent a week-long training session, focusing on critical aspects of the research such as land-use classification, traffic counting, and proper utilization of the checklist. A particular emphasis was placed on ensuring the reliability of subjective classifications, like land use, which can often vary depending on individual perspectives. To address this, inter-rater reliability measures were implemented, where the assistants conducted trial runs to compare their observations. In cases where discrepancies arose, they were discussed and resolved collectively, ensuring that all assistants had a uniform understanding of the criteria for classifying land uses and traffic features. This process not only helped minimize errors but also ensured that data collection was reliable and consistent across the study area. Data on traffic volume and composition were manually collected using a hand-tally method for several reasons. This approach allows for detailed recording of various vehicle types, which is essential for analyzing their impact on road usage and congestion. It offers flexibility in selecting times and locations for counts, enabling researchers to capture peak traffic periods effectively. Manual counting also allows observers to account for situational variables like road conditions and weather, providing qualitative context to the quantitative data. Additionally, this method is cost-effective, particularly for short-term studies, and can yield more accurate results in low-traffic areas compared to automated systems. However, potential limitations include human error and observational biases. To address these, thorough training for data collectors and standardized protocols for data collection are essential. The traffic counts were strategically conducted during peak hours—morning (7:00 am to 10:00 am) and evening (3:00 pm to 6:00 pm)—to capture fluctuations in traffic flow. These counts took place on Monday, Wednesday, and Saturday to account for both weekday and weekend variations in traffic patterns. The decision to conduct traffic counts on Monday, Wednesday, and Saturday was strategically made to capture a comprehensive view of traffic patterns throughout the week. Monday was selected for its high commuter activity as people return to work or school after the weekend. Wednesday provided insights into midweek traffic flow, helping to identify typical weekday patterns. Saturday represented weekend traffic, capturing travel for leisure, errands, and social activities. This combination of days ensured a comprehensive analysis of both weekday and weekend traffic dynamics, allowing for a deeper understanding of the factors influencing traffic volume and composition. The data from these three days were averaged to provide a more representative picture of the typical daily traffic flow. To maintain consistency in the traffic counts, the traffic was categorized into different types, such

as passenger vehicles, trucks, and motorcycles, with each category recorded separately. This categorization allowed the researchers to gain a detailed understanding of the composition of traffic in the study area. Additionally, supervisors regularly verified the tally sheets used by the assistants to ensure that errors were caught and corrected immediately. Periodic spot checks were also conducted at various observation points to ensure that the traffic counts remained consistent and accurate throughout the study. These measures ensured that the traffic data collected was both reliable and robust, forming a solid foundation for the study's analysis and recommendations.

Statistical treatment

The traffic volume data collected from the manual counts were subjected to a comprehensive statistical analysis to uncover trends, variations, and patterns in traffic flow across different periods and road corridors. Descriptive statistical measures, such as mean, standard deviation, and percentage distribution, were employed to provide a clear picture of the average traffic volume and its variability throughout the study period. The use of mean values helped establish a baseline for understanding typical traffic conditions on different days and during specific time frames, while the standard deviation illustrated the extent of fluctuations around the average, highlighting periods of high and low traffic intensity. To further refine the analysis, the data were disaggregated based on specific factors such as vehicle type (e.g., passenger cars, trucks, motorcycles) and road corridor classification. This categorization allowed for a more granular view of the composition of traffic and its impact on different segments of the transportation network. The patterns observed in vehicle composition were crucial for assessing road capacity and operational efficiency, particularly in identifying corridors that were prone to congestion or overuse. For example, a higher concentration of heavy-duty trucks in certain corridors could indicate the need for alternative routes or infrastructure upgrades to manage the load more effectively. Additionally, peak and off-peak traffic volumes were analyzed separately to capture temporal variations. The morning and evening peak hour data were compared to off-peak periods to determine the intensity of traffic congestion during different times of the day. By using descriptive statistics to quantify the extent of these variations, the study was able to pinpoint critical time slots when traffic was most likely to reach or exceed road capacity. This time-based analysis was instrumental in identifying specific periods that required traffic management interventions, such as re-timing of signals, the introduction of reversible lanes, or restrictions on heavy vehicle movements during peak hours. The analysis incorporated inferential statistical techniques, specifically employing the chi-square test and Analysis of Variance (ANOVA), to investigate differences in traffic volume during peak hours. The chi-square test was selected for its capability to assess whether there were significant deviations between observed and expected traffic volumes, allowing for a clear understanding of fluctuations during specific times of day. In contrast, ANOVA was utilized to evaluate significant variations in traffic volumes across different road types and land-use classifications. This approach was particularly useful in discerning whether differences in traffic flow could be attributed to structural distinctions in the road networks (such as single versus dual carriageways) or the impacts of adjacent land uses (for instance, commercial versus residential areas). This helped isolate the factors contributing most significantly to congestion, providing a basis for targeted policy recommendations and infrastructure planning. The use of these statistical tools provided a robust framework for interpreting the raw traffic data and transforming it into actionable insights. The findings from the statistical analysis were essential for understanding the operational capacity of the road networks, diagnosing traffic bottlenecks, and making informed recommendations for both short-term traffic management and long-term infrastructure improvements. By identifying statistically significant patterns and relationships within the data, the study was able to support its recommendations with empirical evidence, enhancing the credibility and applicability of its findings in urban and regional planning contexts.Top of Form

RESULTS AND DISCUSSION

Unless specified otherwise, all tables and charts presented in this study are derived from the survey conducted in 2024.

Characteristics of road corridors

Table 1 provides insights into the characteristics of the chosen road corridors. These corridors include

Table 1: Characteristics of selected road corridors and associated land uses

SN	Road corridor name	Road types	Types of carriageway	Major intersections	Land use characteristics
1	Adatan/ Asero	Arterial	2-lane (one way)	Adatan roundabout, car wash intersection, Aladesanmi intersection	Public, Religious, Motor Parks, and service industry
2	Panseke-Adigbe	Sub-arterial	2-lane (one way)	Panseke intersection, Ibara roundabout, Kuforiji intersection	Public, Institutional, residential, and retailing shops
3	Kuto-Isabo	Sub-arterial	2-lane (one way)	Kuto roundabout, Iyana Oja intersection	Public, institutional, Motor Park and Market, retailing shops
4	Sapo-Ijaye-Iyana Mortuary	Arterial	4-lane divided (two-way)	Sapon roundabout, Ijaye Roundabout, Iyana-Mortuary intersection	Public, service industry, Commercial Motor Park, Religious, Market

Adatan Car Wash/Asero, Panseke/Adigbe, Kuto/Isabo, and Sapo-Ijaye/Iyana Mortuary. The selected road corridors play a crucial role in connecting various land-use activities within Abeokuta and nearby cities. These corridors include Adatan Car Wash/Asero, Panseke/Adigbe, Kuto/Isabo, and Sapo-Ijaye/Iyana Mortuary roads. To streamline the discussion and reduce redundancy, similar road types have been grouped, allowing for easier comparison and highlighting their unique characteristics. Adatan Car Wash/Asero Road stands out as a key transportation link within the city. Currently operating as a two-lane, one-way road, it is undergoing construction to transform into a four-lane, two-way dual carriageway. This road connects critical land uses such as Isale Abetu Cemetery, Adatan Market, various banks, filling stations, and the Mudasiru Lawal International Stadium. Major intersections include the Adatan Roundabout, Car Wash Intersection, and Aladesanmi Intersection. The expansion of this road is aimed at increasing its capacity and improving access to surrounding commercial and public spaces, making it a vital connector for residential, commercial, and institutional activities. Next, the sub-arterial roads of Panseke/Adigbe and Kuto/Isabo share several similar characteristics, making them suitable for grouping. Both roads are two-lane, one-way roads that are currently under construction for potential upgrades into four-lane, two-way roads. They are integral to the movement of people and goods within the city, connecting essential land-use areas.Panseke/Adigbe serves as an important connector to diverse land uses such as Independent Park (recreational), June 12 Garage/Market (public/market), and a variety of service industries, including banks and retail shops. Major intersections on this road include the Panseke Intersection, Ibara Roundabout, and Kuforiji Intersection. The road's planned expansion is expected to accommodate growing traffic and improve access to commercial areas. Kuto/Isabo functions in a similar capacity, linking important destinations like the MKO International Stadium, the June 12 Cultural Centre, religious sites, markets, and retail shops. Key intersections along this route include the Kuto Roundabout and the Iyana Oja Intersection. Like Panseke/Adigbe, Kuto/Isabo's expansion will ease traffic congestion and facilitate access to important public and commercial sites. Both sub-arterial roads share the challenge of limited capacity, which results in heavy traffic during peak hours. Their upgrades are expected to significantly improve traffic flow and enhance connectivity between recreational, commercial, and institutional areas in Abeokuta.

In contrast, Sapo/Iyana Mortuary Road is already a four-lane, divided, two-way road, setting it apart from the other corridors. It features major intersections at the Sapon Roundabout, Ijaye Roundabout, and Iyana-Mortuary Intersection. This corridor serves a variety of land uses, including saw-mill industries, retail shops, shopping complexes, and other service-oriented businesses. Despite being dualized, the road faces capacity challenges due to the heavy industrial and commercial traffic, especially from large trucks servicing the industrial sector. Unlike the sub-arterial roads that are still being upgraded, Sapo/Iyana Mortuary is fully operational but continues to face congestion issues, making it a key focus for future traffic management strategies. By grouping the

sub-arterial roads and distinguishing the already dualized Sapo/Iyana Mortuary, this discussion presents a more fluid comparison of the corridors, highlighting both their similarities and distinct characteristics. The differences in their levels of development and usage patterns provide insight into their varying roles in Abeokuta's road network.

Traffic characteristics of road corridors

Traffic volume patterns

Average daily traffic volume in the studied roads

Traffic volume, typically measured as Vehicles per Hour (vph), represents the count of vehicles passing a specific point on a roadway within a designated timeframe. For both peak periods (morning and evening), the total three-hour traffic volume was divided by 3 to calculate the number of vehicles per hour. The daily peak is derived from the average of both morning peak vph and evening peak vph. The average peak-hour volume, expressed in vph, is detailed in Table 2.

Traffic volume analysis of road corridors

From Table 2, the Sapo-Ijaye-Iyana Mortuary road stands out as the corridor with the highest traffic volume among the studied road networks. It contributes 37.5% (2367 vph), 31.6% (2263 vph), and 34.4% (2315 vph) to the total traffic during the morning, evening, and daily peaks, respectively. This high traffic volume underscores the significance of the land use activities it facilitates, serving as a vital link to the Lagos/Ibadan expressway through the Ogere road and connecting important establishments like the post office, sawmill, St. Jude Anglican church, and numerous retail shops. The Kuto-Isabo road follows closely, generating the second-highest traffic volume with 1570 vph (24.9%), 1859 vph (26%), and 1714 vph for the morning, evening, and daily peaks, respectively. This road's importance is evident in its connection to MKO International Stadium, June 12 Cultural Center, St. John Anglican Schools (primary and secondary), Kuto Garage, Oba Lipede Ultra-Modern Market, and various retail businesses. Panseke-Adigbe secures the third position, recording 1183 vph (18.8%), 1542 vph (21.6%), and 1363 vph (20.34%) for the morning, evening, and daily peaks, respectively. The traffic flow on Panseke/Adigbe road highlights its significance in connecting June 12 Garage/Market, Independent Park, and several commercial centers linked by the road, serving as a major link to the Lagos/Abeokuta road through Sango Ota. Adatan Car Wash-Asero ranks fourth, registering 1187 vph (18.8%) in the morning peak, 1488 vph (20.8%) in the evening peak, and 1338 vph (19.94%) during daily peaks. This road connects traffic to Ibadan through Apata, links to Adatan Market, and hosts numerous retail shops. The aggregate variation between morning and evening peak hours, depicted in Fig. 1, indicates a higher traffic volume in the evening peak (1788 vph) than in the morning peak (1577 vph). This asymmetry may be attributed to commuters leaving home before or after peak hours to avoid congestion, resulting in a staggered morning traffic pattern. However, in the evening, individuals might be eager to return home promptly after work. This traffic pattern is consistent across all road corridors, except for Sapo-Ijaye-Iyana Mortuary, where the morning peak (2367 vph) surpasses the evening peak (2263 vph). Nevertheless, the Chi-square test results ($X = 0.822604$, $p=0.84405$) indicate no significant differences in the number of vehicles per hour between morning and evening peaks among the studied road corridors. The Chi-square test results, which yielded a statistic of $X=0.822604X = 0.822604$, and a p-value of 0.844050, suggest that there are no significant differences in the number of vehicles per hour between morning and evening peak periods across the studied road corridors. This lack of statistical significance implies that any observed variations in traffic volume during these peak hours can be attributed to random chance rather than underlying patterns or trends. In this context, "random chance" refers to the idea that

Table 2: Average peak hour volume in selected Road Corridors

SN	Road Corridors	Morning Peak		Evening Peak		Daily Peak	
		vph	%	vph	%	vph	%
1	Adatan-Car-wash-Asero	1187	18.8	1488	20.8	1338	19.9
2	Panseke-Adigbe	1183	18.8	1542	21.6	1363	20.3
3	Kuto-Isabo	1570	24.9	1859	26.0	1714	25.5
4	Sapo-Ijaye-Iyana Mortuary	2367	37.5	2263	31.6	2315	34.4
Total		6307	100	7152	100	6730	100

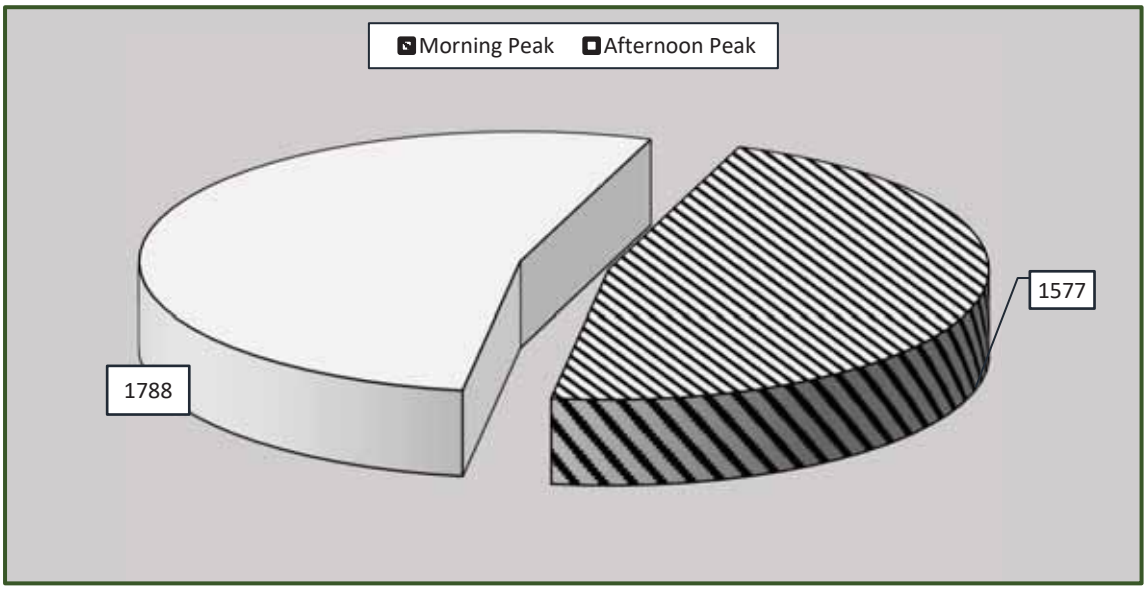


Fig. 1: Average morning and evening peaks in the studied road corridors

the variations in traffic counts observed might occur due to factors unrelated to the specific characteristics of the road corridors or the time of day. Essentially, the similarities in traffic volume across different corridors may not stem from distinct differences in land-use or road design, but rather from common factors affecting all corridors uniformly. Several possible reasons might explain the absence of significant differences in vehicle counts. One potential reason could be the uniformity in land-use patterns across the studied corridors, which means that they may attract similar volumes of traffic regardless of time. For instance, if multiple corridors serve similar commercial, residential, or recreational purposes, the overall demand for road usage may remain consistent, leading to similar traffic patterns. While the Chi-square test indicates that the statistical differences are not significant, it is crucial to approach these findings with caution. The absence of statistical significance does not invalidate the practical significance of the observed variations. Qualitative factors, such as local traffic management strategies, seasonal variations, special events, or even socio-economic dynamics, could provide valuable insights into the traffic patterns. Incorporating local knowledge and qualitative assessments can lead to a more nuanced understanding of traffic dynamics in these corridors, beyond what statistical tests can reveal.

Analysis of average traffic volume by selected days of the week

The traffic counts were conducted on Monday, Wednesday, and Saturday, offering insights into the variations in traffic volume based on these specific days. The aggregate data on traffic volume revealed distinct implications for different days of the week. The overall distribution demonstrates that Monday had the highest share, accounting for 39% of the total traffic generated on the selected road corridors over the three days. Following closely is Wednesday with 34%, and Saturday with 27%, as illustrated in Fig. 2. This variation in traffic volume among the selected days carries economic implications. The heightened traffic volume on Monday is likely attributed to its perception as the most economically crucial day. Individuals are eager to commence their workweek on a positive economic note, contributing to the increased traffic. Wednesday, while still a significant working day, might not be viewed as economically pivotal as Monday. This perspective possibly results in a slight dip in traffic volume on Wednesdays. On the other hand, Saturday, being a weekend associated with relaxation and social events, experiences a comparatively lower traffic volume during peak hours. This phenomenon aligns with the general trend of fewer people rushing out on weekends, contributing to the observed decrease in traffic volume on Saturdays.

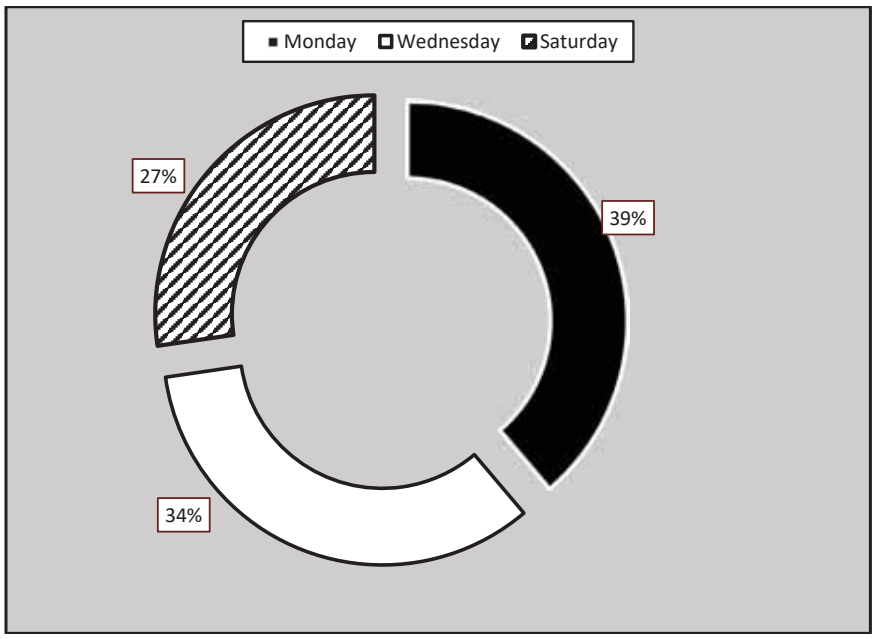


Fig. 2: Overall daily traffic volume on the studied roads

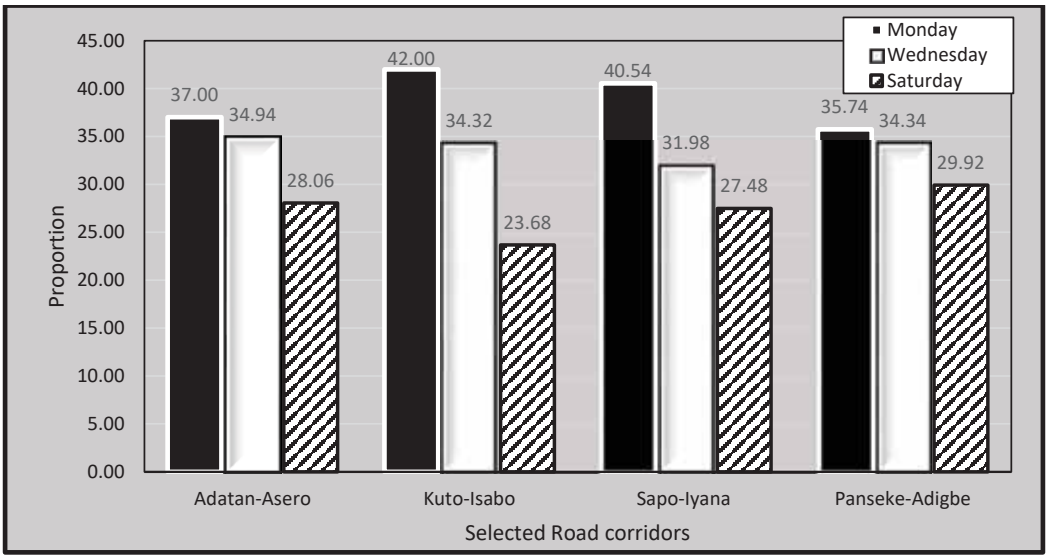


Fig. 3: Proportion of traffic volume by selected days of the week in the studied roads

The data breakdown for each specific location reveals a consistent pattern with the overall distribution, as depicted in Fig. 3.

Pattern of traffic composition

The traffic composition across the studied corridors is detailed in Table 3. The data reveals that cars, encompassing both private cars and taxis, constitute the largest share with 44% of the total volume, amounting to 4444 vehicles per hour (vph). This stands in contrast to the findings of Aderamo & Atomode (2012), where motorcycles were reported to be the predominant vehicle type in Ilorin. Nevertheless, motorcycles still account for a substantial

Table 3: Traffic composition at the studied Road Corridors

Vehicle Type	A	%	B	%	C	%	D	%	Total	%	vph
Motorcycle	1752	21.8	2572	31.5	3266	31.8	4028	29.0	11618	28.8	2905
Car	4200	52.3	3588	43.9	4394	42.7	5594	40.3	17776	44.0	4444
Bus	1198	14.9	1280	15.7	1838	17.9	2992	21.5	7308	18.1	1827
Lorry/Tipper	876	10.9	736	9.0	788	7.7	1278	9.2	3678	9.1	920
Total	8026	100	8176	100	10286	100	13892	100	40380	100	10095
vph	1338	19.9	1363	20.3	1714	25.5	2315	34.4	6730	100	

Note: A= Adatan/Asero, B=Panseke/Adigbe, C=Kuto/Isabo, D= Sapo/Iyana Mortuary

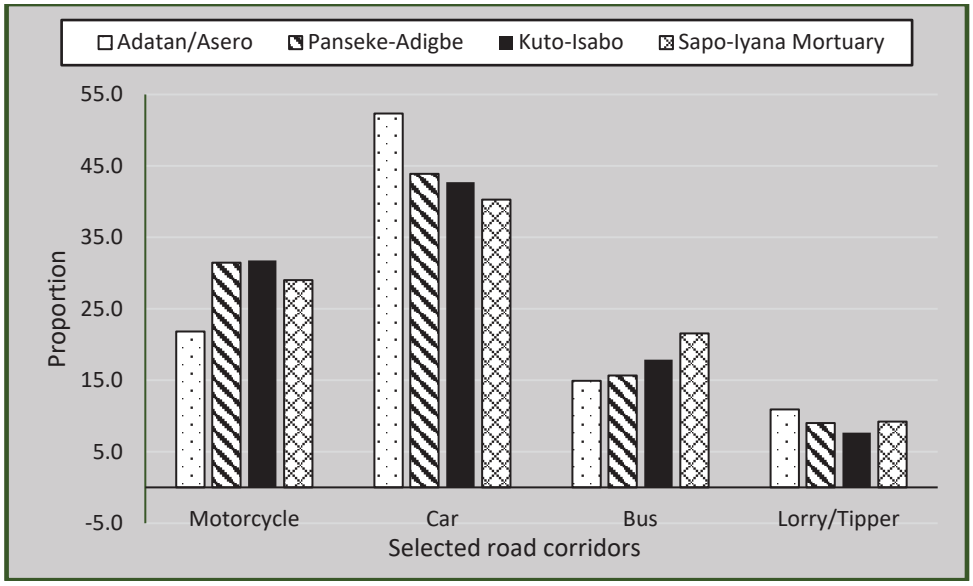


Fig. 4: Vehicle composition by road corridors

portion, comprising the second-highest type with 28.8% and 2905 vph. Buses and lorries/tippers follow, contributing 18.1% (1827 vph) and 9.1% (920 vph), respectively. The prevalence of cars in Abeokuta signifies its dependency on automobiles for urban mobility. While cars offer individuals the convenience and flexibility to travel easily from one point to another, their extensive use raises significant concerns for the environment, public health, and the overall livability of the city. Moreover, overreliance on cars for transportation may exclude individuals who are unable to drive due to age, disability, or other reasons. This lack of inclusivity can contribute to social isolation and limit participation in various activities. The noticeable increase in motorcycle presence further reflects a growing inclination toward using them as a key solution to tackle transportation challenges within the urban landscape.

The distribution of vehicle types exhibits a similar trend across road corridors, albeit with varying levels of deviation. In the Adatan/Asero corridor, over half (52.3%) of the vehicles were either private or commercial (taxi), whereas this figure was 43.8%, 42.7%, and 40.3% in Panseke/Adigbe, Kuto/Isabo, and Sapo/Iyana Mortuary, respectively. Kuto/Isabo recorded a higher proportion of motorcycles at 31.8%, surpassing Panseke/Adigbe (31.5%), Sapo-Iyana Mortuary (29%), and Adatan/Asero roads, in descending order (see Fig. 4).

The prevalence of buses is notably higher on Sapo/Iyana Mortuary Road (21.5%) compared to Kuto/Isabo (17.9%), Panseke/Adigbe (15.7%), and Adatan/Asero Roads (14.9%). Adatan/Asero Road experiences a more frequent presence of Lorry/Tippers (9.2%) than Sapo/Iyana Mortuary Road (9%), Panseke/Adigbe Road (9%), and Kuto/Isabo Road (7.7%), in

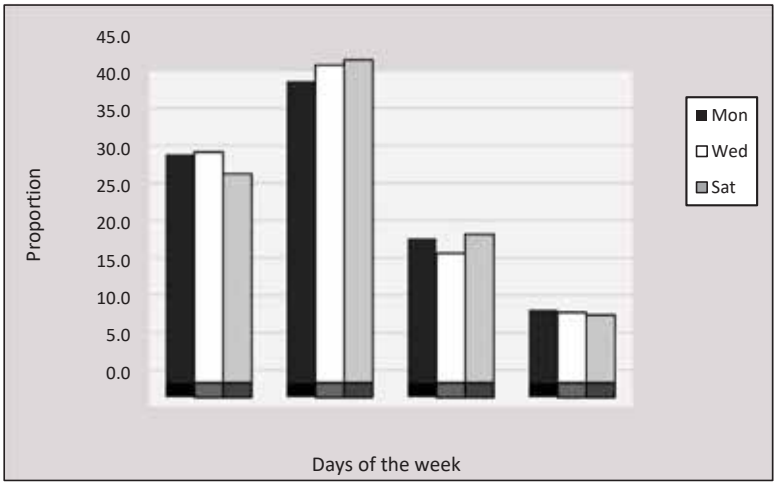


Fig. 5: Vehicle composition by road corridors

Table 4: ANOVA: Traffic composition in the studied road corridors

ANOVA						
Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	0.0025	3	0.000833	3.3106	1.0000	3.490295
Within Groups	3020.011	12	251.6676			
Total	3020.013	15				

descending order. Analyzing the distribution of vehicle types throughout the week reveals consistent patterns, but a closer examination (see Fig. 5) exposes notable variations. Specifically, car traffic is relatively higher on Saturdays (43.1%) than on Wednesdays (42.4%) and Mondays (40.3%), possibly due to increased weekend activities leading to greater individual car usage. Motorcycles show a higher prevalence on Wednesdays (30.9%) compared to Mondays (30.5%) and Saturdays (27.9%), suggesting mid-week transportation needs or commuting patterns favoring motorcycles. Buses are more abundant on Saturdays (19.9%) than on Mondays (19.3%) and Wednesdays (17.3%), possibly reflecting heightened demand for public transportation during weekends, particularly for leisure activities. Conversely, there is minimal variation in the presence of Lorry/Tippers on Monday (9.8%), Wednesday (9.4%), and Saturday (9.1%), indicating a consistent presence throughout the week, potentially linked to commercial or industrial activities.Top of Form

The elevated counts of cars and buses on Saturday were anticipated, as it is a day traditionally designated for errands, shopping, and recreation. Residents, particularly those in two-income families with constrained schedules during weekdays, utilize Saturdays for shopping, running errands, social visits, and recreational activities. Despite observed variations in traffic composition, ANOVA results indicate that, with f=3.3106 and p=1.0000, there is no significant variance in traffic composition across the surveyed roads (refer to Table 4).

Traffic capacity of the studied roads

The computed Passenger Car Unit (PCU) for the selected road corridors, outlined in Table 5, results in the following traffic capacities: Adatan/Asero road corridor - 2375 PCU/hr; Panseke/Adigbe - 2325 PCU/hr; Kuto/Isabo - 2957 PCU/hr; and Sapo/Iyana Mortuary - 4389 PCU/hr. Sapo/Iyana Mortuary boasts the highest traffic capacity, closely followed by the Kuto/Isabo road. Adatan/Asero and Panseke/Adigbe roads follow in descending order.

The examination of traffic data reveals that buses, with a capacity of 4,872 Passenger Car Units per hour (PCU/hr), play a significant role in the traffic load on the selected roads. This is closely followed by cars, which contribute 2,963 PCU/hr, lorries/tippers at

Table 5: Passengers Car Unit Equivalent (PCUE) of traffic volume in the road corridors

Vehicle Type	*PCUE*	*A (PCUE)*	*B (PCUE)*	*C (PCUE)*	*D (PCUE)*	*Total (PCUE)*	*PCUE/hour*
Motorcycle	0.75	1314	1929	2450	3021	8714	1452
Car	1	4200	3588	4394	5594	17776	2963
Bus	4	4792	5120	7352	11968	29232	4872
Lorry/Tipper	4.5	3942	3312	3546	5751	16551	2759
Total		14248	13949	17742	26334	72273	12045
PCUE/hour		2375	2325	2957	4389	12045	

Note: A= Adatan/Asero, B=Panseke/Adigbe, C=Kuto/Isabo, D= Sapo/Iyana Mortuary

Table 6: Level of service (Source: adapted from Gajjar and Mohandas, 2016)

LOS	Volume/Capacity Ratio (V/C)	Level of comfort	Nature of flow
A	<0.30	Highest	Free Flow
B	0.30 – 0.50		Reasonably free flow
C	0.50 – 0.70		Stable flow
D	0.70 – 0.90	Threshold	Approaching unstable flow
E	1.00		unstable
F	>1.00	Lowest	Forced flow

2,759 PCU/hr, and motorcycles at 1,452 PCU/hr. Notably, motorcycles have the least impact on the traffic dynamics of the studied road corridors. The findings highlight that while buses exert considerable influence on traffic volumes, they also can accommodate more passengers compared to other vehicle types. Consequently, this dynamic suggests that buses contribute to lower levels of congestion than private cars, particularly when they carry an average of more than 4.5 passengers. Practically, these insights underscore the importance of prioritizing buses within the multimodal travel framework to enhance urban mobility. By increasing the proportion of buses in the transportation mix, cities can effectively reduce congestion levels, particularly during peak hours when road usage is at its highest. This could involve expanding bus routes, increasing the frequency of bus services, and improving overall bus infrastructure, such as dedicated bus lanes and strategically placed bus stops. Moreover, policymakers and urban planners can leverage this data to design targeted interventions aimed at promoting public transportation. Initiatives such as subsidies for bus fares, enhanced safety and comfort features on buses, and public awareness campaigns about the benefits of bus travel can encourage more commuters to choose buses over private vehicles. Ultimately, these strategies not only have the potential to alleviate congestion but also contribute to sustainable urban development by reducing the carbon footprint associated with private car usage. By recognizing the pivotal role of buses in the traffic ecosystem, stakeholders can make informed decisions that foster a more efficient and environmentally friendly transportation network.

Level of service (LoS) of the studied roads

Road capacity signifies the maximum flow rate under specific LoS conditions, accounting for prevailing roadway and traffic conditions. LoS serves as a qualitative measure encompassing factors like speed, travel time, maneuverability, convenience, comfort, safety, and traffic disruptions (Gajjar & Mohandas, 2016). The Volume/Capacity Ratio (V/C ratio) emerges as the most precise predictor of congestion and LOS, with higher ratios indicating greater congestion. Table 6 displays the V/C ratio and associated LoS indicator values across different scenarios.

The Volume/Capacity ratio was computed by comparing the traffic volume with the specified traffic capacity, as outlined in Indian Road Congress (IRC) 106:1990, to assess the Level of Service for the Roads. The volume capacity ratios for the studied roads are as follows: Adatan/Asero (1.25), Panseke/Adigbe (1.22), Kuto/Isabo (1.56), and Sapo/Iyana Mortuary (1.51).

Nevertheless, referring to Table 7, the level of

Table 7: Level of service in selected road corridors

SN	Road Corridors	Description	Derived Traffic capacity in PCUE/hr	Recommended Capacity (IRC 106:1990)	Volume Capacity Ratio	Level of Service
1	Adatan-Car-wash-Asero	2-lane (one way)	2375	1900	1.25	F
2	Panseke-Adigbe	2-lane (one way)	2325	1900	1.22	F
3	Kuto-Isabo	2-lane (one way)	2957	1900	1.56	F
4	Sapo-Ijaye-Iyana Mortuary	4-lane divided (two-way)	4389	2900	1.51	F

Fig. 6: Traffic standstill at Panseke- Adigbe road

service for all the studied roads is categorized as F, signifying forced flow. At this level, forced operations occur at low speeds, leading to volumes below capacity. Congestion can result in notable decreases in speed and occasional or extended stoppages. In extreme cases, both speed and volume may be reduced to zero. These conditions characterize the traffic situations on the selected roads, as illustrated in Figs. 6 and 7.

The forced flow of traffic on all the studied roads, as indicated by the LoS of F, suggests an overextended usage of the roads beyond the recommended capacity. Table 7 displays the percentage difference between the derived and recommended capacity. It is evident from the table that the existing peak-hour volume for all roadways surpasses the IRC-recommended capacity.

Table 8 reveals that the Kuto/Isabo road operates at a capacity 56% beyond the recommended limit, making it the most overstretched among the studied corridors. Sapo/Iyana Mortuary is the second most overstretched, exceeding the recommended capacity by 51%. Adatan/Asero Road surpasses the recommended capacity by 25%, and Panseke/Adigbe Road operates 22% above the recommended limit. Particularly, Kuto/Isabo and Sapo/Iyana Mortuary,

Fig. 7: Traffic congestion at Adatan-Asero road

operating well beyond capacity, indicate severe traffic congestion, leading to delays for commuters and potential economic losses. Residents on these roads may face a reduced quality of life due to prolonged commutes, stress, and safety concerns. Additionally, overstretched roads contribute to unsafe conditions, increasing the risk of accidents. The extent of capacity beyond the recommended limit correlates with heightened road safety concerns, impacting residents' decisions on housing, business locations, and overall urban satisfaction.

Areas for future study

For further study, several areas merit exploration to deepen our understanding of traffic congestion and potential solutions in Nigeria. First, future research could focus on the impact of road pricing systems on reducing traffic during peak hours. By examining various pricing models, researchers could assess how these systems influence commuter behavior, their financial viability, and long-term effectiveness in managing traffic congestion. Another area for exploration is the adoption of telecommuting and flex-time policies. Further investigation into the extent to which businesses are adopting these strategies and their actual effect on reducing traffic congestion would provide valuable insights. Challenges faced by employers and employee preferences regarding these policies could also be explored to better understand barriers to implementation. Additionally, the feasibility and success of carpooling and public transport enhancements, such as introducing high-capacity buses, could be assessed. This line of inquiry would help determine how these initiatives influence commuter behavior, reduce vehicle numbers on the road, and promote long-term sustainable travel practices. Further research could also address the environmental and health impacts of traffic congestion. By quantifying emission reductions and health improvements resulting from alternative transportation modes, such studies could emphasize the broader benefits of reducing reliance on private vehicles. Another key area is the implementation of ITS. Research could investigate the benefits of smart traffic management, real-time traffic data, and automated traffic signals to enhance the flow of vehicles and reduce congestion in urban centers. Alternative traffic routes also warrant exploration. Developing dedicated lanes for heavy-duty trucks or establishing rail lines for freight movement could alleviate pressure on the road network. Studies in this area could focus on the practical and financial aspects of implementing these alternatives and their potential effects on overall traffic flow. Lastly, research into the behavioral factors contributing to single-occupant vehicle use would be beneficial. Un-

Table 8: Capacity of the studied road corridors

SN	Road Corridors	Description	Derived Traffic Capacity in PCU/hr	Recommended Capacity (IRC 106:1990)	% Difference
1	Adatan-Car-wash-Asero	2-lane (one way)	2375	1900	(+)25%
2	Panseke-Adigbe	2-lane (one way)	2325	1900	(+)22
3	Kuto-Isabo	2-lane (one way)	2957	1900	(+)56
4	Sapo-Ijaye-Iyana Mortuary	4-lane divided (Two way)	4389	2900	(+)51

derstanding this preference's socio-economic and cultural reasons could lead to more effective policies and incentives that encourage shared transportation modes and reduce traffic congestion. These areas of further study would expand on the current findings, offering a more comprehensive approach to managing traffic in Nigeria and improving urban transportation systems.Bottom of Form

CONCLUSION

This study highlights several critical issues in traffic analysis. First and foremost, it reveals substantial variations in traffic volume during peak hours and across different days of the week. Notably, the evening peak registers higher traffic volumes than the morning peak, with Mondays identified as having the heaviest traffic. In light of these findings, the study advocates for the implementation of a road pricing system during rush hours. This strategy aims to incentivize individuals to explore alternative transportation modes and adjust their travel times, particularly during peak evening hours. Additionally, the study suggests that businesses adopt flex-time policies, allowing employees to work flexible hours. This would help disperse commuting demand and reduce congestion during specific peak periods. Moreover, telecommuting or remote work options are recommended as an effective means to lower the number of commuters on Mondays and during peak evening hours. By integrating these strategies, commuters would have diverse choices, which would, in turn, lessen the overall demand on the road network during critical times. Successful implementation of these measures requires close collaboration with businesses, local authorities, and the community, taking into account their unique circumstances and needs. The second key issue centers on the composition of traffic, revealing a significant influx of single-occupant vehicles in the study area. This trend contributes to traffic congestion, largely due to individuals' preference for driving. To combat this issue, a multifaceted approach is recommended, encompassing various policies, infrastructure enhancements, and behavioral changes. The urban authority is urged to restrict private car circulation during certain periods and in designated areas. Furthermore, promoting and facilitating carpooling and ridesharing programs could help alleviate congestion. Enhancing the public transportation system by introducing high-capacity buses is also essential. To further support these efforts, awareness campaigns highlighting the environmental and health impacts of excessive car use should be implemented. Such campaigns would emphasize the benefits of alternative transportation modes and the long-term consequences of heavy reliance on private cars. The third critical issue pertains to the traffic volume-to-capacity ratio, which indicates that all studied roads, particularly the segments between Adatan-Car Wash to Asero and Panseke to Adigbe, have exceeded their carrying capacities. Therefore, urgent infrastructural development is recommended, focusing on road expansion and dualization to accommodate escalating traffic volumes in these corridors. Optimizing intersection and roundabout designs, especially at key locations like Adatan and Ijaye, is crucial for ensuring smoother traffic flow. As an overarching recommendation, the urban authority is encouraged to invest in intelligent transportation systems, which represent a holistic approach to modernizing urban mobility. Additionally, establishing alternative traffic routes, such as rail lines, would facilitate the movement of heavy-duty trucks, thereby alleviating the strain on existing road networks. This comprehensive strategy not only addresses immediate congestion concerns but also lays the groundwork for a sustainable and efficient urban transportation infrastructure.

AUTHOR CONTRIBUTIONS

David Victor Ogunkan conceptualized the study, led data collection and analysis, and drafted the initial manuscript. Eyitayo O. Olaleye contributed to the research design, supervised data analysis, and assisted with manuscript development. Olusegun P. Akinpelu supported data collection, data interpretation, and manuscript revisions. Idowu O. Oyeleye supported data collection, did an additional literature review, contributed to the interpretation of the findings, and approved the final manuscript. All authors reviewed and approved the final version.

ACKNOWLEDGEMENT

The authors acknowledge the contributions of the editorial team and reviewers, which strengthened the quality of the presentation of this research manuscript.

CONFLICT OF INTEREST

The authors declare no potential conflict of interest regarding the publication of this work. In addition, the ethical issues, including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, and redundancy have been completely witnessed by the authors.

ABBREVIATIONS

ANOVA	Analysis of Variance
IRC	Indian Road Congress
ITS	Intelligent Transport Systems
LoS	Level of Service
PCUE	Passengers Car Unit Equivalent
Passenger Car Units per hour	*(PCU/hr)*
R.I.I.	Relative Importance Index
V/C	Volume/Capacity Ratio
VPH	Vehicles Per Hour

REFERENCES

Abuh, P. O.; John, J. A., (2023). Geographic analysis of traffic congestion in FCT-Abuja, Nigeria. Journal of Sustainability and Environmental Management., 2(1): 26-32 **(7 pages).**

Abdulsattar, H.; Siam, M. R. K.; Wang, H., (2020). Characterisation of the impacts of autonomous driving on highway capacity in a mixed traffic environment: An agent-based approach. IET Intell. Transp. Syst., 14(9): 1132-1141 **(10 pages).**

Acheampong, R. A., (2020). Spatial structure, intra-urban commuting patterns and travel mode choice: Analyses of relationships in the Kumasi metropolis, Ghana. *Cities.*, 96: 102432-102440 **(9 pages)**.

Aderamo, A. J.; Atomode, T. I., (2012). Traffic congestion at road intersections in Ilorin, Nigeria. *Mediterranean Journal of Social Sciences.*, 3(2): 1-10 **(10 pages).**

Afrin, T.; Yodo, N., (2020). A survey of road traffic congestion measures towards a sustainable and resilient transportation system. *Sustainability.*, 12(11): 4660-4669 **(10 pages).**

Ajala, T. A., (2019). Analysis of traffic congestion on major urban roads in Nigeria. *Journal of Digital Innovations & Contemporary Research in Science, Engineering & Technology.*, 7(3): 1-10 **(10 pages).**

Al-Turki, M.; Ratrout, N. T.; Rahman, S. M.; Reza, I., (2021). Impacts of autonomous vehicles on traffic flow characteristics under mixed traffic environment: Future perspectives. *Sustainability.*, 13(19): 11052-11063 **(12 pages)**.

Ambühl, L.; Menéndez, M.; González, M. C., (2023). Understanding congestion propagation by combining percolation theory with the macroscopic fundamental diagram. *Commun. Phys.*, 6(1):1-7 **(8 pages)**.

Arti, C.; Sharad, G.; Pradeep, K.; Chinmay, P.; Kumar, S. S., (2022).

Urban traffic congestion: Its causes- consequences-mitigation. *Res. J. Chem. Environ.*, 26(12): 164-176 **(13 pages)**.

Berry, B. J. L.; Horton, F. E., (1970). Geographic perspective on urban systems. Englewood Cliffs, N.Y: Prentice-Hall. **(564 pages).**

Drličiak, M.; Celko, J.; Cingel, M.; Jandačka, D., (2020). Traffic volumes as a modal split parameter. *Sustainability.*, 12(24): 10252-10260 **(9 pages)**.

Droj, G.; Laurenţiu, D.; Badea, A., (2021). GIS-based survey over the public transport strategy: An instrument for economic and sustainable urban traffic planning. *ISPRS Int. J. Geo-Inf.*, 11(1): 16-23 **(8 pages)**.

Gajjar, R.; Mohandas, D., (2016). Critical assessment of road capacities on urban roads–a Mumbai case study. *Transp. Res. Procedia.*, 17: 685-692 **(8 pages)**.

Harriet, T.; Poku, K.; Emmanuel, A. K., (2013). An assessment of traffic congestion and its effect on productivity in urban Ghana. *Int. J. Bus. Soc. Sci.*, 4(3):1-9 **(10 pages)**

Irunokhai, E. A.; Onihunwa, J. O.; Oni, E. K.; Adigun, J. O.; Dada, O. S., (2020). Analysis of traffic congestion on Nigerian roads (A case study of Sango T Junction, Ibadan, Oyo State). *Int. J. Comput. Appl.*, 975: 8887 **(8 pages)**.

Karbasi, A. H.; Mehrabani, B. B.; Cools, M.; Sgambi, L.; Saffarzadeh, M., (2022). Comparison of speed- density models in the age of connected and automated vehicles. *Transp. Res. Rec.*, 2677(3): 849- 865 **(17 pages)**.

Li, Y., (2023). Exploring the impact of first mile/last mile solutions on traffic congestion and air quality in urban areas. *Stud. Soc. Sci. Humanit.*, 2(3): 66-74 **(9 pages)**.

Li, T.; Zhang, J.; Yao, Z.; Li, Z., (2023). Trajectory vector field calculation and visualization method for regional congestion evaluation. *3rd Int. Conf. Internet Things Smart City (IoTSC 2023)* **(10 pages)**

Mehdi, M. Z.; Kamoun, H. M.; Benayed, N. G.; Sellami, D.; Damak, A., (2022). Entropy-based traffic flow labeling for CNN-based traffic congestion prediction from meta-parameters. *IEEE Access.*, 10: 16123-16133 **(11 pages).**

Olagunju, K. (2015). Evaluating traffic congestion in developing countries. A case study of Nigeria. *Journal of the Chartered Institute of Logistics and Transport-Nigeria.*, 2(3): 23-26 **(4 pages)**.

Olawale, A. O., (2020). Analytical study of causes, effects, and remedies of traffic congestion in Lagos, Nigeria. *International Journal of Engineering Research and Advanced Technology.*, 6(4): 78-85 **(8 pages)**

Olawepo, R. (2015). Learning from the People: A Geographer's Mandate for Sustainable Rural Development. *Library and Publications Committee, University of Ilorin* (**59 pages**)

Onyeneke C.C., (2018). Causes and effects of traffic congestion in Nigeria. *Global Journal of Science Frontier* (**10 pages**)

Otto, C. G.; Ogboda, C. E., (2022). A Survey of Traffic Congestion Measure Towards a Sustainable Traffic Flow at Garrison Intersection in Port Harcourt, Nigeria. *J. Newviews Eng. Technol.*, 4(2): **(8 pages)**

Parisi, D. R.; Sartorio, A. G.; Colonnello, J. R.; Garcimartín, Á.; Pugnaloni, L. A.; Zuriguel, I. (2021). Pedestrian dynamics at the running of the bulls evidence an inaccessible region in the fundamental diagram. *Proc. Natl. Acad. Sci. U.S.A.*, 118(51): e2111445118. **(9 pages)**

Raji, B. A.; Muse, O. S. (2009). Flow Patterns of Vehicular Traffic along Highway Toll Plaza in Ogun State. *Indones. J. Geogr.*, 41(1): 1-12 **(12 pages)**

Rahman, M. M.; Najaf, P.; Fields, M. G.; Thill, J. C. (2022). Traffic congestion and its urban scale factors: Empirical evidence from American urban areas. *Int. J. Sustain. Transp.*, 16(1): 1-16 **(16 pages)**

Rossi, R.; Ceccato, R.; Gastaldi, M. (2020). Effect of road traffic on air pollution. Experimental evidence from COVID-19 lockdown. *Sustainability.*, 12(21): 8984 **(17 pages)**

Salisu, U. O.; Akanmu, A. A.; Fasina, S. O.; Sanni, S. M. (2020). Traffic congestion and intelligent transport system in a fast-growing Nigeria city. *Sci. J. Silesian Univ. Technol. Ser. Transp.*, 108: 123-134 **(12 pages)**

Wang, Y.; Zhang, D.; Zhang, Y. (2022). GPS data mining at signalized intersections for congestion charging. *Comput. Econ.*, 59(4): 1713-1734 **(22 pages)**

Wegener, M. (2021). Land-use transport interaction models. *J. Transp. Land Use*, 14(1): 1-15. **(15 pages)**

Xie, D.; Wang, M.; Zhao, X. (2020). A spatiotemporal apriori approach to capture dynamic associations of regional traffic congestion. *IEEE Access.*, 8: 123456-123467 **(12 pages)**

Zhu, H.; Zhang, K.; Wang, C.; Jia, L.; Song, S. (2023). The impact of road functions on road congestions based on POI clustering: an empirical analysis in Xi'an, China. *J. Transp. Geogr.*, 102: 103456 **(17 pages)**

HOW TO CITE THIS ARTICLE

Ogunkan, D. V.; Olaleye, E. O.; Akinpelu, O. P.; Oyeleye, I. O., (2025). Navigating urban gridlock: A study of traffic congestion and sustainable mobility solutions in the urban center. Int. J. Hum. Capital Urban Manage., 10(2):251-268.

DOI: 10.22034/IJHCUM.2025.02.04

URL: https://www.ijhcum.net/article_717659.html

Int. J. Hum. Capital Urban Manage., 10(2): 269-282, Spring 2025

International Journal of Human Capital in Urban Management
(IJHCUM)

Homepage: http://www.ijhcum.net/

ORIGINAL RESEARCH PAPER

Integrating Artificial Intelligence in urban re-design: A collaborative approach to post-war design phases

I. A. Alshafei [1, *], R. T. N. Almashhour [2]

[1] *Department of Architecture Engineering, Munib and Angela Masri Faculty of Engineering, Aqaba University of Technology, Aqaba, Jordan.*

[2] *Architecture Engineering Department, Faculty of Engineering, Nahda University, Benisuef City, Egypt.*

ARTICLE INFO

Article History:
Received 16 May 2024
Revised 22 August 2024
Accepted 15 October 2024

Keywords:
Artificial Intelligence (AI)
AI-assisted design approach
Conventional design approach
Data management
Post-war redesign

ABSTRACT

BACKGROUND AND OBJECTIVES: This study explores the phased approaches of post-war urban re-design to present a collaboration between Artificial Intelligence and traditional processes for post-war urban recovery. A hybrid approach enables stakeholders to actively define their city's future by simulating several re-design scenarios utilizing AI data management. This interactive representation of possible results enables well-informed decision-making, where the advantages and limitations are carefully considered, guaranteeing that the re-design aligns with the requirements and needs of the local communities. This integrative method promotes openness and a feeling of responsibility, establishing the basis for resilient urban environments that emerge from conflict.

METHODS: The study establishes a foundation for using Artificial Intelligence technologies to solve complex urban development challenges by critically examining existing approaches for urban re-design after the war and promoting interventions powered by Artificial Intelligence-driven processes. This study aims to contribute to the field of post-war rebuilding of urban landscapes by developing a solution that can be generalized. This study adopts a qualitative methodology approach to investigate the possible integration of Artificial Intelligence in re-designing urban landscapes post-war. The methodology is structured to examine existing approaches and studies of post-war urban recovery, compare traditional and AI-assisted approaches, and propose a hybrid approach that combines both. The study structure is a literature review and theoretical approach development, data collection, and analysis, depending on multiple sources, including government reports and academic research, as well as hybrid approach development.

FINDINGS: The discussion provides theoretical evidence of the potential advances in this empirical approach, highlighting the efficiency improvements achievable by using Artificial Intelligence technologies in a hybrid phased approach that integrates traditional post-war processes with Artificial Intelligence-assisted ones. The study also highlights the importance of ethical considerations in Artificial Intelligence restoration procedures, addressing acceptance, community involvement, and cultural heritage safeguarding concerns. This emphasis on ethics reassures the audience about Artificial Intelligence's responsible and conscientious use in post-war re-design.

CONCLUSION: The study explores the potential integration of Artificial Intelligence in re-designing postwar urban landscapes. It compares conventional methods of urban revival with innovative Artificial Intelligence-supported methods to determine the advantages of utilizing Artificial Intelligence in post-war urban re-design. Traditional techniques for gathering data, allocating resources, and engaging the community have many challenges that negatively affect the effectiveness of re-designing and re-design measures. This study suggests that integrating Artificial Intelligence with traditional strategies can help overcome these challenges by analyzing extensive datasets, which leads to effective decision-making. A hybrid approach combining conventional and Artificial Intelligence-supported methods is suggested to improve the resiliency and sustainability of the re-designing process. It aims to enhance resource distribution and strategic planning through Artificial Intelligence-assisted strategies.

DOI: 10.22034/IJHCUM.2025.02.05

NUMBER OF REFERENCES	NUMBER OF FIGURES	NUMBER OF TABLES
62	5	1

*Corresponding Author:
Email: *islam_alshafei@aut.edu.jo*
Phone: +962798018150
ORCID: 0000-0001-9057-219X

Note: Discussion period for this manuscript open until July 1, 2025 on IJHCUM website at the "Show Article.

INTRODUCTION

Architectural design and planning strategies commonly have various design parameters and involve numerous stakeholders based on the scale of these projects, such as extensive infrastructures like cities (Li *et al.*, 2019; Kim and Alseadi, 2021; E. N. Shaqour, 2022; Manoharan *et al.*, 2023). The architectural design process includes many aesthetic, sociological, psychological, anthropological, and economic factors(Alkassabany and Mousa, 2020; Ibrahim, 2022; Hettithanthri, Hansen and Munasinghe, 2023). Technology benefits the design process, methodologies, and feedback utilization at different stages. The recent technological movement is to increase conception and provide uncomplicated user control (Wu, 2018a; Mitchell *et al.*, 2021). Data parameterization facilitates opportunities to achieve intelligent analyses (Gubbi *et al.*, 2013). Urban data are usually organized by non-architects, such as programmers, and data analysis is used to construct datasets like CubiCasa 5K (Kalervo *et al.*, 2019). Using data in technology-driven architectural design speeds up the performance of processes such as generative design, contextual awareness, and algorithmic thinking. Enhancing the quality of services provided and supporting users' lifestyles was the significant barrier to urban re-design in the post-war period based on the utilization level of the data set provided to integrate into the design process (Reijneveld *et al.*, 2024). Optimal utilization of urban designers' data input is essential for adequate decision-making concerning the most influential urban interventions that best utilize time, budget, and resources (Yarwood, 2010; Reijneveld *et al.*, 2024). Conventional post-war reconstruction models, frequently impeded by fragmented data and manual evaluations, do not effectively tackle the complex rebuilding issues. The inefficient allocation of resources, which prioritizes short-term requirements at the expense of long-lasting resilience, endorses vulnerabilities and obstructs the achievement of sustainable recovery (Al-Mosawy *et al.*, 2021a; UNDP, 2021). Planners and designers designed the development plans for urban areas post-war based on the available data, implementing three strategies to read the data: Description, Interpretation, and Deconstruction, to make response strategies in the form of conceptual design (Al-Mosawy *et al.*, 2021b; UNDP, 2021). Artificial Intelligence (AI) is a technological advance that improves urban design by managing and analyzing complicated datasets, providing predictive understandings, and enhancing decision-making in the urban development process (de Jong *et al.*, 2015; Wu, 2018b; Liu and Zhang, 2023). Previous studies approve that AI integrates data from diverse sources, such as sensors, (IoT) devices(Ali and Panchal, 2020; Pramanik *et al.*, 2023), and geospatial data, to monitor urban environments in real-time and forecast future tendencies(Embarak, 2022). As well as AI can also power simulation strategies and decision-making support systems to allow urban planners to test scenarios, assess risks, and derive data to make various choices depending on sustainability and efficiency (Singh and Manoharan, 2024). AI encourages public engagement between people and decision-makers by automating conventional design tasks and supports the development of resilient and smart cities (Komninos, 2006; Voda and Radu, 2018; Ahmed *et al.*, 2021). Traditional urban rehabilitation after a war generally faces numerous complex challenges: a lack of comprehensive data hinders correct evaluation, limited resources contribute to inefficient distribution, and a lack of coordination between planners and people undermines the effectiveness of rebuilding efforts (WB, 1998; Kokkala and Marinos, 2022). This study explores the phased approaches of post-war urban re-design to present a hybrid framework that integrates AI with traditional frameworks to post-war urban recovery frameworks. A hybrid approach enables stakeholders to actively define their city's future by simulating several re-design scenarios utilizing AI data gathering and analysis. This interactive representation of possible results enables well-informed decision-making, where the advantages and limitations are carefully considered, guaranteeing that the re-design aligns with the requirements and ambitions of the individuals who will reside there. This integrative method promotes openness and a feeling of responsibility, establishing the basis for resilient urban environments that emerge from adversity and are more robust and dynamic than ever.

Literature review

Conventional approaches for urban re-design

In Architectural and Urban Design and Planning, the conventional design process starts with collecting project needs and then iterating various visions

while maintaining a feedback process with project stakeholders (Lawson, 2006). Architecture Design inputs that determine the outputs are varied and changeable based on project type, context, and scale. The design process needs creativity (Woodbury, Williamson and Beesley, 2011). Designers must use their expertise and theoretical understanding to decide on the best design option for their present needs (Bradner *et al.*, 2014). The subsequent nature of the design process can be adjusted to align with the needs and context, applying an equivalent rotation of brainstorming and verification to create concepts and details. Design plays a crucial role in architecture. Communicating design intent in architecture and diagrams is essential to incorporate topology, scale, form, context, and orientation (Gross & Yu, 2001). A distinctive approach of designers is the systematic methods planners use to create novel ideas that meet the existing norms and address fundamental issues. Moreover, a particular complexity in urban design is that the problem is frequently specific to the site, resulting in each design challenge being sure of the program itself (Razzouk and Shute, 2012). Traditional analysis techniques, such as statistics, Geographic Information Systems (GIS), and case study reviews, are employed to understand the vast amount of data and reports available (Casali, Aydin and Comes, 2022).

AI-assisted approaches

The inflow of technology has led to several significant changes in different fields and sectors, including the architecture design process (Mohammed, 2020). Urban planners face substantial challenges due to the fast growth of urban areas and the increasing complexity of urban issues. Based on these issues, like all fields, urban design and architecture are presently being transformed by integrating AI technologies (Peng *et al.*, 2023). Extensive data from various sources, such as the vehicle-to-everything (V2X), Internet of Things (IoT), Information Communication Technologies (ICT), and social media, along with comprehensive research and publications, has equipped urban designers with enhanced abilities to comprehend urban dynamics and recognize issues almost instantaneously(Zhang and Lu, 2021). Mechanization and visualization have been at the forefront, simplifying the design process and allowing real-time visualization of changes through interactive interfaces. Many new design approaches depend on technology that has appeared during the last century, such as Building Information Modeling (BIM), computational design, and parametric design(Tezel *et al.*, 2020; E N Shaqour, 2022). The mentioned technologies facilitate and change the design process by permitting massive data processing like environmental analysis. 3D printing and standardization also facilitate the discovery of complicated forms (Trindade *et al.*, 2017). AI is considered an influential invention in many fields, such as architecture, because it allows the creation of new creative design concepts and resolutions (Komninos, 2016). Machine Learning (ML) enhances operations in diverse industries and delivers the imaginable in all design phases by recognizing patterns in input data (Akinosho *et al.*, 2020). ML can significantly benefit from architectural data to create and design new features and their interrelationships(Meeran and Conrad Joyce, 2020). The rise of AI, particularly language models like ChatGPT created by OpenAI, machine, and deep learning models, enhanced computational capacity, software, and algorithms, providing new possibilities for urban designers to utilize helpful understandings to address complex urban challenges (Zhang and Lu, 2021). Additionally, artificial intelligence is used to forecast alterations in land utilization (Aburas, Ahamad, and Omar, 2019). AI has the potential to be a helpful tool for urban planners by providing decision support, responding to questions, and making suggestions (Bai *et al.*, 2022). Over the last twenty years, many studies have used quantitative planning models through Planning Support Systems (PSS), such as Cellular Automata (CA) models, to classify the lands based on the level of development, such as DINAMICA and SLEUTH. DRAM/EMPAL are large-scale urban models that predict future land uses. Another model is the California Urban Futures model, which provides detailed regulations for land development. The last one is Agent-Based Models (ABMs) that analyze changes in the built environment (Peng *et al.*, 2023). Utilizing satellite imagery assessment and sentiment evaluation tools can yield significant and informative perspectives (UN-Habitat, 2022; UNESCO, 2023a). The UN Global Pulse highlights another approach where AI is used in predictive modeling and risk assessment (United Nations Global Pulse, 2023). AI algorithms can forecast

probable infrastructure failures, natural disasters, and civil unrest, which can aid in determining the most essential actions to take and develop resilience. Recently, AI appeared in relevant theoretical and practical studies and is seen as an assistant in post-war rehabilitation, where specific considerations and approaches are acknowledged accordingly. Some of the general approaches found in research are using AI to manage information and analyze data utilizing specific AI tools that provide valuable insights into post-conflict rehabilitation and reconstruction. In this matter, AI can examine extensive quantities of data about impaired infrastructure, displaced populations, and the availability of resources.

A theoretical and practical exploration of post-war re-design

A previous study seeks a method for re-designing the city while maintaining its identity, urban heritage, and texture. It aims to revitalize urban identity by maintaining symbolic structures to keep identity (Hussein, Abdulla, and Salih, 2019). International events can significantly improve urban development and guide decision-makers to direct integrated urban development for the advantage of the people and the city(He *et al.*, 2020). The role of events like wars in shaping urban development strategies has become increasingly important. Policies centered around events encompass economic, social, and cultural factors that impact and guide the development of cities (Richards, 2020). Many studies are concerned with the morphological transformation in the urban design of cities post-war, highlighting the significance of reconstruction agendas that maintain the urban and architectural identity. It also emphasizes the need to integrate old sites with the new ones resulting from war (Salman *et al.*, 2021). Urban designers should maintain sustainable development while re-designing and reconstructing cities after wars. They need a comprehensive approach considering financial, social, environmental, institutional, organizational, and cultural dimensions. Designers also adopted principles, means, and techniques for reconstructing Mosul City after the war (Abdul Razzaq Mohsen Al-Samurai & Subhi Ramdan Al-Qaraghuli, 2021). Previous studies have discussed many post-war approaches to city re-design. They discuss revitalization as a critical preservation method used to conserve sites of important historical, cultural, and urban importance (Al-Khafaji, Al-Salam, and Alrobaee, 2021). It is concerned with keeping buildings in adequate physical shape and selecting specific areas for preservation based on their historical or architectural value to maintain a community's sense of identity. This approach undermines conflict morale (Altaee & Al-Ani, 2020; Hussein *et al.*, 2019). Other studies discuss the idea of "renewal," which involves bringing a building back to its earliest function after critical maintenance or changing it for new or different activities. In the renewal of areas with partially damaged buildings, urban, economic, and social concerns are crucial(Steinberg, 1996). Renewal strategies prioritize active preservation and include various indicators(Zheng *et al.*, 2014). The deconstruction approach is used for areas with significant damage. The goal is to clear and rebuild the land to promote positive land use, remove polluted sites, decrease poverty, renew urban work areas, and promote eco-friendly industries(Al-Jaberi *et al.*, 2019). Prioritizing redevelopment improves mobility and contributes to a better quality of life for residents(Almeida, Ramos, and Silva, 2018). However, careful planning is needed to minimize their effect on construction waste generation. Recently, several studies between theory and practice approached post-war urban rehabilitation. Many international organizations focus their reports on rehabilitation values after wars. For example, Sierra Leone, in 2023, approached post-war rehabilitation from the perspective of peacebuilding. Their study emphasizes the promotion of enduring peace through addressing trauma, supporting reconciliation, and developing social cohesiveness. Illustrative instances encompass community peacebuilding conversations, trauma-informed reconstruction projects, and programs that amalgamate cultural heritage into public places (Leone, 2023). Post-war rehabilitation within an urban context refers to the complex and diverse process of restoring, revitalizing, and rebuilding cities and communities after experiencing the negative impacts of armed conflict. It goes beyond physical reconstruction, integrating social, economic, and cultural elements to establish long-lasting and inclusive urban settings(UN-Habitat, 2022). From another perspective, similar studies focus on several practical considerations in their approaches to post-war rehabilitation. One example is the Land Restitution Program facilitated by the

United Nations Development Programme (2022), which acknowledged the resolution of opposing assertions regarding land and property as essential for establishing stable ownership and facilitating the reconstruction process. Another study focused its approach on livelihoods and economic development, suggesting that reducing employment positions and avenues for growth is vital for sustaining recovery by allocating funds toward local enterprises, nurturing the spirit of entrepreneurship, and delivering comprehensive training programs to enhance skills(ILO, 2023). Lastly, UNESCO approached post-war rehabilitation from the perspective of Cultural heritage preservation, where the incorporation of cultural legacy into the process of re-design promotes the development of identity, enhances communal togetherness, and creates economic prospects. This includes restoring impaired sites, integrating cultural values into urban planning, and promoting traditional crafts and arts(UNESCO, 2023b). These principles are generic, and the specific contributions of each facet will vary based on the distinct setting of each post-war situation. The post-war urban re-design aims to establish peaceful, resilient, egalitarian, and sustainable urban environments for populations impacted by war by integrating several theoretical and practical domains. Specific approaches for dealing with post-war re-design are typically generalized and found accordingly.

MATERIALS AND METHODS

To this end, this study explores the role of AI in re-designing urban spaces after the war. In the context of the challenges of traditional post-war rebuilding, the study identifies the transformative potential of AI applications in enhancing urban efficiency, depending on previous studies and cases. The study lays the groundwork for implementing AI as an innovative solution to complex urban development issues by critically examining existing models for urban recovery after war and promoting technological interventions. This study is conducted as academic research inspired by the beginning of the war in Gaza, as a personal contribution to benefit the post-war rebuilding field that can be generally utilized in conflict zones. This study adopts a qualitative methodology approach to investigate the possible integration of AI in re-designing urban landscapes post-war. The methodology is structured to examine existing models and studies of post-war urban recovery, compare traditional and AI-assisted approaches, and propose a hybrid approach that combines AI with conventional processes. The study phases are:

1. Literature Review and Theoretical Framework Development will analyze studies discussing conventional architectural and urban design approaches, post-war urban re-design, and AI-assisted processes. The results will be implemented to develop a conceptual approach that combines conventional and AI-supported processes.

2. Data Collection and Analysis depend on various sources, including government reports and academic research. The data were categorized into three main groups: traditional approaches, AI-assisted approaches, and post-war design perspectives. Based on the analyzed data, the three approaches will be designed.

3. Hybrid approach Development: A hybrid approach that integrates AI applications with traditional urban re-design methods was developed based on the literature review analyses. The hybrid model aimed to improve the urban redevelopment process after the war, engaging the community and preserving cultural heritage preservation.

The following, shown in Fig. 1, is a conceptual framework of this study, summarizing the steps in building the hybrid integrative model for post-war re-design.

RESULTS AND DISCUSSION

Traditional and AI-assisted approaches in Post-war Urban Re-design

Post-war scenarios leave a persistent scar on urban landscapes that are usually characterized by the troubling loss of human lives and assets, as well as significant damage to urban structures. Reconstructing post-war is a process that demands practical approaches that target complicated vulnerabilities and generate stable and flexible potential. Accordingly, the studies reviewed shed light on how conventional approaches to post-war urban re-design have laid the groundwork for the process. At the same time, they also highlighted the acknowledgment of how AI methods and tactics can significantly improve urban landscape re-design after the war.

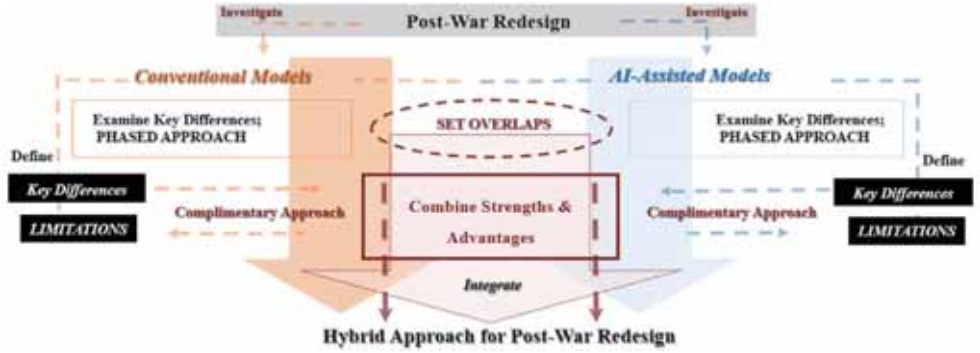


Fig. 1: Conceptual illustration of the methodological framework of the study (Adapted by authors)

Conventional approaches

Throughout history, the re-design of post-war areas depended on existing well-established frameworks. The literature review conducted by the researchers reviewed various theoretical studies and practical publications and retrieved existing data on such frameworks for conventional post-war re-design. One of the main understandings seen as typical is that conventional post-war re-design is a phased approach, which elaborates on the importance of having a systematic and sequenced process for post-war re-design. Each phase builds upon the previous one in a way that enhances an effective and sustainable recovery process. The studies reviewed highlight those specific processes and are accordingly outlined into four main distinct stages that are discussed as follows:

1. The Emergency Relief stage is the initial phase within conventional post-war re-design frameworks. Throughout this stage, the main focus is on providing direct assistance and aid to respond to the immediate needs of the communities under conflict to ensure their survival and well-being. This includes the most basic needs like food, water, shelter, and medical attention.

2. Throughout the Peacebuilding and Early Re-design stage, efforts mainly focus on establishing stability and security, as well as facilitating recovery. This is primarily approached by concentrating efforts on reinstating law and order, rebuilding damaged infrastructures, and neutralizing opponent combatants.

3. The Transformation and Development stage, where the main focus is on providing means to facilitate economic growth within several urban sectors such as healthcare, education, housing, and transportation.

4. The Normalization and Exit stage, considered the final stage, typically focuses on ensuring all affected communities can self-rely on themselves and that all previous efforts and established developments and transformations are stable for the long term.

Moreover, the review identifies some challenges directly associated with the previously outlined phases that must be addressed. The initial phase, for instance, is commonly challenged by aspects such as logistical issues, lack of coordination between involved parties, and the inability to secure sufficient aid. The second phase is usually challenged by difficulties resolving political conflicts, allocating and distributing available resources, and neutralizing opponent combatants. The third phase is highly challenged by difficulties in attracting investments crucial for stimulating economic growth, corruption, governance, and social inequalities. The final stage is commonly challenged by issues such as conflict relapse, accountability, and insufficient development in local capacities. Fig. 2 summarizes the four staged approaches of conventional post-war re-design discussed.

Furthermore, some key aspects are emphasized through relevant studies. Firstly, the role of international actors such as organizations and governments is vital to supporting and assisting throughout all phases discussed. Also, it is essential to develop local capacities by strengthening local institutions to promote sustainable communities that withhold self-reliance capacities for the long run. Finally, conventional models highlight the importance of addressing the possibilities of risks such as conflict relapsing through planning for

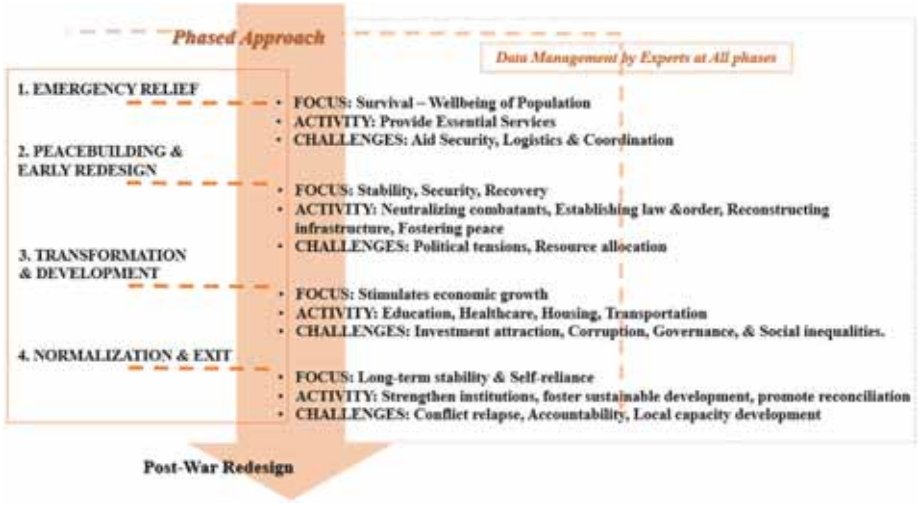


Fig. 2: Phases of the conventional approach for post-war city *re-design* (Adapted by authors)

it from several aspects, such as understanding and preparing for the causes of conflicts, which promotes resolving them and building peace.

AI-Assisted approaches

The literature reviewed also looked into specific studies where AI technologies are incorporated for assistance in several processes, such as providing enhanced decision-making and appropriate resource allocation and distribution for post-war re-design. The researcher suggests that AI-assisted frameworks, similar to conventional ones, commonly present themselves through a set of consecutive processes that are leveraged through the incorporation of AI algorithms that contribute to enhancing several aspects, such as decision-making, effective and efficient allocation of resources, and monitoring. Accordingly, the study outlines five main stages and processes for AI-assisted post-war re-design, which are summarized in the following Fig. 3 and then discussed following:

1. In the Data Gathering and Analysis stage, the initial phase commonly focuses on identifying damage by gathering and analyzing sufficient data. During this stage, data is also collected and analyzed for vulnerabilities and social damages. Here, the role of AI algorithms is to help process and analyze the collected data, which usually presents itself in large quantities, help in damage mapping, and outline potential risks.

2. The Simulation and Scenario Planning stage focuses on visualizing scenarios for re-design, considering any potential impact for each scenario. The role of AI here is to help stimulate several strategies for re-design scenarios and test the suggested designs while simultaneously predicting how effective they can be as an efficient intervention.

3. The Participatory Planning and Decision-Making stage mainly concentrates on approaching communities in conflict and involving them in the decision-making processes on platforms that AI powers. Moreover, AI here contributes to providing digital tools for communication, collaboration, and decision-making.

4. The Resource Allocation and Optimization stage usually focuses on optimally distributing resources according to the needs identified based on previously collected data. AI is used to track progress, identify priorities to focus on, and make decisions driven by data.

5. The Monitoring and Evaluation stage, this final stage, mainly focuses on continuously monitoring efforts and progress, adapting strategies, and identifying possible challenges to the process. AI here analyzes data from sources such as sensors and social media, amongst others, to help assess the interventions for their impacts and adjust them as required.

However, each of the stages is associated with some limitations and challenges that require consideration. Stage one requires ensuring that all collected and analyzed data are accurate and private. Stage two requires paying attention to any bias

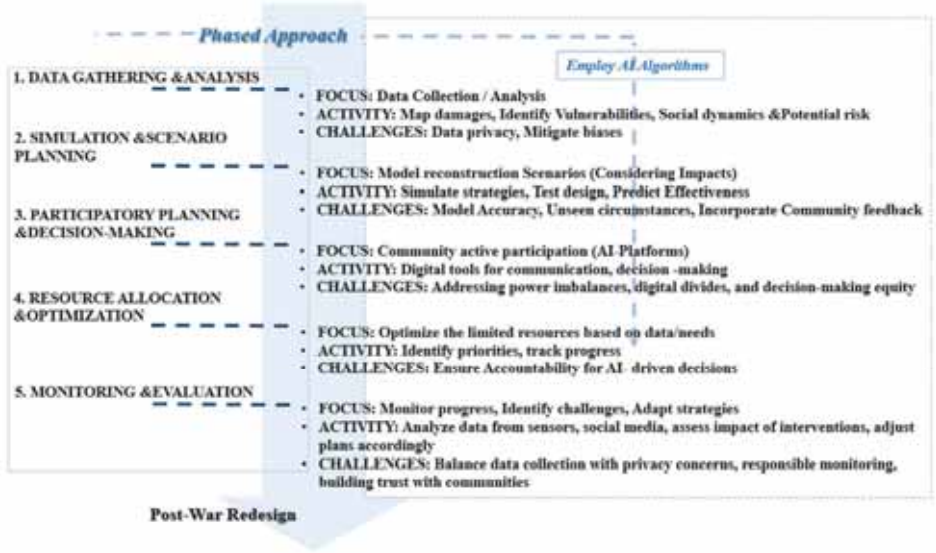


Fig. 3: Phases of AI-assisted approach for post-war city *Re-design* (Adapted by authors)

from AI to provide a decision-making process that is reliable and fair. Stage three requires an efficient incorporation of input from the community to guarantee their meaningful involvement in decision-making procedures. Stage four mainly addresses the technological limitations of AI algorithms by utilizing them in collaboration with human expertise. The final stage highlights the importance of using AI in a way that complies with ethical considerations to avoid unplanned consequences.

Conventional vs. AI-assisted approaches for reinvented post-war re-design

The literature review highlighted how the conventional approaches for post-war urban re-design laid the foundation for rebuilding after conflicts. They gave importance to the role of community engagement in decision-making and planning for long-term effective interventions. However, conventional approaches face several limitations and challenges that obstruct efficient and effective interventions, such as data collection and analysis constraints, flexibility, and obtaining active community involvement where needed. On the other hand, AI-assisted approaches that are emerging and developing in light of the new era of AI technologies are seen to withhold the potential to resolve some of the conventional approaches' limitations with their capabilities of time-effective data collection and analysis, dynamic simulation of re-design scenarios even in the most complex contexts, as well as their interactive platforms that enable easy collaboration, engagement, and involvement. Nevertheless, AI-assisted approaches are also associated with limitations and challenges, as they are subjected to several issues, such as bias, data privacy, and ethical use. From this perspective, this study discusses the potential advances in post-war re-design approaches by combining the strengths of both conventional and AI-assisted approaches while at the same time neutralizing their limitations. Here, the optimal strategy the study proposes is not to work in opposition to the existing approaches but to develop a reinvented approach that leverages both advantages. This hybrid strategy for the post-war re-design of urban landscapes can transform existing and known processes and promote more sustainable and resilient cities and communities. The following Fig. 4 highlights how traditional and AI-assisted methodologies considerably vary, while at the same time, both recognize specific vital indicators for post-war re-design.

The previous illustration in Fig. 4 summarizes the key differences and overlaps between conventional and AI-assisted approaches for post-war re-design. Key differences, as found in relevant studies, are commonly associated with three main aspects and are comparatively discussed as follows:

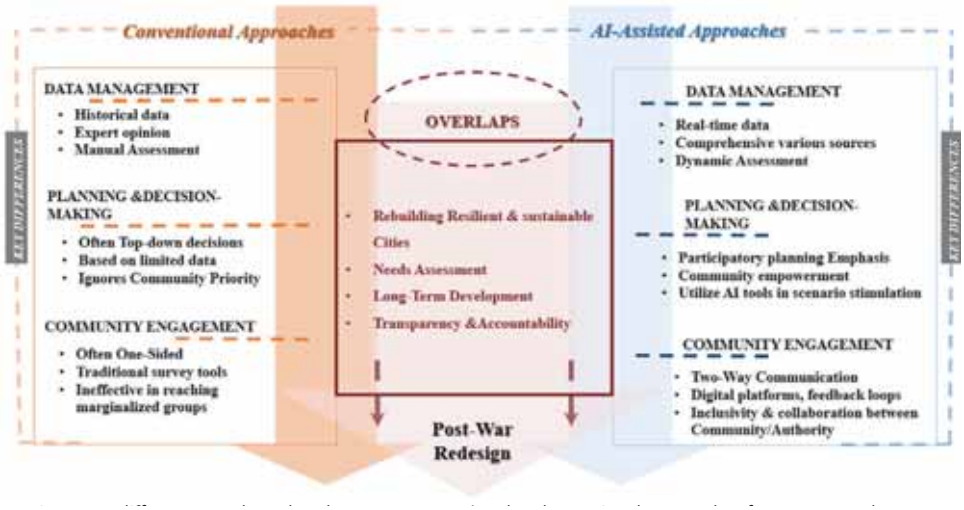


Fig. 4: Key differences and overlaps between conventional and AI-assisted approaches for post-war urban re-design. (Adapted by Authors)

4 First, data and analysis: Conventional approaches rely on expert opinion and historical data, which are considered limited, constrained, and subjective. On the contrary, AI-assisted approaches utilize tools that retrieve real-time data from several resources, providing a more accurate understanding of the constantly shifting needs of communities and urban landscapes facing conflict. For instance, satellite images contribute to detecting damage to infrastructure, while social media platforms can give an up-to-date community apprehension, leading to a full understanding of the situation, which further facilitates the process of effective decision-making.

4 Secondly, planning and decision-making: Conventional approaches usually follow a hierarchical structure that may result in insufficient data collection or not reflect communities' desired needs. On the other hand, AI-assisted approaches provide participatory planning where the simulated models of redesigned urban landscapes in many scenarios enable community members to assess the intervention visually. For instance, individuals can submit their remarks on the simulated designs on interactive platforms, ensuring that their needs and preferences are considered during post-war re-design.

4 Finally, community engagement: conventional approaches contain aspects that may not consider unprivileged communities, such as surveys, forums, and consultation. On the contrary, AI-assisted approaches focus on community inclusion through AI digital-powered tools such as online forums and social media platforms that provide feedback loops from individuals. It is acknowledged that community engagement is highly emphasized in AI-assisted post-war re-design strategies in all stages, as a wide range of individuals participate in active online platforms where discussions are held regarding their needs.

To this end, it is seen that despite the differences in both approaches, they still hold a mutual aim to promote sustainable and resilient urban landscapes and communities after the war. They both share a mutual understanding of several aspects, such as needs assessment, long-term development, transparency, and accountability. Also, their methods vary, yet they both aim to achieve responsible distribution of resources as well as self-reliant, healthy communities in the long run. The study comprehends those differences and similarities and utilizes them in developing a hybrid approach toward post-war re-design. Table 1 below comparatively analyzes the strengths and limitations of conventional VS AI-assisted post-war re-design approaches as seen in the relevant studies and discusses converging strengths and neutralizing limitations.

Hybrid approach of post-war re-design

Although the exact stages of a hybrid framework for post-war re-design may differ based on contextual factors, below is a proposed outline that contains critical phases involving the collaboration between

Table 1: Limitations and Strengths of post-war re-design approaches. (Adapted by Authors)

Conventional Approaches		AI-Assisted Approaches	
Limitations	**Strengths**	**Strengths**	**Limitations**
Limited Data Analysis	Deeply Contextual	Data-Driven Insights	Ethical Concerns
Reactive Approach	Community-Centric	Predictive Modeling	Limited Local Context
Resource Constraints	Human-Centred Approach	Resource Optimization	Accessibility and Capacity
Converge Strengths			
Neutralize Limitations			

humans and AI, community engagement, and ethical considerations:

• *Phase 1: Requirements assessment and strategic planning for humans and collaboration.*

1. Data collection and analysis:

– Human-led: Needs assessments by engaging the community through traditional methods such as surveys, which are further assessed through expert evaluations and data from historical and past resources.

– AI-assisted: Utilize AI tools to examine complex datasets such as satellite images, demographic data, and infrastructure evaluations. This helps detect and understand repeated patterns and emerging trends.

2. Risk prediction and prioritization:

– Human-led: Integrate analysis by experts with communities to understand individual and local vulnerabilities and possible threats, such as stress in the public structure and natural disasters.

– AI-assisted: Utilize AI algorithms to create possible models for future risks and issues, guiding the prioritization process.

3. Development of an integrated human/AI collaboration:

– Organize workshops and meetings between experts, community leaders, and AI professionals to create collaborative human/AI strategies that merge data analysis, risk prediction, and local needs and objectives.

– Ethical considerations: The strategy's design must include ethical concepts such as data privacy, openness, and accountability.

• *Phase 2: Execution and surveillance (Involvement of the community and development of skills)*

1. Community engagement:

– Participatory implementation involves local communities facing conflict in the development of intervention techniques, project implementation, and monitoring progress.

– Capacity building: Provide proper training and the resources that enable local communities to use and effectively contribute to AI-driven tools.

2. AI-assisted intervention:

– Targeted resource distribution: Utilize AI tools to effectively distribute resources in a way that considers aspects of real-time data and changing requirements.

– Implement AI-driven tools to monitor and predict problems such as possible infrastructure problems or resource shortages.

3. Hybrid feedback and adaptation:

– Integrate community feedback: Regularly collect feedback from community members traditionally through meetings, surveys, or focus groups and incorporate it into the decision-making process.

– Employ AI tools to analyze feedback data and then further incorporate AI insights to enhance the creation of solutions as they usually continuously learn and adapt in real-time.

1. Phase 3: Ensuring a facilitated share of knowledge and long-term sustainability:

– Promote community ownership: Build a sense of involvement between the local community's individuals and the sense of control and ownership of repaired infrastructure and systems.

– Continue effective distribution of resources to enhance local skills and facilitate the transfer of knowledge to ensure the project's sustainability for the long term.

2. Knowledge sharing and replication:

– Record and widely spread acquired knowledge: Gather and distribute reasonable and practical methods as well as difficulties faced during the hybrid re-design processes.

– Guidance for future interventions: Participate in establishing a complete international data storage to enhance the efficiency of post-war re-design efforts that can be generalized.

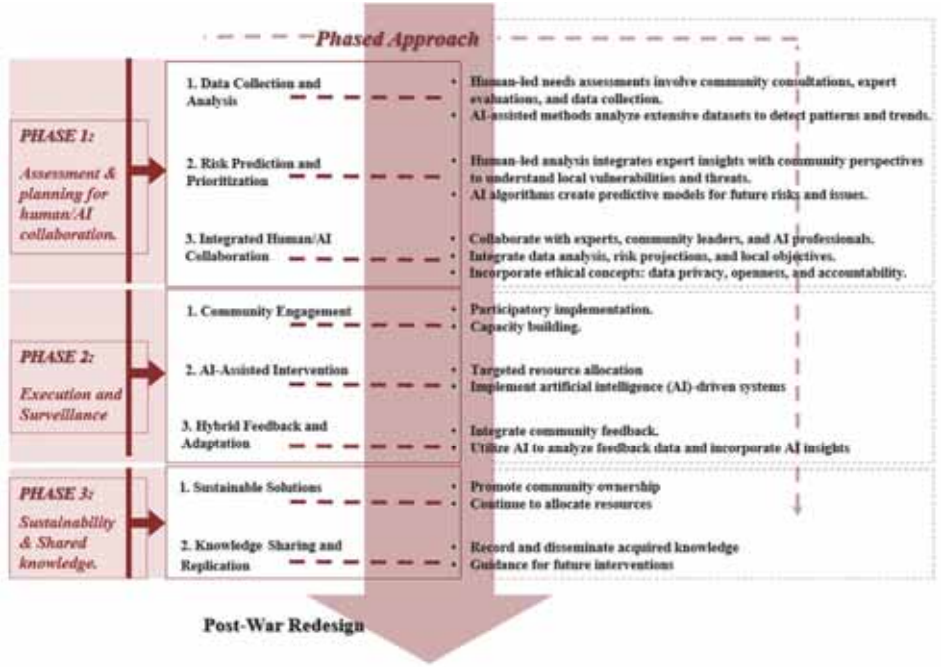


Fig. 5: The hybrid theoretical post-war re-design approach (Adapted by Authors).

The illustration in Fig. 5 summarizes this hybrid approach to reinvented post-war re-design tailored by this study.

It is worth noting here that this discussed approach is flexible and may be adjusted by context to suit specific needs, requirements, and circumstances. The issue is to find a balance between human expertise, community participation, and appropriate use of AI-driven solutions, as it is essential to accomplish long-term and inclusive post-war re-design and rebuilding of urban landscapes.

CONCLUSION

The study explores the potential integration of AI in re-designing post-war urban landscapes. It compares conventional methods of urban revival with innovative AI-supported methods to determine the advantages of utilizing AI in postwar urban re-design. Traditional techniques for gathering data, allocating resources, and engaging the community have many challenges that negatively affect the effectiveness of re-designing and re-design measures. This study suggests that integrating AI with traditional strategies can help overcome these challenges by analyzing extensive datasets, which leads to effective decision-making. A hybrid approach combining conventional and AI-supported processes is suggested to improve the resiliency and sustainability of the re-designing stages. It aims to enhance resource distribution and strategic planning through AI-assisted strategies. The primary characteristics of the hybrid approach show a practical path for re-designing urban areas in post-war settings and offer a base for future and practical case studies to prove the following suggestions:

- *Facilitating human-AI collaboration*: Combine AI tools with professional human judgment and local knowledge to guarantee the development of contextually appropriate and ethically sound solutions.
- *Community engagement*: Involving communities in data collecting, model creation, and feedback loops to ensure that AI solutions get tailored to meet their specific requirements and objectives.
- *Capacity building*: Allocate resources toward providing training and developing infrastructure to narrow the gap in digital access and enable local populations to utilize and contribute to AI-driven solutions effectively.
- *Ethical implementation*: Ensure adherence to ethical standards of data privacy, transparency, and responsibility during the development and utilization

of AI tools.

Combining AI's analytical capabilities with traditional approaches, human comprehension, and community-oriented nature can establish a path for more successful and comprehensive post-war re-design attempts.

AUTHOR CONTRIBUTIONS

I. A. Alshafei performed the initial paper structure, analyzed and interpreted practical data, prepared the manuscript text and preparation, and constructed the results and discussion. Additionally, contributed to the revision and English proofing of the manuscript. R. T. N. Almashhour performed significant parts of the requested revisions, including restructuring the paper and the literature review, enhancing materials and methods, and tailoring the conclusion.

ACKNOWLEDGEMENT

This study was done while the authors were faculty members. Firstly, the Department of Architecture, Faculty of Munib, and Angela Al Masri of Engineering, at Aqaba for Technology University, Jordan. Secondly, the Architecture Engineering Department, Faculty of Engineering, Nahda University, Benisuef City, Egypt. It was not part of any project. The time spent on this work is highly appreciated.

CONFLICT OF INTEREST

The authors declare no potential conflict of interest regarding the publication of this work. In addition, the authors have entirely witnessed ethical issues, including plagiarism, informed consent, misconduct, data fabrication and falsification, double publication and submission, and redundancy.

OPEN ACCESS

PUBLISHER NOTE

ABBREVIATIONS (NOMENCLATURE)

ABM	Agent-based models
AI	Artificial Intelligence
BIM	Building Information Management
CA	Cellular Automata
GIS	Geographic Information Systems
ICT	Information Communication Technology
IoT	Internet of Things
ML	Machine Learning
PSS	Planning Support Systems
V2X	Vehicle-to-Everything

REFERENCES

Al-Samurai, A.; Al-Qaraghuli, A., (2021). Adopting sustainable development in reconstruction Post War City of Mosul Architecture-Case Study. *IOP Conf. Ser.: Earth Environ. Sci.*, *754*(2021): 1-18 **(18 pages)**Aburas, M. M.; Ahamad, M. S. S.; Omar, N. Q. (2019). Spatio-temporal simulation and prediction of land-use change using conventional and machine learning models: a review. Environ. Monit. Assess., 191(4): 205 **(10 pages)**

Ahmed, S., Hossain; Md. F., Kaiser, M. S.; Noor, M. B. T.; Mahmud, M., & Chakraborty, C. (2021). Artificial Intelligence and Machine Learning for Ensuring Security in Smart Cities. In C. Chakraborty, J. C.-W. Lin, M. Alazab (Eds.), Data-Driven Mining, Learning and Analytics for Secured Smart Cities: Trends and Advances (pp. 23–47). Springer Inter. Publishing. **(24 pages)**

Akinosho, T. D.; Oyedele, L. O.; Bilal, M.; Ajayi, A. O.; Delgado, M. D.; Akinade, O. O.; & Ahmed, A. A. (2020). Deep learning in the construction industry: A review of present status and future

innovations. J. Build. Eng., 32 **(32 pages)**

Ali, M. A.; Panchal, V. K. (2020). Smart Cities: Definition, Component, and Technology. International conference on Recent Trends in Artificial Intelligence, IOT, Smart Cities & amp; Applications (ICAISC-2020). SSRN Electronic Journal **(10 pages)**

Al-Jaberi, A. A.; Al-Khafaji, A. S.; Ivankina, N. A.; & Al-Sawafi, M. H. (2019). The idea of pedestrian pockets as a key for successful transit-oriented development for Najaf city-Republic of Iraq. IOP Conf Ser: Mater. Sci. Eng., 698(3): 033029 **(10 pages)**

Alkassabany, N.; Mousa, M. (2020). ARCHITECTURAL DESIGN PROCESS MANAGEMENT. Architecture and Planning Journal (APJ)., 23(2): 1-11 **(11 pages)**

Al-Khafaji, A. S.; Al-Salam, N. A.; Alrobaee, T. R. (2021). The Cognition Role to Understanding Planning and Architectural Production. Civil Engineering Journal., 7(7): 1125–1135 **(11 pages)**

Almeida, C. P.; Ramos, A. F.; Silva, J. M. (2018). Sustainability assessment of building rehabilitation actions in old urban centres. Sustainable Cities Soc., 36: 378–385 **(8 pages)**

Al-Mosawy, S. K.; Al-Jaberi, A. A., Alrobaee; T. R., Al-Khafaji, A. S. (2021a). Urban planning and reconstruction of cities post-wars by the approach of events and response images. Civil Engineering Journal (Iran)., 7(11): 1836–1852 **(17 pages)**

Altaee, Z. M. J.; Al-Ani, M. J. (2020). Urban renewal as a tool of cities sustainability Sulaimani as a case study-north Iraq. Periodicals of Engineering and Natural Sciences (PEN)., 8: 971–990 **(20 pages)**

Bai, Z.; Yang, L., Fu, C.; Liu, Z., He, Z.; Zhu, N. (2022). A robust approach to integrated wireless charging infrastructure design and bus fleet size optimization. Comput. Ind. Eng., 168: 108046 **(10 pages)**

Bradner, E.; Iorio, F.; Davis, M. (2014). Parameters Tell the Design Story: Ideation and Abstraction in Design Optimization. SimAUD 2014 Symposium on Simulation for Architecture and Urban Design Parameters. Tell the Design Story: Ideation and Abstraction in Design Optimization. **(10 pages)**

Casali, Y.; Aydin, N. Y.; Comes, T. (2022). Machine learning for spatial analyses in urban areas: a scoping review. Sustainable Cities Soc., 85: 104050 **(10 pages)**

de Jong, M.; Joss, S., Schraven, D.; Zhan, C.; Weijnen, M. (2015). Sustainable–smart–resilient–low carbon–eco–knowledge cities; making sense of a multitude of concepts promoting sustainable urbanization. J. Cleaner Prod., 109: 25–38 **(14 pages)**

Embarak, O. (2022). Smart Cities New Paradigm Applications and Challenges. In S. Aurelia & S. Paiva (Eds.), Immersive Technology in Smart Cities: Augmented and Virtual Reality in IoT (pp. 147–177). Springer Inter. Publishing **(30 pages)**

Gross, D.; Yu, E. (2001). From Non-Functional Requirements to Design through Patterns. Requirements Engineering., 6(1): 18–36 **(19 pages)**

Gubbi, J.; Buyya, R.; Marusic, S.; Palaniswami, M. (2013). Internet of Things (IoT): A vision, architectural elements, and future directions. Future Gene. Comput. Syst., 29(7): 1645–1660 **(16 pages)**

He, B.; Zhu, L.; Cai, X.; Li, J. (Justin), Zhu, H. (2020). Examining the Impacts of Mega-Events on Urban Development Using Coupling Analysis: A Case Study of the Boao Forum for Asia. Sustainability., 12(2): 730 **(10 pages)**

Hettithanthri, U.; Hansen, P.; Munasinghe, H. (2023). Exploring the architectural design process assisted in conventional design studio: a systematic literature review. Int. J. Technol. Des. Educ., 33(5): 1835–1859 **(25 pages)**

Hussein, S. H.; Abdulla, Z. R.; Salih, N. M. M. (2019). Urban regeneration through post-war reconstruction: Reclaiming the urban identity of the old city of Mosul. Periodicals of Engineering and Natural Sciences (PEN)., 7(1): 294-394 **(11 pages)**

Ibrahim, A. O. (2022). Architectural Projects Design Methodology Process-Design Drawing Sequence and General Notions. In University of Hail. University of Hail **(10 pages)**

ILO. (2023). Investing in youth skills for peace in Afghanistan, International Labor Organization **(10 pages)**

Kalervo, A.; Ylioinas, J.; Häikiö, M.; Karhu, A.; Kannala, J. (2019). CubiCasa5K: A Dataset and an Improved Multi-task Model for Floorplan Image Analysis. In Image Analysis: 21st Scandinavian Conference, SCIA 2019, Norrköping, Sweden, June 11–13, Proceedings 21. (pp. 28–40) **(13 pages)**

Kim, Y.-W.; Alseadi, I. (2021). Identification and Evaluation of the Influencing Factors in Target Value Design Process through an Industry Survey. Journal of Civil Engineering and Construction., 10(2): 75–83 **(9 pages)**

Kokkala, A.; Marinos, V. (2022). An engineering geological database for managing, planning and protecting intelligent cities: The case of Thessaloniki city in Northern Greece. Eng. Geol., 301: 106617-106627 **(11 pages)**

Komninos, N. (2006). The architecture of intelligent clities: Integrating human, collective and artificial intelligence to enhance knowledge and innovation. 2006 2nd IET International Conference on Intelligent Environments - IE 06., 1: 13–20 **(8 pages)**

Komninos, N. (2016). Intelligent cities and the evolution toward technology-enhanced, global and user-driven territorial systems of innovation. In Handbook on the Geographies of Innovation. Edward Elgar Publishing **(10 pages)**

Lawson, B. R. (2006). How Designers Think – The Design Process Demystified. University Press, Cambridge. **(20 pages)**

Leone, S. (2023). Core Report Fiscal Year 2023. Plan International Organization **(10 pages)**

Li, L.; Li, Z.; Li, X.; Wu, G. (2019). A review of global lean construction during the past two decades: analysis and visualization. Engineering, Construction and Architectural Management., 26(6): 1192–1216. **(25 pages)**

Liu, X.; Zhang, Y. (2023). Study on the impact of intelligent city pilot on green and low-carbon development. Environ. Sci. Pollut. Res., 30(20): 57882–57897 **(16 pages)**

Manoharan, G.; Durai, S., Rajesh, G. A.; Razak, A., Rao; C. B. S.; Ashtikar, S. P. (2023). An investigation into the effectiveness of smart city projects by identifying the framework for measuring performance. In Artificial Intelligence and Machine Learning in Smart City Planning (pp. 71–84) **(14 pages)**

Meeran, A.; Conrad Joyce, S. (2020). Machine Learning for Comparative Urban Planning at Scale: An Aviation Case Study. ACADIA. Philadelphia.,178–187 **(10 pages)**

Mitchell, A. S.; Mazhar, M. U.; Painter, B.; Lemon, M. (2021, July 2). From Smart to Cognitive Cities: Learning for Sustainability. Third International Conference at the Institute of Energy and Sustainable Development **(10 pages)**

Mohammed, I. A. (2020). Security, Privacy and Risks Within Smart Cities: Literature Review and Development of a Smart City Interaction Framework. In International Journal of Creative Research Thoughts., 8(1): 1-11 **(11 pages)**

Peng, Z.-R.; Lu, K.-F.; Liu, Y.; Zhai, W. (2023). The Pathway of Urban Planning AI: From Planning Support to Plan-Making. Journal of Planning Education and Research **(10 pages)**

Pramanik, S.; Pandey, D.; Joardar, S.; Niranjanamurthy, M.; Pandey, B. K.; & Kaur, J. (2023). An overview of IoT privacy and security in smart cities. AIP Conference Proceedings, 020057. **(10 pages)**

Razzouk, R.; Shute, V. (2012). What Is Design Thinking and Why Is It Important? Review of Educational Research., 82(3): 330–348 **(19 pages)**

Reijneveld, S. A.; Koene, M.; Tuinstra, J.; van der Spek, S. C.; Broekhuis, M.; Wagenaar, C. (2024). Making post-war urban neighbourhoods healthier: involving residents' perspectives in selecting locations for health promoting urban redesign interventions. Cities & Health., 8(1): 82–90 **(9 pages)**

Richards, G. (2020). Urban studies and the eventful city. In The Routledge Handbook of Events (pp. 273–286). Routledge **(13 pages)**

Salman, A. S.; Hussein, A. F.; Nassif, H. A.; Kadhim, I. J. (2021). City architecture after war: a study of the impact of the war event on the architecture of the city of Mosul. IOP Conf. Ser.: Earth Environ. Sci., 779(1): 012046 **(10 pages)**

Shaqour, E. N. (2022a). The impact of adopting lean construction in Egypt: Level of knowledge, application, and benefits. Ain Shams Eng. J., 13(2): 101551-101561 **(11 pages)**

Shaqour, E. N. (2022b). The role of implementing BIM applications in enhancing project management knowledge areas in Egypt. Ain Shams Eng. J., 13(1): 101509-1011519 **(11 pages)**

Singh, C. R.; Manoharan, G. (2024). Strengthening Resilience: AI and Machine Learning in Emergency Decision-Making for Natural Disasters. In Title: Internet of Things and AI for Natural Disaster Management and Prediction (pp. 249–278) **(27 pages)**

Steinberg, F. (1996). Conservation and rehabilitation of urban heritage in developing countries. Habitat International., 20(3): 463–475 **(13 pages)**

Tezel, A.; Taggart, M.; Koskela, L.; Tzortzopoulos, P.; Hanahoe, J.; Kelly, M. (2020). Lean construction and BIM in small and medium-sized enterprises (SMEs) in construction: a systematic literature review. Can. J. Civ. Eng., 47(2): 186–201 **(16 pages)**

Trindade, E. P.; Hinnig, M. P. F.; da Costa, E. M.; Marques, J. S.; Bastos, R. C.; Yigitcanlar, T. (2017). Sustainable development of smart cities: a systematic review of the literature. Journal of Open Innovation: Technology, Market, and Complexity., 3(3): 1–14 **(14 pages)**

UNDP. (2021). URBAN RISK MANAGEMENT AND RESILIENCE STRATEGY **(40 pages)**

UNESCO. (2023a). Artificial Intelligence and Cultural Heritage: Opportunities and Challenges **(11 pages)**

UNESCO. (2023b). Reviving the spirit of Mosul: Restoring cultural heritage **(10 pages)**

UN-Habitat. (2022). Post-Conflict Urban Rehabilitation **(10 pages)**

United Nations Global Pulse. (2023). Data Ethics for a Safe and Inclusive World: A Framework for Implementing the Data Principle **(10 pages)**

Voda, A. I.; & Radu, L. D. (2018). Artificial Intelligence and the Future of Smart Cities. BRAIN. Broad Research in Artificial Intelligence and Neuroscience., 9(2): 110–127 **(18 pages)**

WB. (1998). Post-Conflict Reconstruction The Role of the World Bank **(10 pages)**

Woodbury, R.; Williamson, S.; Beesley, P. (2011). PRARMETRIC MODELLING AS A DESIGN REPRESENTATION IN ARCHITECTURE: A PROCESS ACCOUNT. Proceedings of the Canadian Engineering Education Association (CEEA) **(10 pages)**

Wu, Z. (2018a). Construction Level Ranking of Intelligent Cities. In Z. Wu (Ed.), Intelligent City Evaluation System (pp. 117–159) Springer Singapore **(42 pages)**

Wu, Z. (2018b). Development Stages of Intelligent Cities. In Z. Wu (Ed.), Intelligent City Evaluation System (pp. 45–55) Springer Singapore **(11 pages)**

Yarwood, J. R. (2010). Urban planning after war, disaster and disintegration : case studies. Cambridge Scholars Publishing **(205 pages)**

Zhang, C.; Lu, Y. (2021). Study on artificial intelligence: The state of the art and future prospects. J. Ind. Inf. Integr., 23: 100224 **(10 pages)**

Zheng, H. W.; Shen, G. Q.; Wang, H. (2014). A review of recent studies on sustainable urban renewal. Habitat International., 41: 272–279 **(8 pages)**

HOW TO CITE THIS ARTICLE

Alshafei, I.A.; Almashhour, R.T.N., (2025). Integrating Artificial Intelligence in urban re-design: A collaborative approach to post-war design phases. Int. J. Hum. Capital Urban Manage., 10(2): 269-282.

DOI: 10.22034/IJHCUM.2025.02.05

URL: https://www.ijhcum.net/article_716977.html

Int. J. Hum. Capital Urban Manage., 10(2): 283-300, Spring 2025

International Journal of Human Capital in Urban Management
(IJHCUM)

Homepage: http://www.ijhcum.net/

ORIGINAL RESEARCH PAPER

The impact of detailed architectural elements on the mental image of the university campus

D. H. Ghanim*; E. H. Ismaeel

Department of Architecture, College of Engineering, University of Mosul, Iraq,41002

ARTICLE INFO

Article History:
Received 16 May 2024
Revised 22 August 2024
Accepted 09 October 2024

Keywords:
Mental image
Urban environment
Urban fabric
Built elements
Campus

ABSTRACT

BACKGROUND AND OBJECTIVES: The urban environment on a university campus is constituted by a complex and multifaceted fabric, comprising a diverse array of elements. An understanding of the configuration and relationships between these elements enables designers and planners to create urban architecture that meets the needs of residents. The present study seeks to identify the specific factors that shape the mental image of the urban fabric of the University of Mosul campus. To this end, it reviews and analyses some related studies.

METHODS: This study used a mixed methodology, including quantitative and qualitative methods, to evaluate the impact of architectural elements on the mental image of a university campus. Qualitative information was collected through interviews with urban design experts and old pioneers, while a semi-structured questionnaire was administered to professors, graduate students, and final-year students at the Department of Architecture to obtain quantitative data. The aim was to build on the data and obtain reliable results.

FINDINGS: The results show the most important elements that impacted the mental image, with the opening elements being the most memorable, as they were recognized with about 92% accuracy. In contrast, the plant elements group had less impact, being identified with approximately 33% accuracy.

CONCLUSION: Understanding the process of forming mental images of the urban environment is crucial for future city quality enhancement. Mental images consist of physical and non-physical elements, and attention to detail, aesthetics, and people's preferences can lead to sustainable urban design. The location, design, and functionality of elements and social activities can significantly impact the mental image, influencing comfort, security, and belonging.

DOI: 10.22034/IJHCUM.2025.02.06

NUMBER OF REFERENCES	NUMBER OF FIGURES	NUMBER OF TABLES
39	13	3

*Corresponding Author:
Email: *dhuha.22enp48@student.uomosul.edu.iq*
Phone: +9647725390527
ORCID: 0009-0004-9113-4094

Note: Discussion period for this manuscript open until July 1, 2025 on IJHCUM website at the "Show Article.

INTRODUCTION

The shapes and relationships of buildings and spaces significantly impact urban environmental sustainability. The form, details, height, and location of a building affect the microclimate between buildings. Additionally, incorporating human scale and vegetation improves the quality of life and enhances sustainability by clarifying the components of the urban environment and making them readable and easy to understand, such as through signs, landmarks, and monuments (Moazzeni and Villalobos, 2023). The urban landscape consists of a complex visual system consisting of several elements. In visual evaluation, it is important to analyze these elements, know the connections that bring them together, and determine which element is the most important to creating an urban design that suits people (Hussein and Armstrong, 2016). The urban environment is represented by formal characteristics that reflect the physical and sensory concepts, and the way buildings are interconnected with spaces gives the identity of the place (Caldera *et al.*, 2020). The urban landscape brings together individuals, activities, and material elements and develops over time (Elabd, 2022). A good image of a city acts as a tool to capture people's memories and provide a place that is easily remembered by all people. The physical elements are important in determining the image of a place, and from here, the importance of determining the elements of the MI becomes clear (Fahri and Rahmadyani, 2023). People's perception of the urban environment, with the addition of experience, culture, and feeling, transforms perception into an image that is formed gradually over time (Tang *et al.*, 2023). This study aims to identify the factors influencing the formation of MI at the University of Mosul (UoM) by reviewing and analyzing some previous studies that dealt with the concept of MI to identify and classify the elements that work on or contribute to its formation. To achieve this, the research used a qualitative and quantitative method to obtain information and data, as a group of experts and associates at the UoM who were interviewed were used to reach better indicators, as they were asked a set of questions related to their recollection of the detailed elements in the paths that were chosen, and then a questionnaire was conducted after collecting the variables to achieve the goals in a purposive sample consisting of students and professors of the UoM, and through the questionnaire, quantitative information was obtained from 50 participants with varying backgrounds in experience. To achieve these objectives, the research survey was conducted in residential areas of Mosul City, Iraq, in 2024.

The townscape

The townscape is defined as the visual organization of elements of buildings, roads, and spaces in urban areas formed organically during development processes or growing unintentionally (Setiawan *et al.*, 2022). The clarity of the urban scene depends on variable factors such as the observer's distance, lighting conditions, and weather conditions, where the observer's field of vision plays an important role in seeing the urban scene. When the visual elements are clear, individuals can form mental maps and facilitate their navigation within the urban environment (Bashri*et al.*, 2023). It is part of the urban environment, which is a complex multi-element system that includes buildings and natural elements, deals with cultural and social aspects, and is affected by many factors, including philosophy, science, economics, and aesthetics. It is also characterized by interconnected spatial, environmental, and social dimensions. The evaluation of the urban environment depends on several matters, including its architectural system, development, nature, and structural infrastructure to improve its quality (Romice*et al.*, 2022). The townscape is formed within the urban fabric, which is defined as a combination of building blocks that represent the physical part and urban spaces that represent the moral part, and the way they are interconnected constitutes the structure of the city. The urban fabric has two different patterns: the organic urban fabric, in which spaces are the basis of the composition, and the urban fabric pattern, represented by modern trends, in which blocks are often distinguished in the formation of the fabric (Taher*et al.*, 2014).

Characteristics of the environment and urban fabric

The characteristics of the urban fabric are represented by many features and details, such as the general urban structure, which deals with the relationships between areas, blocks, natural and open environments, and activities; urban grain to achieve a balance between open spaces and the fragmentation of the architectural structure; and

the extent to which the area is divided into smaller pieces or blocks, density, and mixture represent level density. Development and the diversity of different uses, such as residential, commercial, institutional, or recreational, while masses and heights are the scale of buildings relative to height and their relationship to the land, buildings, and surrounding roads (Alabaachi and Alalaf, 2023). Streetscape and landscape include the design of public places such as streets, open spaces, paths, and walkways, as well as natural scenes, shading patterns, facades, and interfaces, which are the relationship of buildings to the site, the street, and the buildings. Details and materials include the appearance of the elements and the type of material selection in terms of details, texture, color, durability, sustainability, and processing methods. It includes furniture streets, road paving materials and methods, paths, lighting elements, installations, and signage, while the public realm is concerned with urban design and the management of the public space used and how it is tested, used, and benefited from, while topography, landscape, and environment include the surface topography and shape of the land, water elements, plants, and animals, whether natural or artificial, which may be in the form of rivers, streams, or lakes and is often referred to as "infrastructure." The social and economic fabric represents the non-material aspects of the urban form, which include social factors such as culture, participation, health, and well-being, as well as the productive capacity and economic prosperity of the community (Omar, *et al.*, 2022). The scale is the size, area, masses, and perception of buildings and spaces. Size refers to the height, width, and depth of a building compared to other surrounding buildings, while urban form means the coordination and form of arrangement of a specific built area, and it consists of many components, including how the buildings are close together and what uses they are found in (Urban Design Institute, 2015).

Mental image

Lynch defines Mental Image (MI) as the product of immediate sensation and memory of previous experience and is used to interpret information. It is a general mental representation of any city that is intertwined with many individual images, or perhaps there is a series of general images that make it up. The Intermediate Dictionary defines the image as "the form, the three-dimensional statue, the image of a thing, its abstract essence, and its imagination in the mind or mind" (Lynch, 1964). Clarity is the ease of forming MIs of places, which helps individuals navigate urban environments. People should be able to recognize urban elements and organize them coherently when moving through the urban environment (Hamad and Ismaeel, 2023). Kevin Lynch was able to shape mental maps from participants' minds by asking them to draw maps of the city. Meanwhile, the concept of recognition, which is considered an agent of the clarity concept introduced by social psychologist Milgram, aims to enhance and develop collective mental maps by presenting images of the city to participants. They are asked to recognize the location of each image and identify the important urban elements that were recognized by the majority of participants, making the city clear and familiar (Constantinides *et al.*,2021). According to (Lynch, 1964), the MI consists of five basic and pivotal elements on which it is based, namely paths, which mean the channels through which movement takes place in the city. These elements may be streets, paths, and railways; Districts are medium-to large-sized parts of a city that are viewed as having a two-dimensional scale, recognizable from the inside, and used as an external reference. Landmarks are used to highlight the uniqueness of the item and are usually seen from several angles. Nodes or transition points are strategic locations in the city, and nodes may simply be a concentration of events. Edges are the elements between two stages that are used as linear separations that require continuity, such as beaches, railway lines, and fences. These edges may be permeable barriers or isolate one area from another. (Lee, 2016) responded to Lynch's claim that in the process of wayfinding, the environ MI is "the generalized MI of the external physical world that the individual carries" and assumed that program and appearance are linked to remembering spatial identity and that site identity can be formed through architectural elements by integrating urban furniture such as lighting fixtures, bus shelters, garbage containers, columns, and housing.

Characteristics and methods of forming a mental image

A mental image is characterized by a set of features and characteristics. It is ancient, as its origin

goes back to the beginning of human consciousness, and all individuals possess MIs, so it is comprehensive, and the MI tends to be repeated without change and is characterized by clarity or ambiguity and truth or unreality. Social and psychological factors influence its formation, and building an honest image takes a long time. It is characterized by dynamism and takes into account the requirements of reality in terms of place, time, and the individual's outlook (Karima and Mahmoudi, 2021). Individuals receive different forms of information as they move in the urban environment, and the level of understanding of this information depends on its clarity in terms of whether it is dense or complex (Shams Aldin and Al-Madhaji, 2015). Forming the MI of the city includes the physical elements, activities, social practices, and events that occur in the spaces (Artemenko and Artemenko, 2018). The MI of the recipients differs from the real environment, as individuals obtain information from the external environment through visual perception (Latypova*et al*., 2021). After the process of collecting data, it is organized in the mind based on the person's priority; some details are neglected, then personal interpretations and ideas are added to it, and they differ according to age and gender (Topcu and Topcu, 2012). There are many visual treatments to confirm the formation of a clear MI that is easily perceived by the residents through simplicity, continuity in the elements of the formation, and clarity of the visual boundaries. The method of communication between the elements and their strength contributes to the clarity and perception of the MI, as does the difference in level between two points (the city center and the seashore, for example). Forming elements in a way that increases vision gives a strong MI; working to organize elements in a way that provides a sense of movement; creating a sequence of elements that strengthens their perception; and using names to form identity and meaning more than physical aspects (Al-Khafaji and Ismaeil, 2020: AL-Kam, 2009).

Previous literature

In this part, several previous studies will be analyzed to determine the most important factors influencing the formation of the MI in the urban environment. The most important of these studies is the study of Hussein and Armstrong (2016). The study is concerned with treating visual disturbances. The research aims to identify the most important elements in visual evaluation and explore the relationships between them. The research uses computational methods outside the field of urban design to evaluate the townscape. This study presents two types of data in analyzing the urban scene, which includes quantitative data that includes the percentage of the urban area, the number of visible peaks of the urban scene, and the difference in position and color, while the second type is subjective data, which means the extent to which the observer responds to quantitative data. While Firjatullah *et al*., (2017) deal with finding the way, the idea is to research the difficulties that new students at Brawijaya University face in finding the way. The research adopts the methodology of analyzing mind maps and space composition rules using the Depthmap software as well as a questionnaire. Each element is evaluated on a set of criteria, including paving, scale, connection method, building materials, ease of viewing, historical value, distinctive form, function, and ease of viewing. Sensory information includes paving materials and sidewalk furniture that affect memory for pedestrians and street lighting, which works to direct people, especially at night, and is an aesthetic element. Vegetation cover acts as a guidance element and borders areas, as well as an aesthetic element, and adds shade to the place. Signs and markings provide directional elements. Osóch and Czaplińska (2019) state that a person's arrangement of meanings for elements of urban space depends on his personal and cognitive preferences. The study aims to examine how residents of the city of Szczecin (Poland) perceive urban space and to emphasize the relationship between the elements that make up the MI. The research uses Lynch's methodology of analyzing mind maps, with the addition of in-depth interviews and a questionnaire. The results show that the road is the most common element to describe the city. The age of the participants has an impact on the details of the drawings of the mental map, as the younger the people, the fewer the elements and details, and the means of transportation also have an impact on the perception of the elements. Chan (2020) discusses the idea of how individuals understand the environment surrounding them during their movement and the impact of different means of transportation on movement. He follows the methodology of interviewing 30 random samples of

people, drawing the participants, and explaining their movements in the urban environment. Lynch elements are included in the drawings, with the addition of traffic lights, trees, poles, and street names. The main results are that the path is considered the most important element in navigation, followed by landmarks, with the presence of other elements including green spaces, buildings, and traffic signals. The means of transportation have also been shown to affect people's concentration. Latypova *et al.,* (2021) attempted to see how individuals understand the image of the city and what the best experimental research methods are. The study relies on data from two cities. The objectives of the research are to study how to define the image of the region and to introduce mental maps into scientific research. The research uses the methodology of drawing mental maps of the study area and conducting in-depth interviews and an opinion poll via social media. It is concluded that the image of the city consists of environmental symbols, distinctive urban elements, iconic buildings, signs, and urban spaces. Guyot *et al.,* (2021) state that individuals' perception of the urban environment is affected by the surrounding townscape and is thus reflected in their behavior and activities. The study aims to define the urban fabric in Brussels in the same way as the traditional morphological approach, relying on the pedestrian perspective and the introduction of green spaces, using treatment protocols. Modern Geographic MFA (Multiple Fabric Assessment) with the addition of three indicators related to vegetation cover and one indicator for the pedestrian area. To verify the validity of the added indicators, the MFA is conducted twice, the first for 17 indicators within three categories: street network morphology, built morphology, and network-building relationships, and the second with indicators added for vegetation cover. The results for the two groups are compared. The results show the importance of vegetation in determining the urban fabric and that it is an integral part of the townscape. While Phetsuriya and Heath (2022) address the local perception of the street scene in Chiang Mai Old City, the research aims to improve the urban street scene. It adopted the methodology of a questionnaire and in-depth interviews with specialized engineers and residents, as well as evaluating eight streets in the city and improving its landscape in terms of physical elements. It is clear from the results of a convergence of opinions between engineers and residents that both relied on the quality of pavement, traffic management, and increasing green spaces and should cross-urban furniture affect the social and cultural values of the place. Yetim and Yıldırım (2022) state that current cities do not leave any image in the mind as a result of the absence of elements and formations that give the place its identity. The research aims to investigate how religious buildings are seen during pedestrian movement and whether these buildings can be landmarks. Visual analysis technology is used. As a result of the analyses, it is determined whether religious structures were aware or not. Next, the perception of the buildings is analyzed based on their locations, the physical road structure, the visibility of the building, the strength of its appearance, its uniqueness, and its continuity. The results show that historical buildings affect the perception of place, especially when they are visible in a sequential view during movement. The perception of buildings is greater depending on their position on the road, at intersections, and sudden turns. For buildings to be landmarks, they must be effective, continuous, and unique. While Tang *et al.,* (2023) confirm that people's perception of the urban environment is affected by their culture and experience, and this perception is transformed into the image of the city. The research aimed to find the attitude of Wuhan residents towards the image of the city, including the degree of admiration, the degree of familiarity, and the degree of importance. The research uses Kevin's method. Lynch created an image of the city and conducted a questionnaire in 15 areas by selecting random samples and using the SPSS program to analyze 10 images of the city. It has been shown through research that when the size of a city is expanded, convenient transportation and people's awareness expand people's perception of the city. The study by Zhanga *et al.,* (2023) addresses how to use artificial intelligence techniques to shape images of cities. The researcher proposes the urban visual intelligence framework, which specializes in integrating images with artificial intelligence to achieve goals by measuring and representing the urban environment and the interaction of the physical environment with the social and economic environments. The study consists of four levels: how to observe and measure the urban physical environment, how to extract

information through images, as well as the interaction between the physical environment and the social and economic environments. These four levels are also related to four measures of street-level image use. The results show that the use of artificial intelligence techniques contributes to the creation of effective cities that facilitate the lives of their residents more than traditional methods. Su *et al.*, (2023) state that the MI is the image of the place in a person's mind, works to embody feelings, sensations, and opinions, and is expressed in pictorial and textual ways. The research aims to know the urban image of Zhongshan city and its elements, which are not limited to the physical aspects only. The study uses social media to obtain information, and the study uses three software programs to process a huge amount of data. This study explores a way to classify types of images and reach a comprehensive picture of the city. Urban images can also be combined with tourism to obtain an urban interactive system. Fahri *et al.*, (2023) explain that people's MI is influenced by their culture and history and that identifying the physical elements is important before determining the city's image. The research aims to identify the physical elements of the city using Lynch's theory. The researcher uses a descriptive and qualitative approach, and data is collected using observations, a questionnaire, an interview, and drawing mind maps. The researcher classifies the elements into two physical categories; the first category includes form and function, while the second consists of visual, activity, and functional. The two categories are then linked to Ling's MI elements. The results show that the items most remembered by the population are the ones most accessible. Arora and Kumar, (2023) explain that heritage areas are considered important components of the city, improve and contribute to the image of the place, and act as cultural and social centers. The city of Batala in India is considered one of the cities that mix the old with the modern and is a multi-functional area. The researcher suggests several things related to Kevin's elements. Ling, in improving the city, states that the path is the most important organizational element in building the image and reducing congestion, providing public transportation and being linked to parts of the city, designing important nodes in a way that encourages pedestrians, landmarks being visible from distant points, and edges being designed to add entertainment places. Along the route, revitalizing areas encourages tourists and help residents socialize, leading to the preservation of heritage monuments and increasing city revenues. As a result of analyzing previous studies, it can be noted that most of these studies have adopted some aspects related to the MI of the urban fabric and have isolated or neglected other elements and aspects, as shown in Table 1.

Elements of the townscape

Panavaitė (2023) explains that the townscape in the city can be viewed in two ways, from the inside and the outside. He adds that the assessment of the townscape from the outside is done from a bird's eye perspective and includes the building's shape, size, height, density, composition of building roofs, street network structure, and evaluation of the panoramic views of the city, while the internal image of the city through the closed perspective of buildings includes the deviation and rotation at an angle of a particular element or building, protrusions and eclipses, and landmarks that are distinguished by their uniqueness from the context. The internal and external evaluations have psychological effects on the observer. Another evaluation related to scientific and practical activities can be reached, which is represented by the structure plan, block size, building height, building density, building density of land use, the ratio of street width to building height, as well as the arrangement of high-rise buildings in the plan, the internal structure of the blocks, and their sizes. Squares and public places, their types and sizes. Alzamil (2022) states that the elements of townscape formation are embodied in three main foundations, including urban morphology, urban fabric, and land uses. While visual composition includes analyzing place identity and how residents view the townscape, social, economic, and cultural dimensions are considered essential aspects for understanding changes in the townscape. The elements that make up the townscape can be divided into two parts: the structural elements, which include walls (urban facades), floors, and ceilings, and the non-structural elements, which include urban furniture and activities in the urban space.

Structural elements

The structural elements include urban facades, urban roofs, and urban floors, as follows:

Table 1: Analysis of previous studies

Previous studies	Urban fabric type			Elements of the urban environment					Study method						
Author and year	Modern fabric	Traditional fabric	campus	Elements of mental image	Urban facade elements	Floor elements	Urban furniture	Vegetation	mental map	Computer programs	interview	Questionnaire	Digital questionnaire	observation	Arithmetic methods
Hussein and Armstrong,2016	■					■									■
Firjatullah and Purnamasari, 2017			■	■		■	▒	■	■	■		■			
Osóch and Czaplińska, 2019	■			■			▒	▒	■		■				
Chan,2020			■	■			▒	▒	■		■				
Latypova,2021	■			■				■	■		■	■	■		
Guyot, *et al.,* 2021	■							■		■					
Phetsuriya and Heath, 2022		■				■	■	■			■	■			
Yetim and Yıldırım, 2022	■			■						■					
Tang, *et al.,* 2023	■			■						■		■			
Zhanga, et al., 2023	■			■						■					
Su, *et al.,* 2023	■			▒	▒	■	▒	■		■			■		
Fahri, *et al.,* 2023	■			■					■	■	■	■		■	
Arora and Kumar, 2023	■	■		■					■						

All items ■ A specified number of items ▒

First: Urban facades

Urban facades have many elements that affect people and the urban environment, including formative elements such as columns, blocks, balconies, screens, signs, the canopy above the entrance, doors, windows, stairs, and elevators (Hussein and Armstrong, 2016). The building materials in the facades and their relationship with the street also impact the urban landscape (Sanders and Woodward, 2015).

Second: Urban roofs

Urban roofs consist of many configurations, including shades, which are considered one of the most important means of improving the urban environment and work to achieve aesthetic integration with other elements in urban spaces (Zhang, S., *et.al.*, 2022). Porticoes and gates are built over streets and paths at the entrances to gardens and buildings, as well as pergolas, and are used to provide shaded spaces in gardens and at the intersection of paths (AL-Kam, 2009).

Third: Earth's elements

It includes different types depending on the nature of use, including streets, which are known as an important element in defining the character of cities and stimulating social activities (Kethusha and Sooriyagoda, 2022). Paths are considered one of the most important elements in the urban environment, and it is necessary to pay attention to their shading, furnishing, and provision of security and comfort (Tahir and Taylor, 2023). Sidewalks are located next to roads and use building materials that are convenient for pedestrian movement, while stairs and elevations are used to connect roads, paths, and gardens of different levels (AL-Kam, 2009).

Non-structural elements

Other elements that make up outdoor spaces

Table 2: Elements affecting the formation of the MI

Elements affecting the formation of the MI			Common elements, properties, and relationships
Structural elements	**Urban facades**	Walls Openings include windows, doors, and other openings Prominent elements include columns, curtains, frames, and cornices. Signs and banners on facades Balconies, canopies, and a shed above the entrance	Color, Texture, Vegetation, Degree of openness of the street, Space containment, Decoration, measure, technical elements, Finishing materials, Repetition, Symmetry, Rhythm, Continuity, Diversity, Variance, Singularity, Form Simplicity, Continuity, Clarity of Joins, Directional Differentiation, Visual Scope, Motion Awareness, Time Series, Names and Meanings, harmony
	Urban roofs	Sunshade, Gallery, Pergola	
	Floor elements	Streets, Pathway, sidewalks, Stairs, slop, and escalators	
Non-structural element	**Urban furniture**	Fountains, Lighting installations, Seating, Public restrooms, Garbage containers, Pergolas, Sculptures, booths, Signboards, flower beds, Taps	
	Activities in urban space	Comfort, Relaxation, Passive Engagement, Active Engagement, Discovery	

include urban furniture and events in the space. Urban furniture represents all the elements that facilitate the lives of residents and make the urban environment useful and functional, including lighting installations, telephone booths, mailboxes, fences, transportation stations, garbage cans, benches, bicycle paths, and garden boundaries (Gamito and Moreira, 2021). They include benches, waste containers, signs, lighting installations, fountains, barriers, sculptures, and artwork (Yücel, 2013). While events in urban spaces depend on open spaces and activities in urban spaces, to have an effective design and management of public spaces, it is necessary to understand the role these places play in people's lives. There are five types of reasons: comfort, relaxation, passive engagement, active engagement, and discovery (Carmona and Tiesdell, 2007). Table 2 summarizes the most important factors and characteristics affecting the formation of MI in the urban environment, according to what has been derived from relevant literature and studies.

MATERIALS AND METHODS

A mixed methodology - quantitative and qualitative - was used in this study to assess the impact of architectural elements on the MI of the University Campus (UC). To ensure the reliability of the results, qualitative information was collected by interviewing some experts in the field of urban design among the professors of UoM, as well as some old pioneers of the university who have been there for more than 15 years. They were asked a series of semi-open questions to elicit the necessary information, with the opportunity to provide any other data related to the research topic. The researchers also carried out field trips and observations and used the checklist to document the main details related to the aspects identified in the theoretical framework. In the next stage, a semi-structured questionnaire was administered to a group of respondents selected from professors, graduate students, and final year students at the Faculty of Engineering, Department of Architecture, because they can visualize and understand the MI to a greater extent than others. The test aimed to build on the set of data previously collected through interviews and observation and to obtain quantitative information that could be relied upon to extract reliable results. The UoM was chosen as a case study, consisting of a group of buildings and spaces that were designed cumulatively and not in a single period. The Depth map program was used to reach some paths, which are among the most

important paths on the UC. We also benefited from the answers of experts who stressed the importance of these paths. The first path is located between the Industry Gate (A) and the Stadium Gate (B), while the second path is located between the Science Portal (C) and the Dentistry Portal (D), as shown in Fig. 1.

A group of buildings are located on these paths with different functions, including educational, administrative, and recreational. Due to the diversity of these functions, the detailed elements of the urban landscape that they contain vary, the influential elements of which were identified based on interviews with several university employees and field visits by the researcher. The main goal was to determine the impact of these detailed elements on the MI of individuals. Through personal interviews, the experts were asked to identify the architectural, structural, and non-structural details that could be remembered within these paths and that represent positive or negative influencing elements for them, to identify and know their impact on shaping the image. The mentality of the urban fabric of the UC. Then, multiple sets of photos were taken of these identified elements and placed in classified groups based on the theoretical framework. The questionnaire targeted several students and professors at the UoM. Participants in the questionnaire were asked to identify and designate the locations of the elements that they could distinguish within the campus, and through conducting the questionnaire, they reached several results related to the impact of these elements on the MI of the UC.

RESULTS AND DISCUSSION

The elements that were reached by taking pictures in the paths of the UoM were classified into some groups. The first group included window elements. The window of the Deanship of the College of Engineering building was the most influential and distinguished by people, as were the openings of the kindergarten building, which was the least influential. They are the openings of the Student Center building and the windows of the College of Sports and Physical Education, which did not receive much attention or distinction. Fig. 2 shows the elements of the first group. The second group included parts of the distinctive facade elements, as the first and fifth elements in the arrangement were parts of the College of Arts building, and the first part was more distinctive, while the other element was less influential. The second element was also part of the Assyrian Library, and the fourth element was part of the Central Library. Most individuals were able to remember it, and on the contrary, the third element

Fig. 1: The selected paths within the UoM campus

Fig. 2: Elements of group 1

Fig. 3: Elements of group 2

Fig. 4: Elements of group 3

was the least remembered by the participants, which was represented by the arch of the facade of the building of the Department of Qur'anic Sciences and Islamic Education. Fig. 3 shows the elements of the second group. The third group includes the entrances to several buildings, including the entrance to the College of Arts, the Student Center building, the College of Pharmacy, and the Assyrian Library, and was identified by approximately 73% of people. Fig. 4 shows the elements of the third group. While the fourth group represented several facades that included finishing materials, the response rate for the first item, which is part of the finishing materials for the facade of the renewable energy building, decreased, while many participants were able to distinguish the finishing materials for other facades. Fig. 5 shows the number of elements in the fourth group. Likewise, for the fifth group, represented by seats and furniture, the respondents' answers on some items were low, except for the third item, which was the most distinctive. Fig. 6 shows the number of elements in the fifth group. The percentages of the group of umbrellas and roofs varied between the types of umbrellas that were very influential, such as the dome of the student center, which was recognized by the majority of participants, while there were umbrellas that were the least influential. Fig. 7 shows the number of elements in the sixth group. The group of plant elements was the least distinguished among the groups, and elements were not identified at all.

Fig. 5: Elements of the Group 4

Fig. 6: Elements of the Group 5

Fig. 7: Elements of the Group 6

Fig. 8: Elements of the Group 7

Fig. 8 shows the number of elements in the seventh group. There was also a group of water elements for several fountains distributed in different places, as the first element was the most memorable, while the other elements were less influential. Fig. 9 shows the elements of the eighth group. As for the group of kiosks, the participants' answers differed, except for the kiosks of the communication line companies that were identified. Fig. 10 shows the elements of the ninth group. The proportions of the group of fences varied. The most remembered were the tennis court and the open theater in the College of Arts, and the least remembered were the car garage wall and the fence separating the university and the technical institute. Fig. 11 shows the elements of the tenth group. The first and third items in the stairs and steps group were the most familiar and memorable, in contrast to the second item. Figure 12 shows the

Fig. 9: Elements of the Group 8

Fig. 10: Elements of the Group 9

Fig. 11: Elements of the Group 10

Fig. 12: Elements of the Group 11

elements of the eleventh group. 67% of people were able to recognize the mural art on the facade of the student center, while 64% of individuals were able to recognize the sculpture in front of the central library. Fig. 13 shows the elements of the twelfth group. Table 3 shows the most important results and percentages obtained by each element of each group within the study case under test.

The results were sorted according to important aspects, less important aspects, and neglected aspects, and it was found that each element of one group varied in proportions, and the proportions also varied between the groups. The first group consisted of window elements, as the knowledge of the participants varied, and they distinguished some of them based on the characteristics of the element, as many were able to do so. Among the participants was the distinction between the windows of the Deanship of the College of Engineering building and the openings of the Kindergarten building due to

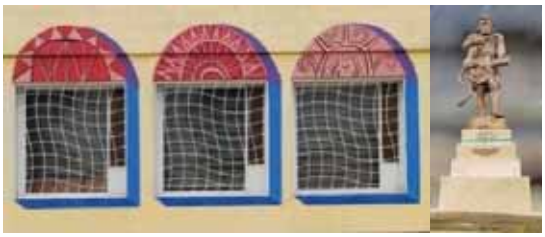


Fig. 13: Elements of the Group 12

the different shapes in design as well as the color characteristics, which many of the experts who were interviewed stated as the characteristic that most influence the formation of the image in the mind of the individual, while the least distinguishable were the openings of the building of the College of Sports and Physical Education due to the location of the college and its use by a limited number of students, the recognition rate of the window of the Student Center building was also reduced due to the elements of wall art around it, which gave a more memorable impression. Figure 2 shows the elements of the first group.

The second group included parts of the facade elements. The first element was distinguished due to its location in the middle of the building's facade as well as the color characteristic, while the fifth element of the same facade received a lower percentage due to its location in the side part of the facade. Participants were able to distinguish parts of the Central and Assyrian libraries due to their locations within the US, which are places frequented by a large number of participants. As stated by Yetim and Yıldırım (2022), the elements that are most remembered by residents are the ones most accessible, in contrast to the building of the Department of Qur'anic Sciences and Islamic Education, which is limited to a certain number of university members and students, as the function of the building has a role in influencing the image of the place, the black color characteristic of the central library and its elements that were chosen at eye level had a positive impact on the respondents' answers.

The third group consisted of some building entrances, and the characteristics of uniqueness and quality of the final materials, such as the contrast with the materials, as in the gate of the College of Arts, and the characteristic of the large size of the student center gate influenced most of the respondents in remembering them.

The fourth group consisted of several interfaces that included different memorable finishing materials in colors that attracted attention, whether positive or negative, and had a significant impact on the respondents' answers. The response rate for the first item decreased as a result of the similarity to the materials of another building, while many participants were able to distinguish the finishing materials for other facades as a result of the use of materials in colors different from the context of most buildings at the university, which gave a negative impression of the university buildings, according to the opinion of the experts who were interviewed. Fig. 5 shows the number of elements in the fourth group.

As for the fifth group, represented by seats and furniture, the answers of some respondents were similar to those of other elements located in locations outside the chosen paths. As a result, the percentage of recognition and discrimination of these elements in their original locations decreased. The third element was more recognizable as a result of its location in the parks most frequently visited by the participants. In contrast to the fifth element, represented by the shape of the track's floor design, which is located in gardens designated for a specific number of students, Fig. 6 shows the number of elements in the fifth group.

The dome of the student center was distinguished by the majority of participants due to its large size, building materials, and location in the most common places, while canopies were the least distinguished due to their location, unobtrusive shape, and lack of use.

Among the reasons that made the group of plant elements less known was the difference in the participants' answers with another similar element in

other locations, as in the first element, and elements that were not identified at all. The reason for this is their location among other elements that attract more attention and are below the level of sight, while it was possible. Many participants distinguished the College of Arts course due to its location and distinctive appearance with various plant varieties. Fig. 8 shows the number of elements in the seventh group.

The first element in the group of water elements was the most memorable due to its association with an artistic element and the different colors that attracted attention, as well as its location opposite one of the main university gates, while the other elements were in places used by a small number of individuals. Fig. 9 shows the elements of the eighth group.

As for the group of kiosks, as a result of their unified and close design, the participants' answers varied, and thus, the percentage of knowing and identifying the locations of these elements accurately decreased, except for the kiosks of the communication lines companies, which had a different design and attractive colors. Fig. 10 shows the elements of the ninth group.

As for the group of fences, the most memorable were those associated with recreational activities on the tennis court and then returning to the open theater in the College of Arts. The least remembered were the car garage fence and the fence separating the university and the technical institute for reasons related to the location and the lack of distinctive characteristics that affect the MIs of the recipient. Fig. 11 shows the elements of the tenth group.

Many participants were able to know and remember the first and third elements due to their size, use, size, height, and ability to be seen from multiple places, unlike the second element. Fig. 12 shows the elements of the eleventh group.

Some people were able to distinguish the mural art on the facade of the Student Center due to its uniqueness within the environment, its color theme, and its location on the most used building on the UC, while many individuals were able to recognize the sculpture in front of the Central Library due to its presence among the buildings frequented by the majority of students. Fig. 13 shows the elements of the twelfth group.

Urban facades and other physical elements on campuses significantly influence the MI of the campus. The location of these elements affects their visibility and memorability, with memorable elements being more visible and at eye level. Unique and distinctive designs of window elements also affect people's attention, making them easier to remember. Openings that interact with the surrounding environment enhance the visual memory of the place, making it easier to remember. Urbanism plays an important role in shaping MI through symbolic, visual, and sensory effects. Building positioning on campus can influence individuals' ability to recall specific attributes and features of those buildings. Buildings situated in highly accessible and frequently traversed locations, as well as in central and prominent positions, tend to be more visible to the majority of users. The function of a building also impacts its capacity to be remembered. Buildings that are used by the majority of users and visited regularly, such as library buildings, student centers, and facilities used for specific activities, are typically more memorable. Individual experiences of specific locations may also influence the ease with which they are remembered due to the association of the location with a particular event or experience. The non-material elements of a UC, including activities and events, play a significant role in shaping the MI of the campus environment. These elements complement the material elements, adding interaction and vitality to the campus. Social activities contribute to the formation of a social interaction that greatly affects the MI of these sites. Social activities serve to enhance the cultural identity of the UC, foster a sense of connection between students, and imbue the environment with a distinctive character. The impact of urban environmental elements on the formation of an MI is subject to variation. The questionnaire and interviews with university professors and students revealed a significant difference in the perception of environmental elements between different groups and within each group. It is necessary to identify elements that positively impact the MI and provide a sense of comfort, security, and belonging to the place. These elements can be identified by considering their characteristics, such as color, texture, size, and other distinctive characteristics. The architectural characteristics of detailed elements exert a perceptual and differentiating influence to varying degrees. Color is considered the greatest influence,

as it has the potential for visual perception to exert a significant influence on memory. Buildings painted in bright, eye-catching colors play an important role in forming the MI of the building, while calm, neutral colors have a less pronounced effect but harmonize well with the surrounding environment. Warm colors evoke a sense of energy and vitality, while cold colors impart a feeling of comfort. Size affects the perception and recollection of detailed elements of buildings, regardless of whether they are small or large scale. Texture, which pertains to the quality of final materials, affects the perception of elements. Distinctive and unfamiliar surfaces render the detailed elements of buildings more memorable. Smooth and shiny surfaces create a sense of modernity. The variance in knowledge of elements between different groups is influenced by several factors, including the location of elements within the UC. The uneven distribution of elements makes it challenging to identify them, particularly given the similarities between plant elements in several locations on the campus. The choice of locations was based on the paths selected by respondents, which may have introduced bias and affected the validity of the results. Additionally, how elements are integrated into the UC environment affects the clarity of these elements, making it difficult to distinguish them. To address these factors, a comprehensive design can be developed to distribute elements in a balanced manner within the environment, ensuring clarity and durability. The dome of a student center is a memorable architectural feature due to its distinctive design, size, shape, and blue color. Its location within the building, as a central gathering point for students and a venue for various activities, contributes to its prominence in collective memory. The findings of this study can be applied to establish a sustainable campus environment by reinforcing the campus's identity and augmenting the attraction and aesthetic appeal of its constituent elements. Sustainable design aims to achieve a balance between functionality and aesthetics, integrating plant and water elements into the design. This approach enhances the attractiveness of the place and the comfort of users, while also focusing on sensory experiences, such as lighting and sound. The study provides valuable insights into the development of the campus environment, allowing for the involvement of students and professors in the design process. The distinctive urban façade elements, including windows and doors, can be enhanced to foster a sense of campus identity. The elements that reflect the campus's history and culture can be employed to foster a sense of belonging and identity. The design should focus on the elements of the study, allowing greater attention to urban spaces. This includes improving urban furniture elements, introducing architectural elements into urban spaces to increase social interaction, and incorporating plant and water elements and digital screens. The findings can inform the design of educational environments that enhance the urban identity of educational institutions and improve user experiences by enhancing tangible and intangible elements that positively affect people's memory and impressions.

CONCLUSION

Understanding and perceiving the process of forming MIs in the urban environment is a crucial necessity for the development and enhancement of city quality in the future. MI comprises several elements interconnected through various relationships and characteristics. Physical elements interact with non-physical elements to form a city image, which can either be positive or give a negative impression. Attention to detail, aesthetics, and people's preferences in urban spaces achieve sustainable urban design and sustainable MIs. The proportions varied among elements within the same group and also between different groups for several reasons affecting the formation of individuals' MIs, including elements' characteristics such as color, texture, size, and their location within the space. Placing elements within urban scenes in locations used by everyone makes them more memorable and recognizable than elements in locations used by a specific number of people. The urban facades and physical elements that comprise a campus significantly influence the MI that individuals form on that campus. The location of these elements affects their visibility and memorability. Memorable elements are more likely to be visible and positioned at eye level. Furthermore, the distinctive design of window elements has been found to affect people's attention, thereby enhancing their memorability. The incorporation of openings that interact with the surrounding environment serves to enhance the visual memory of the place in question. The concept of urbanism plays an important role in shaping MI

through the application of symbolic, visual, and sensory effects. The positioning of buildings on campus can affect an individual's ability to recall specific attributes and features of those buildings. It can be observed that buildings situated in locations that are highly accessible and frequently traversed tend to be more visible to the majority of users. The function of a building also affects its capacity to be remembered. The non-material elements of a UC, including activities and events, serve to complement the material elements, thereby enhancing the campus's capacity for interaction and vitality. The occurrence of social activities has an impact on the formation of social interactions, which in turn affects the MI of these sites. The impact of urban environmental elements on the formation of an MI is subject to variation. It is, therefore, necessary to identify those elements that positively impact the MI and provide a sense of comfort, security, and belonging to the place.

AUTHOR CONTRIBUTIONS

Both researchers were involved in writing the theoretical framework, participated in fieldwork to document the relevant elements, and contributed to the analysis of the results of the practical questionnaire.

ACKNOWLEDGEMENT

The authors thank and appreciate the contribution of the Department of Architecture at the University of Mosul in providing the laboratories and scientific materials required for this study. They also thank the members of the scientific committee that discussed the research proposal to reach the basic and important aspects to work on in the current study.

CONFLICT OF INTEREST

The authors declare no potential conflict of interest regarding the publication of this work. In addition, the ethical issues, including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, and redundancy have been completely witnessed by the authors.

OPEN ACCESS

PUBLISHER NOTE

ABBREVIATIONS (NOMENCLATURE)

UC	University Campus
MI	Mental Image
UoM	University of Mosul

REFERENCES

Alabaachi, M.K.M.; Alalaf, E.H., (2023). Impacts of sustainable transportation on the development of historic cities: A case study of the historic city of Mosul. Int. J. of Sustainable Dev. Plan., 18(10): 3085-3095 **(11 pages)**.

Al-Khafaji, I.; Ismaeil, M, (2020). The Impact of Spatial Location of Functions to Identify Architectural Forms as a Landmark (Case Study-Contemporary Islamic Architecture). J. Al-Israa Univ. Coll.Sci. Eng., 2(1): 13-41 **(29 pages)**.

AL-Kam, A. F., (2009). Developing and improving the visual and aesthetic elements in the central area of Tulkarm.]An-Najah National University, College of Graduate Studies[**(140 pages)**.

Alzamil, S.; Al-Abbad, N.; Refaat, H.; Alamuddin, Z., (2022). A Proposed Townscape Improvement Framework for the Historical Areas: An Approach to Sustainable Tourism Development. J. Al-Azhar Univ. Eng. Sect., 17(63): 820-841 **(22 pages)**.

Artemenko, A.; Artemenko, Y., (2018). "Mental image of the city". J. Human. Bulletin., 1(1): 82-90 **(9 pages)**.

Arora, N.; Kumar, U., (2023). Enhancing the Perception of an Urban

Area - A Case Study of Batala City. J. Visual Perform Arts, 4(2): 28–41 **(14 pages)**.

Bashri, S.; Che Amat, R., (2023). Townscape and Wayfinding: A Review of Existing Literature. Int. J.Bus. Technol. Manage., 5(S2): 421-438 **(18 pages)**.

Carmona, M.;Tiesdell,S. (Eds.). (2007). Urban design reader. Routledge

Chan, A., (2020). Drawing the Commute: Application of Drawing and Sketch Maps on the Mental Image and Perception of Commutes in Montréal. Unpublished B.A. thesis, McGill University, Department of Geography, Montréal, Québec, Canada **(64 pages)**.

Caldera, S.; Desha, C.; Reid, S.; Newman, P.; Mouritz, M., (2020). Principles of design for ensuring sustainable urban centres. In 1st Asia Pacific Sustainable Development of Energy Water and Environment Systems. 4(2): 28-41 **(18 pages)**.

Constantinides, M.; Joglekar, S.; Šćepanović, S.; Quercia, D,. (2021). Imagine a Walkable City: Physical activity and urban imageability across 19 major cities. EPJ data science, 10(1): 56 **(12 pages)**.

Elabd, A., (2022). The role of decorative design to face societal changes and reshaping the visual scenes in new cities. Int. Des. J., 12(2): 445-460**(16 pages)**.

Fahri, M.; Harsritanto, I.; Rahmadyani, H., (2023). Kajian Elemen Fisik Kota Palembang berdasarkan Analisis Persepsi dan Unsur Elemen Pembentuk. J. Teknik, 21(1): 43-57**(15 pages)**.

Firjatullah, H.; Kurniawan, B.; Purnamasari, D., (2017, June). Wayfinding concept in University of Brawijaya. InIOP Conf. Ser. Earth Environ. Sci., 70(1): 012056 **(10 pages)**.

Gamito, M.; Moreira, F. (2021). Chromatic Plans for Urban Furniture: The Case of Multicolored Urban Zones. In Advances in Ergonomics in Design: Proceedings of the AHFE 2021 Virtual Conference on Ergonomics in Design, July 25-29, 2021, USA (pp. 127-133). Springer Int. Publishing.

Guyot, M.; Araldi, A.; Fusco, G.; Thomas, I., (2021). The urban form of Brussels from the street perspective: The role of vegetation in the definition of the urban fabric. Landsc. Urban Plan., 205, 103947 **(35 pages)**.

Hamad, A.A.; Ismaeel, E.H., (2023). Integrative conservation for recovering the riverfront of Mosul town. Int. J. Sustainable Dev. Plann., 18(1): 41-51 **(11 pages)**.

Hussein, D.; Armstrong, P., (2016). Visual Consistency in Townscape: Developing an Arithmetic Evaluation Based on Visual Parameters and Users' Preferences., 137-145 **(9 pages)**.

Karima, D.; Mahmoudi, A., (2021). The effect of promotional deception on the customer's mental image of the institution. J. AL-Meaar., 25(53): 573-591**(19 pages)**.

Kethusha,K.; Sooriyagoda,G., (2022). Street as a place: a study of sense of place in commercial streets of Jaffna, Sri Lanka.pp., 40-48 **(9 pages)**.

Latypova, M.; Mingalimova, E.; Rubtsova, A.; Tazov, A., (2021). Empirical study of the mental representation of the image of the city (on the example of Kazan and Naberezhnye Chelny). In E3S Web of Conf. 274: 01034**(20 pages)**.

Lee,T., (2016). Urban Amnesia. Architecture Thesis Prep. 350 **(96 pages)**.

Lynch, K. (1964). The image of the city. MIT press **(103 pages)**.

Moazzeni, A.; Villalobos, H. (2023). Mindscape and its effect on cities' sustainability: A case study of Bronzeville Neighborhood—Chicago. Chin. J. Urban Environ. Stud., 11(03):2350016 **(29 pages)**.

Omar, M.J.; Ismaeel, E.H.; Mustafa, F.A., (2022). Long-term expansion plan of intermediate cities using GIS: The case of Sinjar city, Iraq. Int. J. Sustainable Dev. Plan., 17(3): 863-873 **(11 pages)**.

Osóch,B.; Czaplińska,A., (2019). City image based on mental maps—the case study of Szczecin (Poland). Miscellanea Geographica, 23(2): 111-119 **(9 pages)**.

Panavaitė,L., (2023). Townscape: concept and research origins. Mokslas–Lietuvos ateitis/Science–Future of Lithuania., 15 **(11 pages)**.

Phetsuriya,N.; Heath,T., (2022). In the Architects' Eyes and Local People's Perception: The Further Management of Streetscape Characteristics in Chiang Mai Old City, Thailand. Presented at the CSEAS 14th International Conference on Thai Studies, Individual Paper Sessions | Urban space, [1C04-08] Urban Space-1. Moderator: Chiranthanin Kitika. University of Nottingham **(19 pages)**.

Romice,O.; Rudlin,D.; AlWaer,H.; Greaves,M.; Thwaites,K.; Porta, S., (2022). Setting urban design as a specialised, evidence-led, coordinated education and profession. Proc.Inst. Civ. Eng. Urban Des. and Plann., 175(4): 179-198 **(11 pages)**.

Sanders,P.; Woodward,S., (2015). Morphogenetic analysis of architectural elements within the townscape. Urban Morphol., 19(1): 5-24 **(20 pages)**.

Setiawan,D.; Pangarso,B., (2022). Physical-Spatial Aspect in Local Expression of Townscape on Samirono Yogyakarta. Riset Arsitektur (RISA)., 6(01): 74-91 **(18 pages)**.

Shams Aldin, M.; Al-Madhaji, M., (2015). Studying and Measuring the Effectiveness of Mental Image to Identify Urban Empty Spaces of Cities A Case Study of Sana'a City. J. Sci. Technol., 20(1): 43-62 **(20 pages)**.

Su,L.; Chen,W.; Zhou,Y.; Fan,L., (2023). Exploring City Image Perception in Social Media Big Data through Deep Learning: A Case Study of Zhongshan City. Sustainability., 15(4): 3311 **(22 pages)**.

Taher, A.; AL-Abbasi, Z.; Al-Atabi, M., (2014). The Effect of Religious Monuments in the Plan of the Arabian Islamic city Samarra City – Case Study. J. Iraqi Arch., 28(2): 128-147 **(21 pages)**.

Tahir, M.; Arzal, T., (2023). Pedestrian Path Infrastructure in Urban Public Green Open Space (Case Study: Green Open Space Religious Monument Kendari City, Indonesia) J. Civ. Eng. Archit., 11(5): 2631-2643 **(13 pages)**.

Tang, S.; Qiao, H.; Yang, H.; Liu, W.; Huo,X.; He, G.; Ma, B., (2023). Research on the city image and cognitive distance based on chromatogram at the scale of mega city in Wuhan. J. Asian Archit. Build. Eng., 22(2): 675-692 **(19 pages)**.

Topcu, D.; Topcu, M., (2012). Visual presentation of mental images in urban design education: cognitive maps. Procedia-Soc. Behav. Sci., 51: 573-582 **(11 pages)**.

Urban Design Institute. (2015). What is Urban Design? Retrieved from, Dec., 8, 2023.

Yetim, Ş.; Yıldırım, Y., (2022). Perceptionality of Religious Buildings in Trabzon's Main Pedestrian Ways.J.GRID Archit. Plann. Des., 5(2): 193-225 **(33 pages)**.

Yücel, F., (2013). Street furniture and amenities: Designing the user-oriented urban landscape. In Advances in Landscape

Architecture. IntechOpen.
Zhanga, F.; Mirandaa, S.; Duarte, F.; Vale, L.; Hack, G.; Liu, Y.; Ratti, C., (2023). Urban Visual Intelligence: Studying Cities with AI and Street-level Imagery. arXiv:2301.00580 **(41 pages)**.
Zhang, S.; Liu, N.; Li, W.; Yan, S., (2022). Umbrella structure building design method via case-based design and statistical analysis of structural morphological parameters. J. Build. Eng., 45: 103542 **(24 pages)**.

HOW TO CITE THIS ARTICLE

Ghanim, D. H.; Ismaeel, E. H., (2025). The impact of detailed architectural elements on the mental image of the university campus. Int. J. Hum. Capital. Urban Manage., 10(2): 283-300.

DOI: 10.22034/IJHCUM.2025.02.06

URL: https://www.ijhcum.net/article_716436.html

Int. J. Hum. Capital Urban Manage., 10(2): 301-316, Spring 2025

International Journal of Human Capital in Urban Management
(IJHCUM)

Homepage: http://www.ijhcum.net/

ORIGINAL RESEARCH PAPER

Assessment of livability in urban fabric: A comparative analysis

A. Fouladi[1], E. Sherafati Moghaddam[2,*], Y. Gholami[3]

[1] *Department of Geography and Urban Planning, Kashan University, Kashan, Iran*

[2] *Department of Urban and Planning, Iran University of Science & Technology, Tehran, Iran*

[3] *Department of Geography, Urban and Rural Planning, Hakim Sabzevari University, Sabzevar, Iran*

ARTICLE INFO

Article History:
Received 07 July 2024
Revised 25 October 2024
Accepted 08 December 2024

Keywords:
Kashan city
Livability
Structural equation modeling
Urban management
Urban fabric

ABSTRACT

BACKGROUND AND OBJECTIVES: Livability, as a concept and approach, aims to reduce environmental, economic, and social problems in cities and communities based on their needs and capacities. This broad concept encompasses a variety of meanings in terms of physical, socio-cultural, economic, and environmental dimensions, both subjectively and objectively. Therefore, ensuring livability standards in the urban fabric is of considerable importance and necessity. The present study seeks to provide a basic understanding of the livability status in the city of Kashan.

METHODS: To achieve this goal, employing a library method and a researcher-made questionnaire tool, 384 residents from seven old and five new neighborhoods were evaluated using a stratified (simple random) sampling method. The collected data were analyzed using SPSS software, one-sample t-test analysis, and structural equation modeling.

FINDINGS: The results showed that the livability status in the new districts was better than the livability in the old ones. The findings reveal that overall livability in Kashan falls short of the desired average, with economic, cultural, and social aspects scoring the lowest. Environmental quality, on the other hand, was assessed as satisfactory. When comparing livability across old and new districts, the study found that newer districts have a higher overall livability compared to older ones. To further understand the factors influencing livability, the study prioritized the six dimensions of livability: infrastructure, politics, economy, environment, society, and culture. The economic factor emerged as the most influential, followed by social and infrastructural factors. Within the economic factor, job opportunities were identified as the most impactful aspect, while social cohesion and physical infrastructure held the greatest importance within the social and infrastructural factors, respectively.

CONCLUSION: Importantly, the study highlights the role of effective urban management in enhancing livability, particularly in addressing economic disparities, fostering social inclusion, and improving infrastructure. Strategic interventions, such as targeted economic development policies, community engagement programs, and infrastructure investments, are essential for enhancing Kashan's livability and quality of life.

DOI: 10.22034/IJHCUM.2025.02.07

NUMBER OF REFERENCES	NUMBER OF FIGURES	NUMBER OF TABLES
47	4	8

*Corresponding Author:
Email: *Ehsansherafati.official@gmail.com*
Phone: 09155466803
ORCID: 0009-0004-6316-7585

Note: Discussion period for this manuscript open until July 1, 2025 on IJHCUM website at the "Show Article.

INTRODUCTION

Importance and Necessity of Research, Goals, and Objectives

In today's rapidly urbanizing world, cities are facing a multitude of challenges, including environmental degradation, social inequities, and economic disparities (Medayese *et al.*, 2020). As cities continue to grow and evolve, there is an increasing need to create sustainable and livable urban spaces that promote the well-being of their inhabitants (Augustin *et al.*, 2023). Livability, a multifaceted concept encompassing various dimensions of urban life, has emerged as a key focus in urban planning and design discourses (World Health Organization, 2016). It encompasses a range of factors, including physical infrastructure, social cohesion, economic opportunities, environmental quality, and cultural vibrancy (Medayese *et al.*, 2020). Assessing and enhancing livability is crucial for promoting sustainable urban development and ensuring the quality of life for city dwellers (Augustin *et al.*, 2023). The concept of livability has gained significant attention in recent decades, driven by growing concerns about the livability of cities worldwide (Medayese *et al.*, 2020). Urbanization, characterized by the rapid growth and concentration of populations in cities, has brought about a range of challenges, including environmental degradation, social fragmentation, and economic inequalities (Augustin *et al.*, 2023). These challenges have raised concerns about the quality of life in cities and the need to create more livable urban environments (Medayese *et al.*, 2020). Livability is not merely the absence of problems or the presence of amenities; it is a positive concept that encompasses the overall quality of life in urban areas (Medayese *et al.*, 2020). It reflects the extent to which cities meet the needs and aspirations of their residents, providing them with opportunities to thrive and enjoy a fulfilling life (Augustin *et al.*, 2023). A livable city is:

- *Physically attractive and functional:* It has a well-designed and maintained physical infrastructure, including clean and safe streets, efficient transportation systems, and adequate housing options (Medayese *et al.*, 2020; Augustin *et al.*, 2023).
- *Socially cohesive and inclusive:* It fosters a sense of community, promotes social interaction, and provides opportunities for participation in civic life (Medayese *et al.*, 2020; Augustin *et al.*, 2023).
- *Economically vibrant and sustainable:* It offers diverse economic opportunities, supports local businesses, and promotes sustainable economic development practices (Medayese *et al.*, 2020; Augustin *et al.*, 2023).
- *Environmentally friendly and healthy:* It protects the environment, reduces pollution, and promotes sustainable resource management practices (Medayese *et al.*, 2020; Augustin *et al.*, 2023).
- *Culturally rich and diverse:* It celebrates its cultural heritage, promotes cultural diversity, and provides opportunities for cultural expression and engagement (Medayese *et al.*, 2020; Augustin *et al.*, 2023).

Iran, with its rich history, diverse cultures, and rapidly growing urban population, faces unique challenges and opportunities in terms of urban livability (Sadeghi *et al.*,2023; Ghasemi *et al.*, 2019). The country's urbanization rate has accelerated in recent decades, leading to the expansion of existing cities and the emergence of new urban centers (Sadeghi *et al.*, 2023). This rapid growth has put a strain on urban infrastructure, services, and the environment, posing challenges to livability (Ghasemi *et al.*, 2019). Despite these challenges, Iran has made significant strides in improving livability in its cities (Sadeghi *et al.*, 2023). The government has implemented various policies and initiatives aimed at enhancing urban infrastructure, promoting social cohesion, and fostering economic development (Ghasemi *et al.*, 2019). However, there is still a significant need for further research and interventions to address the persistent challenges and promote more livable urban environments in Iran (Sadeghi *et al.*, 2023; Ghasemi *et al.*, 2019). Kashan, a historical city located in the central province of Isfahan, Iran, provides a compelling case study for examining livability in the context of Iran's urban fabric (Sadeghi *et al.*, 2023). With its rich cultural heritage, diverse neighborhoods, and ongoing urban transformation, Kashan offers insights into the dynamics of livability in Iranian cities. Kashan's old districts, characterized by traditional architecture and narrow streets, exude a unique charm and sense of identity (Sadeghi *et al.*, 2023). These districts, with their intricate alleyways, mudbrick houses, and historic landmarks, are a testament to Kashan's rich history and cultural heritage. However, these districts

often face challenges related to aging infrastructure, limited accessibility, and a lack of modern amenities (Ghasemi *et al.*, 2019). The narrow streets and traditional houses of Kashan's old districts can hinder pedestrian movement and limit access to vehicles, particularly emergency services (Sadeghi *et al.*, 2023). Additionally, the aging infrastructure of these districts, including outdated water supply and sewage systems, can pose health and safety risks (Ghasemi *et al.*, 2019). Moreover, the lack of modern amenities, such as green spaces, playgrounds, and recreational facilities, can limit the livability of these districts for residents, particularly families with children (Sadeghi *et al.*, 2023). In contrast to Kashan's old districts, the newer developments showcase modern urban planning principles, offering wider streets, improved infrastructure, and access to modern amenities (Ghasemi *et al.*, 2019). These districts, often characterized by grid-like street patterns, multi-story buildings, and modern parks, reflect the city's efforts to modernize and accommodate its growing population. However, these newer districts may lack the character and sense of community found in the older districts (Sadeghi *et al.*, 2023). The wider streets and modern buildings can create a feeling of detachment and anonymity, while the lack of traditional architectural features can diminish the city's cultural identity (Ghasemi *et al.*, 2019). Additionally, the rapid development of these new districts may have outpaced the provision of social services and infrastructure, leading to challenges such as traffic congestion, pollution, and a lack of affordable housing (Sadeghi *et al.*, 2023). Despite the growing body of research on livability in Iran, there is a lack of studies that specifically focus on the comparative assessment of livability in old and new districts of Iranian cities (Sadeghi *et al.*, 2023; Ghasemi *et al.*, 2019). This study aims to address this gap by investigating the livability of Kashan City, with a particular focus on the comparison between its old and new districts in 2024. The objectives of this study are twofold:

• *Objective 1:* To assess the overall livability status of Kashan City, considering its various dimensions, including physical infrastructure, social cohesion, economic opportunities, environmental quality, and cultural vibrancy.

• *Objective 2:* To compare the livability of Kashan's old and new districts, identifying the key factors that contribute to the differences in livability levels between these two types of urban areas.

Effective urban management is crucial for enhancing livability and addressing the complex challenges faced by cities. By understanding the factors that influence livability in different urban contexts, policymakers and practitioners can develop targeted strategies to improve the quality of life for residents. This study aims to contribute to this knowledge base by providing a comparative analysis of livability in Kashan's old and new districts. The findings of this research are expected to inform the development of evidence-based urban management policies and practices that prioritize livability and sustainability.

Definitions

The term "livability" stems from the German verb "Leben," which means "to live", "to have life", "to create a life for someone," or "to live in a place for some time" (Srinivas, 2012). "Desirability of a place" is the chosen Persian translation for the English term "livability". Webster's Dictionary defines livability as "a place suitable for human habitation." Livability is also defined as the quality of life, living standards, or overall happiness of the population living in a place like a city. In the Oxford English Dictionary, "livability" is defined as "the worth of living" and "a place suitable for living," while "vitality" is defined as "being active and energetic" (Pandey *et al.*,2013). The presence of the word "live" or "life" in the construction of this word has led to the notion of livability taking on a primarily biological meaning. The use of this word in its biological sense, "that something is livable," dates back to at least the early 17th century in the poultry industry, where it indicated the likelihood of a chick hatching from an egg. In addition to its biological application, this term also has a distinct cultural-social background (Heidari *et al.*, 2023). Livability, a multifaceted concept, has become a central focus in urban planning and design discourses (Medayese *et al.*, 2020; Augustin *et al.*, 2023). It encapsulates the overall quality of life experienced by residents within an urban environment (World Health Organization, 2016). While there is no single, universally accepted definition, several key aspects contribute to its meaning:

• *Meeting needs and aspirations:* A livable city caters to the basic and higher-order needs of its

residents, offering them opportunities to fulfill their aspirations and live a satisfying life (Augustin *et al.*, 2023; UN-Habitat, 2016). This includes access to essential services like healthcare, education, and employment, as well as opportunities for cultural engagement, leisure activities, and personal growth (Augustin *et al.*, 2023).

• *Well-being and flourishing:* Livability goes beyond simply meeting basic needs; it fosters a sense of well-being and allows residents to flourish (Kiani & Javadiyan, 2019). This encompasses physical, mental, and social well-being, promoting a healthy and fulfilling life for all residents (World Health Organization, 2016).

• *Sustainability and quality of life over time:* A livable city not only provides a good quality of life for current residents but also ensures its sustainability for future generations (Tarigh Sheikh & Ameigde, 2022). This involves adopting environmentally responsible practices and ensuring that the city can support a good quality of life in the long term (Kiani & Javadiyan, 2019).

Aspects of livability

Livability, a multifaceted concept, plays a crucial role in shaping the overall well-being and satisfaction of a city's residents. It encompasses a range of interconnected elements that contribute to the quality of urban life. Let's delve deeper into some key aspects of livability, drawing on diverse sources to gain a comprehensive understanding:

A. Physical infrastructure: The quality and functionality of a city's built environment significantly impact livability (Medayese *et al.*, 2020; Augustin *et al.*, 2023). Efficient public transportation networks, well-maintained roads that prioritize pedestrians and cyclists, and accessible public transit options are essential for mobility and social inclusion (World Health Organization, 2020). Studies like the one by Newman and Jennings highlight the positive correlation between well-developed public transportation and a city's livability, particularly for residents with limited access to cars. (Newman & Jennings, 2008). Safe, secure, and affordable housing options cater to the diverse needs of residents, whether it's families seeking spacious accommodations or young professionals desiring smaller, more centrally located apartments (UN-Habitat, 2016). A report by the McKinsey Global Institute (2016) emphasizes the importance of affordable housing in fostering economic growth and social stability in cities (McKinsey Global Institute, 2016).

B. Social cohesion: A strong sense of community, belonging, and social interaction among residents is a critical aspect of livability (Medayese *et al.*, 2020; Augustin *et al.*, 2023). This fosters a sense of safety, facilitates civic participation, and contributes to a city's vibrancy. Close-knit communities and supportive social structures are essential pillars of social cohesion (Dalvand *et al.*, 2021). Putnam argues that strong social capital, characterized by trust and reciprocity within communities, enhances civic engagement and fosters a stronger sense of place (Putnam, 2000). A vibrant city welcomes people from various backgrounds, ethnicities, and cultures. This fosters a sense of belonging, acceptance, and social tolerance (Florida, 2002). Richard Florida's work on the "creative class" highlights how diversity attracts talent and innovation, contributing to economic growth and a more dynamic urban environment (Florida, 2002). A secure environment free from crime also allows residents to feel safe and comfortable in their surroundings. It fosters a sense of trust within communities, encouraging social interaction and engagement (UN-Habitat, 2016).

C. Economic opportunities: A supportive environment that encourages innovation and fosters small business growth contributes to a thriving economy (Florida, 2002). This can involve initiatives like business incubators, access to capital, and training programs to equip entrepreneurs with the skills needed to succeed.

D. Environmental quality: A healthy and sustainable environment is fundamental to livability (Medayese *et al.*, 2020; Augustin *et al.*, 2020). This includes protecting natural resources, promoting sustainable practices, and mitigating the impact of pollution. Clean air and water are essential for human health and well-being. Exposure to pollutants can lead to respiratory problems and other health issues (World Health Organization, 2020). Initiatives that promote clean energy sources, reduce reliance on private vehicles, and invest in green infrastructure can help improve air quality in urban environments. Efficient waste collection and disposal practices are crucial for a clean and healthy urban environment. Implementing recycling programs, composting

initiatives, and waste-to-energy solutions can contribute to a more sustainable city (World Bank, 2021).

E. Cultural vibrancy: A thriving cultural scene enriches the lives of residents and contributes to a city's attractiveness. Access to museums, theaters, public art installations, and cultural events fosters creativity, engagement, and a sense of place (MollaMirzaei & Sajjadzadeh, 2023). Preserving historical buildings and districts' cultural heritage contributes to a city's unique character and sense of identity. Striking a balance between preserving the past and adapting to future needs is crucial for a livable and sustainable city (Dalvand *et al.*, 2021).

F. Education and skills development: A strong education system and opportunities for skills development are essential aspects of livability. This allows residents to reach their full potential and contribute to the city's economic and social fabric. Access to quality education across all levels, from primary to higher education, equips residents with the skills and knowledge needed to succeed in a competitive world (UN-Habitat, 2016). Providing opportunities for continuous learning and skills development ensures that residents can adapt to changing job markets and contribute to a city's ongoing innovation (Florida, 2002).

G. Governance and effective leadership: Effective and transparent governance fosters a sense of trust and participation among citizens. Engaging residents in decision-making processes promotes a sense of ownership and fosters a more inclusive and responsive urban environment (UN-Habitat, 2016). Strong and accountable leadership is crucial for implementing policies that address the needs of all residents and promote a sustainable and equitable city (World Bank, 2017).

H. Technological infrastructure: Access to reliable and affordable technology infrastructure is increasingly important for livability. High-speed internet access connects residents to information, education, and economic opportunities. It fosters innovation and promotes participation in the digital economy (UN-Habitat, 2016). Implementing smart city technologies, such as intelligent transportation systems and energy grids, can contribute to a more efficient, sustainable, and livable urban environment (Rabitaille, 2022).

Approaches to livability

A cornerstone of contemporary livability approaches is the integration of sustainability principles. As highlighted by authors like Ruth & Franklin, cities face challenges like climate change and resource depletion. Livability strategies now prioritize environmental protection, resource efficiency, and sustainable practices. Examples include promoting green infrastructure, encouraging renewable energy use, and implementing circular economy principles in waste management (Ruth & Franklin, 2014). A just and equitable city is a more livable city. Contemporary approaches to livability recognize the importance of addressing social inequalities and fostering inclusive spaces (Hubbard, 1992). This involves ensuring access to quality education and healthcare for all residents, regardless of background (UN-Habitat, 2021). Additionally, it necessitates promoting social cohesion and reducing spatial segregation within cities (Hubbard, 1992). By creating a city where everyone feels safe and valued and has opportunities to thrive, livability efforts can enhance social well-being for all. Technological advancements offer exciting possibilities for enhancing livability. The rise of "smart cities" exemplifies this trend. By leveraging technology for data collection, analysis, and service delivery, cities can improve efficiency in areas like transportation, energy management, and waste reduction (Kumar, 2021). Additionally, technologies like e-governance platforms can promote citizen participation and enhance transparency in decision-making processes (Kumar *et al.*, 2022). The most effective approaches to livability prioritize active community engagement. Residents, with their unique knowledge of local needs and challenges, are valuable partners in shaping the city's future (Tennakoon & Kulatunga, 2019). Participatory planning processes can foster a sense of ownership and encourage residents to contribute to creating a more livable city (Tennakoon & Kulatunga, 2019). Furthermore, livability approaches must foster resilience in the face of unforeseen challenges, such as natural disasters or economic downturns (Ruth & Franklin, 2014). Cities that can adapt and bounce back from such events are ultimately more livable for their residents.

Livability framework

Cities are complex ecosystems where the

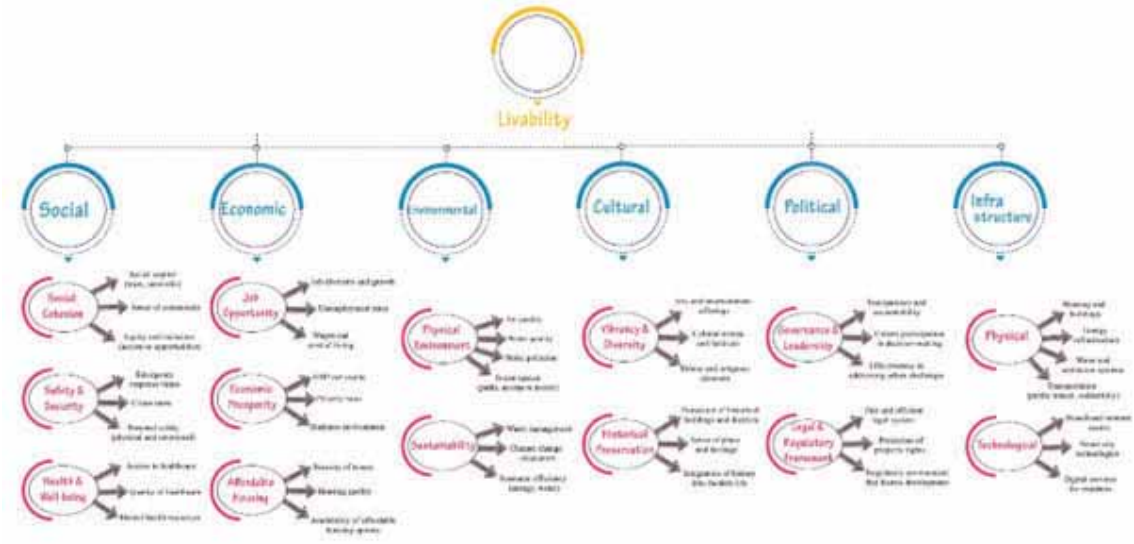


Fig. 1: Conceptual framework of research

quality of life for residents hinges on a multitude of factors. The concept of livability has evolved beyond simply meeting basic needs, encompassing a holistic approach that fosters well-being and societal progress. To guide this approach, a livability framework provides a structured way to assess a city's performance across various dimensions. This framework categorizes livability into key components, such as social cohesion, economic opportunity, environmental quality, and cultural vibrancy. Each component is further broken down into factors and specific criteria for evaluation. By analyzing these elements, cities can gain valuable insights into their strengths and weaknesses in terms of livability. This knowledge empowers them to develop targeted strategies and policies that enhance the overall well-being of their residents and create a truly livable urban environment.

METHODOLOGY

The provided text describes the research methodology of a study that measures livability in the old and new districts of Kashan City. The methodology is structured based on the onion layers of research methodology proposed by Saunders *et al.*, (2019). The text outlines each layer of the onion as follows:

A. Research philosophy: The research philosophy establishes the underlying worldview and assumptions guiding the research. In this case, the positivist paradigm is adopted, emphasizing an objective and measurable approach to reality. This aligns with the emphasis on quantitative data collection and statistical analysis.

B. Research approach: The research approach defines the overall strategy for conducting the research. The inductive /quantitative approach is chosen, reflecting the focus on gathering and analyzing numerical data to uncover patterns and relationships. This approach aligns with the positivist philosophy and the objective of understanding the relationships between variables affecting livability.

C. Research strategy: The research strategy specifies the specific methods and techniques employed to collect and analyze data. Given the positivist philosophy, quantitative approach, and research questions, the strategy of survey and interview is selected. This strategy aligns with the methods of data collection and analysis.

D. Research choice: The research choice determines the type of research conducted. Analytical research is chosen as the study aims to examine the relationships between variables affecting livability. This aligns with the quantitative approach and the focus on uncovering relationships.

E. Research timeframe: The research timeframe defines the period over which the data is collected and the research is conducted. A cross-sectional timeframe is chosen, indicating that data is collected

Table 1: Approaches toward livability

Author(s)	Year	Focus of Expertise	Meaning of Livability	Aspects of Livability	Factors for Assessment	Reference
Ruth & Franklin	2014	Urban Sustainability	Fulfilling basic needs & fostering well-being in an environmentally sustainable way.	Sustainability, Equity, Efficiency	Environmental quality, social cohesion, Economic opportunity, Resource management	(Ruth & Franklin, 2014)
Hubbard, Ph. j	1992	Environmental Psychology	Meeting basic needs & fostering a sense of place & belonging.	Social, Environmental, Psychological	Social interaction, Safety, Cleanliness, Aesthetic appeal, Access to Nature	(Hubbard, 1992)
Kiani & Javadiyan	2019	Urban Planning	The quality of life in a city that meets the needs of diverse residents.	Social, Economic, Environmental, and Infrastructure	Public services, Affordability, Job opportunities, educational opportunities, Transportation options	(Kiani & Javadiyan, 2019)
Medayese *et al.*	2020	Urban Studies	A dynamic concept encompassing physical, social, economic, and environmental factors.	Physical, Social, Economic, and Environmental	Housing, Transportation, Social networks, Job creation, Air quality, Green spaces	(Medayese et al., 2020)
Augustin *et al.*	2023	Urban Planning	A multi-dimensional concept shaping residents' well-being and satisfaction.	Social, Economic, Environmental, and Infrastructure	Social cohesion, Cultural offerings, Public Safety, Economic opportunities, Environmental Quality, Transportation	(Augustin et al., 2023)
MollaMirzaei & Sajjadzadeh	2023	Urban Economics	A vibrant city offering cultural richness, economic opportunities, and a high quality of life.	Cultural, Economic, Social, and Environmental	Arts & Culture, Job diversity, Social networks, Environmental sustainability	(MollaMirzaei & Sajjadzadeh, 2023)
Rabitaille, P. R.	2022	Smart Cities	A combination of physical, social, and technological elements that enhance resident well-being.	Physical, Social, Technological	Infrastructure, Social interaction, Smart governance, Technological innovation	(Rabitaille, 2022)
Florida, R.	2002	Urban Studies	A city attracting talent and fostering innovation through diversity and creativity.	Social, Economic	Diversity & Inclusion, Entrepreneurial environment, Job opportunities	(Florida, 2022)
Newman, P., & Jennings, I.	1989	Transport Planning	A city prioritizing walkable communities and efficient public transportation.	Physical, Environmental	Sustainable transportation, Walkability, Reduced reliance on cars	(Newman & Jennings, 2008)
Putnam, R. D.	2000	Political Science	A city fostering strong social networks, trust, and civic engagement.	Social	Social capital, Community engagement, Sense of belonging	(Putnam, 2000)
World Health Organization	2020	Public Health	A healthy living environment promotes physical and mental well-being.	Environmental, Social	Air quality, Clean water, Access to healthcare, Safety	(World Health Organization, 2020)
Dalvand *et al.*	2021	Urban Planning	A city preserving historical heritage while adapting to meet modern needs.	Cultural, Physical	Historical preservation, Architectural character, Infrastructure development	(Dalvand et al., 2021)
Strauss & Thomas	1998	Economics	A city with strong job opportunities contributing to resident wealth and well-being.	Economic	Job creation, Unemployment rates, Wages	(Strauss & Thomas, 1998)
UN-Habitat	2016	Urban Development	A city promoting inclusivity, participation, and sustainable urban planning.	Social, Political, and Environmental	Citizen participation, Affordable housing, Access to education, Public services, Environmental protection	(UN-Habitat, 2016)
World Bank	2021	Urban Development	A city efficiently manages resources and fosters economic growth.	Environmental, Economic	Waste management, Resource efficiency, Infrastructure investment	(World Bank, 2021)
Kumar, A. *et al.*	2022	Smart Cities	A city leveraging technology for efficient service delivery and citizen engagement.	Technological, Social	E-governance platforms, Data-driven decision-making, Citizen participation	(Kumar, A et al., 2022)
McLaren, D. & Agyeman, J.	2015	Environmental Justice	A city ensuring equitable access to environmental benefits and mitigating environmental burdens.	Environmental, Social	Environmental justice, Pollution exposure, Access to green spaces	(McLaren & Agyeman, 2015)
Banerjee, A. & Duflo, E.	2011	Development Economics	A city provides necessities and opportunities for citizens to improve their lives.	Economic, Social	Affordable housing, Access to healthcare, Education opportunities, Income equality	(Banerjee & Duflo, 2011)

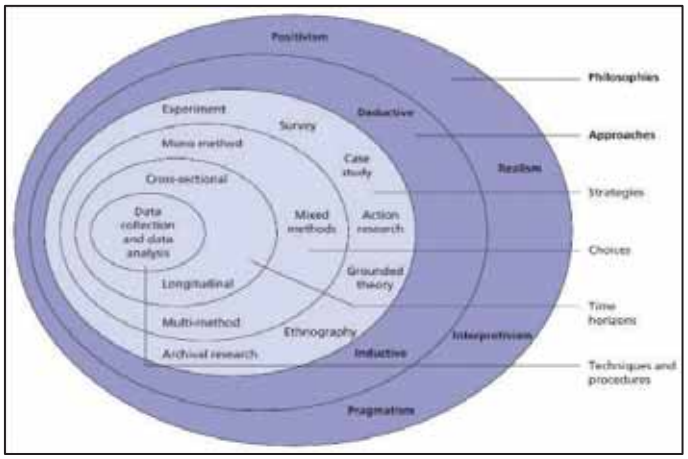


Fig. 2: Layers of Saunders' research method

Table 2: Determination of sample size by texture type of Kashan city

Texture	Neighbors name	Population	Number of questionnaires	Texture	Neighbors name	Population	Number of questionnaires
Old Urban Fabric	Post Mashhad Bala	11976	225	New Urban Fabric	Edare Gas	5123	159
	Bazar	5158			Valiasr	2355	
	Tahero Mansour	5878			AmirKabir	4281	
	Darbe Isfahan	9113			Danesh	4790	
	Mohtasham	6185					
	Post Mashhad Paeen	8745			Farhangian	1301	
	Soltan Amir Ahmad	4521					

at a single point in time. This aligns with measuring livability at a specific time.

F. Data collection and analysis methods: The data collection and analysis methods outline the specific techniques used to gather and interpret the data. Consistent with the previous layers, data collection methods include surveys (questionnaires), interviews (structured or semi-structured), and document reviews. Data analysis methods include descriptive statistics (t-test in SPSS) and Structural Equation Modeling (SEM) using Analysis of Moment Structures software (AMOS) to uncover relationships and test hypotheses.

The target population of this study is the total residents of Kashan city neighborhoods, amounting to 304,478 people, residing in the 7 old city neighborhoods (Posht Mashad Bala, Posht Mashad Payin, Mohtasham, Sultan Amir Ahmad, Darb Isfahan, Bazaar, Taher, and Mansour) and 5 new city neighborhoods (Edare Gas, Farhangian Alley, Vali Asr, Danesh, Amir Kabir) (Table2). The sample size was calculated using Cochran's formula to be 384 individuals,

Descriptive analyses of the collected data were conducted using SPSS software. The reliability test performed using Cronbach's alpha coefficient yielded

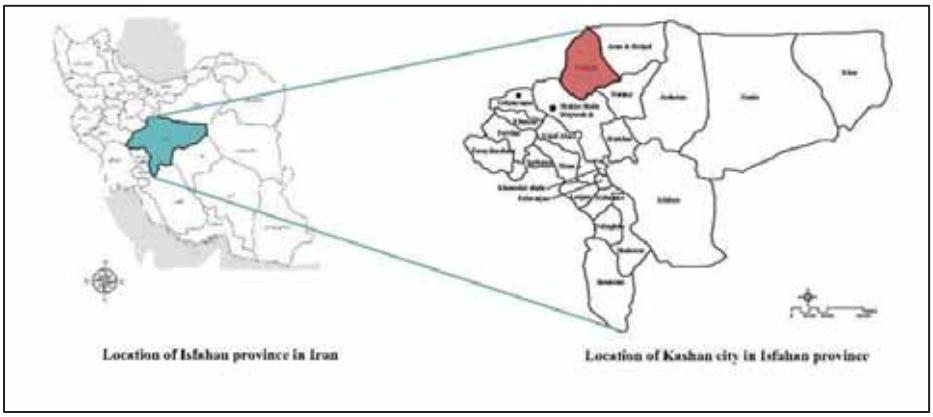


Fig. 3: Location of Kashan city method

an overall statistic of 0.82, indicating the reliability of the research findings at a 95% confidence level. To assess the livability of Kashan City, based on the research background and validity assessment by experts, a questionnaire was developed to examine the fit and consistency between the measurement tool (questionnaire) and the concept of livability. To examine the coherence and logic of the designed questionnaires and assess their structural validity, factor analysis and internal consistency tests were employed. Kashan, a city with a history of over 7,000 years, is located in Isfahan Province, in the heart of the Iranian desert.

This historic city, with an area of approximately 8,500 hectares and a population of 304,478, boasts stunning architecture, numerous natural and cultural attractions, and hospitable people, making it a captivating destination for tourists. The city's climate is dry and semi-arid, with hot summers (influenced by the central desert) and cold winters. The city of Kashan boasts an abundance of natural and historical attractions, along with a rich culture. However, despite these strengths, Kashan faces several challenges that hinder its livability. These challenges include limited green spaces, which negatively impact air quality, mental well-being, and overall livability. Air pollution is another significant concern, primarily due to vehicular emissions and industrial activities, leading to respiratory problems and other health issues. Traffic congestion, particularly during peak hours, further increases travel times, reduces air quality, and contributes to noise pollution. Water scarcity is another pressing issue in Kashan, caused by the arid climate and unsustainable water management practices. This strains water resources and limits access to clean water for residents. Additionally, Kashan's wastewater and solid waste management systems are inadequate to handle the growing volume of waste generated by the city's population, leading to potential environmental contamination and public health concerns. Finally, the lack of sufficient recreational and sports facilities hinders physical activity and overall well-being for residents. If these challenges are not addressed through proper planning, they could significantly impact Kashan's livability indices and the quality of life for its residents. Despite the livability challenges it faces, Kashan possesses several strengths and potential assets that can be leveraged to enhance its livability and establish itself as a sustainable and attractive urban destination. Kashan enjoys a strategic location along major transportation routes, providing access to regional markets and economic opportunities. This strategic positioning can facilitate trade, investment, and economic growth, contributing to the city's overall prosperity. Additionally, Kashan boasts a rich natural heritage encompassing desert landscapes, historical gardens, and natural springs. These natural attractions can serve as tourism draws, providing recreational spaces for residents and generating revenue for the local economy. Furthermore, Kashan's historical fabric is characterized by traditional architecture, wind towers, and underground water channels. This unique cultural heritage offers a distinct identity for the city and presents opportunities for heritage tourism.

Table 3: General status of descriptive information of the filled questionnaires

Describe	Number	Percent	Describe	Number	Percent
	Gender			Marital Status	
Female	190	49/5	Married	176	45/8
Male	194	50/5	single	208	54/2
	Education			Occupation	
Under diploma	113	29/4	Seller	84	21/9
Diploma	124	32/3	Worker	145	37/8
Bachelor	75	19/5	Employee	74	19/3
Master	68	17/7	Student	49	12/8
PhD	4	1/0	housekeeper	32	8/3

Table 4: Condition of livability dimensions of Kashan city with T-test

	Average test=3					
	T	df	Sig. (2-tailed)	Mean difference	95% confidence	
					Upper	Lower
Economy	50.841	383	.000	2.44792	2.3532	2.5426
Political	58.671	383	.000	2.74740	2.6553	2.8395
Culture	67.614	383	.000	3.34646	3.2491	3.4438
Environment	63.717	383	.000	3.41775	3.3123	3.5232
Infrastructure	50.512	383	.000	2.65969	2.5562	2.7632
Social	50.108	383	.000	2.55053	2.4505	2.6506
Livability	- 4.60	383	0.000	- 0.089	- 0.127	- 0.051

Finally, Kashan has a long tradition of producing exquisite handicrafts, such as carpets, ceramics, and rosewater. These handicrafts can contribute to the local economy, providing employment and showcasing the city's cultural richness. By implementing strategic planning and investing in these strengths, Kashan can effectively address its livability challenges, improve the quality of life for its residents, and establish itself as a sustainable and attractive urban destination.

RESULT AND DISCUSSION

To analyze and evaluate the livability components of Kashan city, based on Cochran's formula, 384 residents of this city were surveyed in two old and new textures. Since some of the livability components are relative and individual characteristics and living conditions have a great impact on the way they are viewed, part of the questionnaire was dedicated to descriptive information. Descriptive statistics of the research include gender, education, marital status, and occupation. The status of respondents' information is shown in Table 3.

Liveability of Kashan City

To assess the livability status and differences in the dimensions of livability in Kashan, a composite variable was constructed from each dimension, and a One-Sample t-test was used Table 4. As can be seen, the livability status of Kashan in terms of economic, cultural, and social dimensions is below the average under study and requires planning for improvement. Among these, the cultural dimension is the weakest with a t-statistic of – 6.18. The political and infrastructural dimensions, on the other hand, were rated as average by the respondents, with t-statistics of 1.67 and 1.61, respectively. However, the level of satisfaction with the environmental dimension was assessed as appropriate. The overall assessment of the livability status of Kashan shows that the quality of livability is inadequate and below the expected average. This is supported by the significance level of the test, the negative confidence intervals, and the t-statistic of -4.606.

Comparison of the livability of old and new neighborhoods

To assess the livability status in historical and new urban neighborhoods in Kashan City, a paired-sample T-test was employed for two independent normal populations. The results are presented in Tables 5 and 6.

Table 5: Frequency value, mean, standard deviation, and average standard in two old and new tissues

Texture	N	Mean	Std. Error Mean	Std. deviation
Old neighborhoods	225	2.796	0.365	0.365
New neighborhoods	159	3.071	0.344	0.344

Table 6: Frequency value, mean, standard deviation, and average standard in two old and new tissues

Livability	Levene's Test for Equality of Variances		Independent Samples Test					95% Confidence Interval of the Difference	
	Sig.	f	t	df	Sig.	Mean difference	Std. Error Difference	Upper	Lower
Equal variances assumed	0.547	0.364	- 7.45	382	0.000	- 0.275	0.036	- 0.206	- 0.347
Equal variances not assumed	-	-	- 7.526	352.187	0.000	- 0.275	0.036	- 0.203	- 0.347

In the first step, to utilize the results of this test, Levene's statistic is employed to examine the equality of variances. According to the outcome, a significance level of 0.547, which is greater than 0.05, indicates that the assumption of equal variances is upheld. Therefore, the results of the first row serve as the basis for judgment. Since the significance level of the test is less than 0.05, it implies that the means of the two populations are not equal. Furthermore, as the upper and lower bounds at the 95% confidence level are negative, the livability status in the old fabric is of lower quality compared to the new fabric Table 6.

Prioritizing dimensions and indices of Kashan city's livability

In the continuation of the research process for prioritizing livability indicators in the old and new neighborhoods of Kashan city, Analysis of Moment Structures (AMOS) was used. The purpose of this study was to identify the most influential variables of Kashan city livability variables. Therefore, based on the theoretical foundations of the research, a second-order factor model was developed based on six latent factors (Infrastructural, Political, Economic, Environmental, Social, and Cultural). In this study, using factor analysis, each of the variables that could identify each of the six latent factors was selected and entered into the modeling process Fig. 4.

Fig. 4 presents the second-order factor loading and also the most significant variables and their prominent impacts on the livability of Kashan City. The findings reveal that the economic factor holds the highest factor loading of 0.95, indicating its substantial influence on the city's livability. Following the economic factor, the social factor ranks second with a factor loading of 0.93, and the infrastructure factor comes next with a factor loading of 0.85. The environmental, political, and cultural factors follow with factor loadings of 0.68, 0.51, and 0.5, respectively. Within the *economic factor*, the job opportunities variable holds the highest impact with a factor loading of 0.57, followed by economic prosperity with a factor loading of 0.47. Affordable housing, on the other hand, exhibits the lowest impact with a factor loading of 0.35. The questionnaires employed in this study further break down these variables into sub-variables: job opportunities encompass job diversity and growth, unemployment rate, wages, and cost of living costs; economic property includes GDP (Gross Domestic Product) per capita, poverty rate, and business environment; and affordable housing comprises housing security, housing quality, and availability of affordable housing options. The *social factor* is primarily influenced by the social cohesion and solidarity variable, with a factor loading of 0.79. This variable holds the greatest impact on the social aspect of Kashan's livability. Following this, the safety and security variable ranks second with a factor loading of 0.72, while health and well-being exhibit the least impact among the social variables, with a factor loading of 0.55. The social cohesion and solidarity variable is further broken down into the following sub-variables: social capital, sense of place and community, and equal access to opportunities.

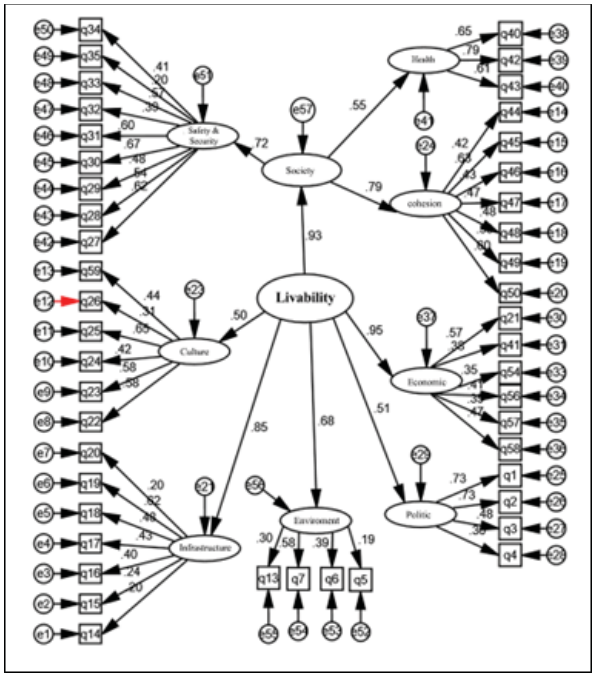


Fig. 4: The final model for prioritizing Kashan's livability indicators

The safety and security variable encompasses responsiveness in emergencies, crime rate, and personal safety (physical and emotional). Finally, the health and well-being variable includes access to healthcare, quality of healthcare, and mental health resources. Within the *infrastructure factor*, physical infrastructure holds the most significant impact with a factor loading of 0.62, while technological infrastructure exhibits the least impact with a factor loading of 0.2. The physical infrastructure variable is further categorized into the following sub-variables: housing and buildings, energy infrastructure, water and sanitation systems, and transportation. The technological infrastructure variable, on the other hand, encompasses broadband internet access, smart city technologies, and digital services for residents. The *environmental factor* comprises two primary variables: physical environment with a factor loading of 0.59, indicating the highest impact, and environmental sustainability with a factor loading of 0.19, representing the least impact. The sub-variables for the physical environment variable include air quality, water quality, noise pollution, and access to green spaces. The environmental sustainability variable encompasses waste management, climate change adaptation, and resource (water, energy) efficiency. The *political factor* consists of two main variables: the regulatory framework with a factor loading of 0.73, indicating the highest impact, and governance and leadership with a factor loading of 0.36, representing the least impact. The regulatory framework variable is further broken down into the following sub-variables: a fair and efficient legal system, protection of property rights, and a regulatory environment that facilitates development. The governance and leadership variable, on the other hand, encompasses transparency and accountability, citizen participation in decision-making, and efficiency in addressing urban problems. The *cultural factor* comprises two primary variables: cultural dynamics and diversity with a factor loading of 0.65, indicating the highest impact, and preservation of historical heritage with a factor loading of 0.31, representing the least impact. The cultural dynamics and diversity variable is further broken down into the following sub-variables: arts and entertainment offerings, cultural events and festivals, and ethnic and religious diversity. The preservation of historical heritage variable, on the other hand, encompasses the protection of historic buildings and sites, sense

Table 7: Default model weighted regression

			Estimate	S.E.	C.R.	P				Estimate	S.E.	C.R.	P
F10	**<---**	**f3**	1.000				**q20**	**<---**	**F4**	1.138	.735	1.548	.026
F4	**<---**	**f3**	.422	.199	2.122	.034	**q1**	**<---**	**f2**	1.000			
F2	**<---**	**f3**	.765	.190	4.037	***	**q2**	**<---**	**f2**	1.027	.177	5.817	***
F9	**<---**	**f3**	.430	.224	1.919	.043	**q3**	**<---**	**f2**	.518	.109	4.734	***
F1	**<---**	**f3**	1.000				**q4**	**<---**	**f2**	.396	.126	3.142	.002
F7	**<---**	**F10**	.321	.105	3.046	.002	**q21**	**<---**	**f1**	1.000			
F6	**<---**	**F10**	.426	.138	3.093	.002	**q41**	**<---**	**f1**	.574	.164	3.506	***
F5	**<---**	**f3**	1.000				**q54**	**<---**	**f1**	.520	.160	3.259	.001
F8	**<---**	**F10**	.529	.154	3.432	***	**q56**	**<---**	**f1**	.760	.201	3.774	***
q44	**<---**	**f7**	1.000				**q57**	**<---**	**f1**	.571	.175	3.259	.001
q45	**<---**	**f7**	1.643	.392	4.188	***	**q58**	**<---**	**f1**	.673	.161	4.182	***
q46	**<---**	**f7**	1.089	.308	3.531	***	**q40**	**<---**	**F6**	1.000			
q47	**<---**	**f7**	1.228	.334	3.681	***	**q42**	**<---**	**F6**	1.081	.181	5.967	***
q48	**<---**	**f7**	1.196	.320	3.739	***	**q43**	**<---**	**F6**	.821	.144	5.719	***
q49	**<---**	**f7**	1.746	.428	4.074	***	**q27**	**<---**	**F8**	1.000			
q50	**<---**	**f7**	1.812	.440	4.117	***	**q28**	**<---**	**F8**	.885	.165	5.375	***
q22	**<---**	**F5**	1.000				**q29**	**<---**	**F8**	.683	.140	4.876	***
q23	**<---**	**F5**	1.078	.191	5.642	***	**q30**	**<---**	**F8**	1.083	.172	6.291	***
q24	**<---**	**F5**	.809	.187	4.327	***	**q31**	**<---**	**F8**	.958	.166	5.786	***
q25	**<---**	**F5**	1.072	.176	6.087	***	**q32**	**<---**	**F8**	.650	.162	4.022	***
q26	**<---**	**F5**	.470	.143	3.293	***	**q33**	**<---**	**F8**	.930	.166	5.599	***
q59	**<---**	**F5**	.667	.151	4.425	***	**q35**	**<---**	**F8**	.310	.145	2.142	.032
q14	**<---**	**F4**	1.000				**q34**	**<---**	**F8**	.706	.166	4.248	***
q15	**<---**	**F4**	1.189	.698	1.703	.046	**q5**	**<---**	**F9**	1.000			
q16	**<---**	**F4**	2.276	1.138	2.001	.045	**q6**	**<---**	**F9**	1.630	.896	1.820	.039
q17	**<---**	**F4**	2.251	1.106	2.036	.042	**q7**	**<---**	**F9**	2.772	1.446	1.917	.045
q18	**<---**	**F4**	2.359	1.137	2.074	.038	**q13**	**<---**	**F9**	1.311	.767	1.710	.047
q19	**<---**	**F4**	2.734	1.277	2.141	.032							

Table 8: The main index of fit

Indicators	scores	Status
CMIN/DF	1.505	Suitable
GFI	0.716	Suitable
AGFI	0.687	Suitable
PRATIO	0.948	Suitable
RMSEA	0.058	Suitable

of place and heritage, and integration of history into modern life. Table 7 presents the non-standard values, critical ratio, and level of significance (P-value). The results of the table indicate that all lambda parameters have a significant difference from zero. The P-value in all the above relationships is less than 0.05, which shows that all the relationships in the model are supported by the empirical data.

After examining the significance of parameters with zero values, the final model of the research is evaluated using overall model fit indices. According to Table 8, the main model fit indices show that the research data has been able to well represent the conceptual model of the research, as the values of the obtained parameters are within the range of the desired fit.

CONCLUSION

The study investigated livability in Kashan, Iran, comparing its old and new districts. The findings reveal that overall livability in Kashan falls short of the desired average, with economic, cultural, and social aspects scoring the lowest. Environmental quality, on the other hand, was assessed as satisfactory. When comparing livability across old and new districts, the study found that newer districts have a higher overall livability compared to older ones. To further understand the factors influencing livability, the

study prioritized the six dimensions of livability: infrastructure, politics, economy, environment, society, and culture. The economic factor emerged as the most influential, followed by social and infrastructural factors. Within the economic factor, job opportunities were identified as the most impactful aspect, while social cohesion and physical infrastructure held the greatest importance within the social and infrastructural factors, respectively. The findings of this study highlight the critical role of effective urban management in enhancing livability across Kashan's districts. The observed disparities between old and new districts suggest the need for targeted interventions to bridge the gap and ensure equitable access to a high quality of life for all residents.

- *Strategic economic development:* Develop and implement strategic economic development plans that focus on diversifying the city's economy, fostering innovation, and creating job opportunities, particularly in the new districts. This can involve attracting new businesses, investing in skills development programs, and providing incentives for entrepreneurship. Effective urban management can bridge the economic gap between districts by directing resources toward the development of lagging areas.
- *Community engagement and social inclusion:* Prioritize community engagement initiatives that promote social cohesion and a sense of belonging in all neighborhoods. Encourage resident participation in decision-making processes and invest in programs that foster social inclusion, particularly in the older districts. This proactive approach can strengthen social bonds and create a more vibrant and inclusive urban environment across the city.
- *Infrastructure investment and maintenance:* Increase investment in upgrading and maintaining physical infrastructure across all districts, with a specific focus on housing, transportation, water and sanitation systems, and energy efficiency in the older districts. Effective urban management can prioritize infrastructure projects that address existing deficiencies and ensure all residents have access to essential services. This will not only improve the overall quality of life but also promote sustainable development in the long run.

By implementing these management recommendations, Kashan can create a more balanced and livable urban environment for its residents. This will not only address the identified disparities but also position the city as a model for sustainable urban development and improved well-being for all.

AUTHOR CONTRIBUTIONS

Y. Gholami supervised and performed the corrections, reviewed the article, and controlled the results of the research. E. Sherafati Moghaddam performed the literature review, took samples for the study, analyzed and interpreted the data, prepared the manuscript text, and edited the manuscript. A. Fouladi also performed an analytical model (using SPSS and Amos) and contributed to taking samples of the study and collecting data.

ACKNOWLEDGEMENT

The authors express their heartfelt gratitude to the commuters who generously contributed their time to respond to the questionnaires. Their willingness to engage and participate, despite their hectic schedules, offered valuable insights for the study, reflecting their commitment to analyze the livability in Kashan city.

CONFLICT OF INTEREST

The authors declare no potential conflict of interest regarding the publication of this work. In addition, the ethical issues, including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, and redundancy have been completely witnessed by the authors.

PUBLISHER NOTE

Tehran Urban Research & Planning Centre (TURPC) takes a neutral position about claims on disputed territories, place names, international boundaries, jurisdiction in published maps, and institutional affiliations. TURPC is committed to retracting a paper after its publication if it becomes apparent that there are serious problems in its content, in terms of research and publication ethics (https://www.ijhcum.net/journal/process?ethics).

ABBREVIATIONS (NOMENCLATURE)

AMOS	Analysis of Moment Structures
SEM	Structural Equation Modeling
%	percent
T	It's a calculated value that measures how far a sample statistic (like the mean) is from a hypothesized population parameter (like the population mean).
df	degrees of freedom
Sig.	significance level
N	Number
Std.	the square root of the variance
f	a ratio of two variances.
S.E.	Standard Error
C.R.	Critical Ratio
P	The Significance Level
F10	Factor number 10
Q10	Question number 10
CMIN/DF	minimum discrepancy of confirmatory factor analysis/degrees of freedom.
GFI	goodness of fit index
AGFI	Adjusted Goodness of fit Index and indicates the degree of freedom
PRATIO	Parsimony Ratio
RMSEA	Root Mean Square Error of Approximation
GDP	Gross Domestic Product

REFERENCES

Alderton, A.; Higgs, C.; Davern, M.; Butterworth, I.; Correia, J.; Nitvimol, K.; Badland, H., (2021). Measuring and monitoring livability in a low-to-middle income country: A proof-of-concept for Bangkok, Thailand and lessons from an international partnership. Cities & health., 5(3): 320-328 **(9 pages)**.

Al-Thani, S.; K., Amato, A.; Koç, M.; Al-Ghamdi, S. G., (2019). Urban Sustainability and Livability: An Analysis of Doha's Urban-form and Possible Mitigation Strategies. Sustainability., 11(3): 1-25 **(25 pages)**.

Augustin, J.; Andrees, V.; Walsh, D.; Reintjes, R.; Koller, D., (2023). Spatial Aspects of Health—Developing a Conceptual Framework. Int J Environ Res Public Health., 20(3): 3-6 **(4 pages).**

Banerjee, A.; Duflo, E., (2011). Poor economics: A radical rethinking of the way to fight global poverty. PublicAffairs.

Cities, L., (2007). The Benefits of Urban Environmental Planning: A Cities Alliance Study on Good Practices and Useful Tools. The Cities Alliance, Washington.

Dalvand, H.; Shaterian, M.; Heidari Sourshajani, R., (2021). Structural Modeling of Livability Effect on Quality of Life based on the Public Survey Case Study: Dorud City. Journal of Sustainable City. 4(1): 72-85 **(14 pages)**.

Florida, R., (2002). The rise of the creative class: And how it's transforming work, leisure, community and the lives of people you know. Basic Books (for diversity and inclusion).

Ghasemi, K.; Hamzenejad, M.; Meshkini, A., (2019). The livability of Iranian and Islamic cities considering the nature of traditional land uses in the city and the rules of their settlement. Habitat International., 90: 215-218 **(4 pages)**.

Heidari, R.; Vafayi, A.; Doolatyaran, K., (2023). Assessment and evaluation of the project of cultural-social regeneration of public spaces with the approach of improving environmental quality and neighborhood identity The case study: historical walkways of Kashan city. Geogeaphical Urban Planning Research., 10(3): 143-170 **(27 pages)**.

Hubbard, Ph. J., (1992). Environment-behaviour studies and city design: A new agenda for research? Journal of Environmental Psychology., 12(3): 269-279 **(10 pages)**.

Kiani, A.; Javadiyan, M. (2014). Evaluating the impact of urban green spaces on livability: A case study of Mashhad, Iran. Sustainable Cities and Societies., 4(S): 90-92 **(3 pages)**.

Kennedy, RJ.; Buys, L., (2012). Dimension of liveability: A tool for sustainable cities. In Proceedings of SB12mad Sustainable Building Conference., In Burgos, A (Ed.) Proceedings of the SB10 Mad Sustainable Building Conference. CIB (International Council for Research and Innovation Building and Construction), Madrid, Spain., 1-5 **(6 pages)**.

Kumar, A.; Kapoor, R.; Chandra, H., (2021). Smart Cities: A Step toward Sustainable Development. CRC Press.

Liang, L.; Deng, X.; Wang, P.; Wang, Z.; Wang, L., (2020). Assessment of the impact of climate change on cities livability in China. Science of the Total Environment., 726: 165-176 **(12 pages)**.

Medayese, S.; Magidimisha, H.; Chipungu, L., (2021). Conceptual nexus of urban liveability and sustainability. IOP Conference Series: Earth and Environmental Science., 654: 1-10 **(10 pages)**.

McKinsey Global Institute, (2016). Urban world: Mapping the economic power of cities. McKinsey & Company (for affordable housing).
McLaren, D.; Agyeman, J., (2015). Sharing Cities: A workbook for a more just and sustainable urban future. Routledge.
MollaMirzaei, R.; Sajjadzadeh, H., (2023). A Systematic Analysis of Creative City Literature Identifying Its Components and Indicators. Armanshahr Architecture & Urban Development., 16(43): 17-29 **(22 pages)**.
National Association of Regional Councils (NARC) ., (2002). Livability Literature Review: Synthesis of Current Practice, Washington.
National Research Council, (2002). Community and Quality of Life: Data Needs for Informed Decision Making. National Academy Press, Washington, D.C.
Newman, P.; Jennings, I., (2008). Cities as Sustainable Ecosystems: Principles and Practices. Island Press.
Pandey. Ru.; Garg, Y. G.; Bharat, A., (2013). Understanding Qualitative Conceptions of Livability: Indian Perspective. International Journal of Research in Engineering and Technology., 2(12): 374-380 **(6 pages)**.
Putnam, R. D., (2000). Bowling alone: The collapse and revival of American community. Simon and Schuster (for social capital).
Rabitaille, P. R.; Arkaraprasertkul, N., (2022). Smart City Primer: Selected Asean Experiences. C asean: Around ASEAN Publisher.
Ruth, M.; Franklin, R. S., (2014). Livability for all? Conceptual limits and practical implications. Applied Geography., (49): 18-23 **(5 pages)**.
Sadeghi, A.; Shakharami, K.; Heydari, M., (2023). Investigating the livability of cities for urban social stability (Case study: the Mashhad metropolis). Human Geography Research Quarterly., 20(3): 265-277 **(12 pages)**.
Srinivas, H., (1991). Viability of informal Credit to finance Low-Income Housing: Case Study Three Squatter Settlements in Bangalore, India. Masters Thesis Report. Bangkok: Division of Human Settlements Development, Asian Institute of Technology., 13: 25-32 **(7 pages)**.
Strauss , J.; Thomas, D. (1998). Health, Nutrition, and Economic Development. Journal of Economic Literature., 36(2): 766-817 **(51 pages)**.
Tarigh Sheikh, W.; Ameigde, J., (2022). Promoting livability through urban planning: A comprehensive framework based on the theory of human needs. Cities., 131: 113-117 **(5 pages)**.
Tennakoon, M.; Kulatunga, U., (2019). Understanding liveability: related concepts and definitions. 8th World Construction Symposium.
UN-Habitat., (2016). Urban planning for a changing world: The New Urban Agenda. UN-Habitat.
World Health Organization, (2020). Healthy cities: Improving urban living environments. World Health Organization.
World Health Organization, (2018). Constitution of the World Health Organization. World Health Organization.
World Health Organization, (2016). Global report on urban health: equitable healthier cities for sustainable development. World Health Organization.
World Bank, (2021). What a waste 2.0: A global review of solid waste management. The World Bank.
World Bank., (2017). Governance for the goals: World development report 2017. The World Bank (for accountable leadership).
Wiryomartono, B., (2020). Livability and Sustainability of Urbanism: An Interdisciplinary Study on History and Theory of Urban Settlement. Palgrave Macmillan.

HOW TO CITE THIS ARTICLE

Fouladi, A.; Sherafati Moghaddam, E.; Gholami, Y., (2025). Assessment of livability in urban fabric: A comparative analysis. Int. J. Hum. Capital Urban Manage., 10(2): 301-316.

DOI: 10.22034/IJHCUM.2025.02.07

URL: https://www.ijhcum.net/article_718871.html

Int. J. Hum. Capital Urban Manage., 10(2): 317-328, Spring 2025

International Journal of Human Capital in Urban Management
(IJHCUM)

Homepage: http://www.ijhcum.net/

ORIGINAL RESEARCH PAPER

Towards building a sustainable future with the tech revolution

E. Allafjafari [1], F. Asayesh [1,*], M. Rostamian[2]

[1] *Department of Business Management, Shahr-e-Qods Branch, Islamic Azad University, Tehran, Iran*

[2] *Department of Governmental Management, kish Branch, Islamic Azad University, Kish, Iran*

ARTICLE INFO

Article History:
Received 21 July 2024
Revised 22 October 2024
Accepted 12 December 2024

Keywords:
Artificial intelligence
Geographic Information Systems
Green technologies
Urban sustainability

ABSTRACT

BACKGROUND AND OBJECTIVES: Urban sustainability is a concept that focuses on creating cities that can meet the existing residents' requirements without compromising future generations' capabilities to fulfill their needs. This approach requires comprehensive and integrated urban planning, development, and management. The current research was conducted to design an urban sustainability model, emphasizing new technologies.

METHODS: Based on the nature of the data, the research method was qualitative and exploratory; the theme analysis method was used to analyze the data. In this study, we conducted semi-structured in-depth interviews using the 5w1h technique on a sample of 13 individuals, including managers, academic staff, specialists, and experts of the 5th district from Tehran Municipality, to gather data. This research was done during the fall and winter of 1402. The criteria for selecting experts include: having at least seven years of useful work experience in Tehran Municipality and relative knowledge of urban sustainability.

FINDINGS: The present research identified five main themes, including social, economic, environmental, technological, and managerial. Two sub-themes (social equality and quality of life in the city) were identified for the social dimension. Also, three sub-themes (economic growth, affordability, and access to financial matters) were identified for the economic dimension. Also, three sub-themes (sustainable transportation, sustainable service, and sustainable energy) were considered for the environmental dimension. Three sub-themes (artificial intelligence capabilities, geographical information systems capabilities, and green technology) have been considered for the technology dimension. Finally, three sub-themes (sustainable strategy, human resource planning, and urban marketing) were stated for the management dimension. A total of 14 sub-themes and 48 codes were identified.

CONCLUSION: By integrating innovative solutions, such as smart grids, green infrastructure, and renewable energy sources, urban areas can become more sustainable and adapt to urban sustainability challenges. Policymakers, planners, and designers must prioritize the implementation of these technologies to build a sustainable future for all residents of urban environments.

DOI: 10.22034/IJHCUM.2025.02.08

NUMBER OF REFERENCES	NUMBER OF FIGURES	NUMBER OF TABLES
40	1	3

*Corresponding Author:
Email: *Farzad.asayesh@gmail.com*
Phone: 09122130375
ORCID: 0000-0002-2497-6636

Note: Discussion period for this manuscript open until July 1, 2025 on IJHCUM website at the "Show Article.

INTRODUCTION

As technology advances, people choose to reside in cities. The United Nations asserts that almost 55 percent of people live in cities, and the number will also rise to 60% worldwide by 2030 (Wu *et al*., 2022). Moreover, there will be 1.5 times more people living in cities by 2045, making it so that almost 7 out of 10 people will live in cities. The average size of towns has grown along with the number of residents. It's important to think about how to adapt to these changes. Hence, cities must develop social and economic structures without harming the environment and create a balance between human residents and natural resources to achieve urbanization to deal with the challenges caused by urbanization, including lack of housing, traffic situation, or waste disposal (Rieder *et al*., 2022). Furthermore, many problems caused by population growth increase pressure on infrastructure and reduce natural resources, so the concept of sustainability is important to solve these challenges and guide urban development. Advanced technology is essential for promoting urban sustainability and fostering a pleasant urban lifestyle. Because the use of today's technology can overcome many problems in cities and guide their planning toward sustainability, these techniques help cities achieve an efficient standard of living while maintaining ecosystems and natural resources (Laffta and Al-Rawi, 2018). In the contemporary digital age, the growing complexity of global cities hinders the effectiveness of traditional urban design and management tactics. This limitation restricts urban management to conventional ways that include a limited number of individuals and stakeholders in decision-making processes. Hence, urban planners must harness the potential of developing technology to make informed and superior decisions (Ye *et al*., 2021). For almost half a century, urbanization has revolved around sustainable cities in the world (Karal and Soyer, 2024). People seek optimal construction sustainability by reducing resource consumption, energy consumption, and waste while increasing social integrity and welfare (Deng, 2021). The existing research and UN policy documents highlight that proper urban management has an impact on climate change (Omole *et al*., 2024), financial growth (Zhang *et al*., 2024), social inclusion and resilience (Zhou *et al*., 2024), the health of citizens (Fernández-Aguilar *et al*., 2023), and the quality of urban life (He *et al*., 2024), which have a positive effect. Global, national, and local policies endorse maintainable cities as the preferred solution to sustainable growth issues, and there is a high demand for various modern and alternative approaches to planning, building, maintaining, and managing cities that utilize technology (Liu, 2021). With the rapid pace of technological advancements in recent years, cities have a unique opportunity to harness the power of technology to tackle sustainable challenges. From smart infrastructure and energy-efficient buildings to data analytics and Artificial Intelligence (AI), technology offers countless tools and resources that can help cities optimize resource use, reduce carbon emissions, and increase overall sustainability (Das *et al*., 2024). Currently, algorithmic urban planning utilizes the analysis of urban big data and planning technologies powered by data to ensure intelligent and sustainable development (Lăzăroiu *et al*., 2020). A thorough comprehension and evaluation of deployed technology is crucial when striving to establish intelligent and environmentally friendly urban growth through urban planning. To accomplish this, a thorough review of existing knowledge and practice on the subject is required, not only for measurement purposes but also as a tool for critically examining the risks, limitations, and future opportunities of AI in urban planning (Agboola and Tunay, 2023). A long-term plan to transform society at an increasing pace should guide strategies for sustainable cities (Wu *et al*., 2022). Sustainable urban development with indicators such as improving the life quality through social communication (Mouratidis, 2021), decreasing energy consumption through green construction design tools (Umoh *et al*., 2024), sustainable transportation (Kirschner and Lanzendorf, 2020), environmental protection and restoration (Zeng *et al*., 2022), renewable energy and waste management (Omole *et al*., 2024), green economies, like green tax guidelines and infrastructure (Liu and Dong, 2021) have been measured. Also, studies investigating the impacts of the digital economy (Liu *et al*., 2024), machine learning (Li *et al*., 2023), urban planning (Puchol-Salort *et al*., 2021), and smart cities (Vardopoulos *et al*., 2023) have focused on urban management and sustainability. This research, by examining the previous research and analyzing it, identifies the weak points and opportunities and seeks to fill these gaps with innovative approaches. This approach can

help to improve existing theories and methods. On the other hand, the use of advanced technology can lead cities to sustainability by overcoming problems. However, studies that have a key focus on the potential of artificial intelligence technologies and geographic information systems for urban sustainability are very limited, and considering the technology dimension is one of the unique features of this research. Also, this study aims to help organizations, policymakers, and urban managers to create a better alignment between sustainable development goals and implementation plans by providing an integrated practical model and comprehensively considering economic, social, environmental, management, and technology dimensions. A study that investigated all these dimensions in the Tehran Municipality was not found. To achieve these goals, the Tehran Municipality in Iran conducted a research study in 2023 and 2024.

Urban sustainability

Since the Brundtland Report's publication in 1987 (Berry *et al.*, 2015), people have recognized the importance of cities in achieving sustainability, and it is the primary focus of international communities. In addition, the United Nations Rio+20 Conference on Sustainable Development recognized cities as a key focus area for the transition to sustainable development (Pineschi, 2024). At the conference, worldwide programs like the C40 initiative showcased the significant roles that cities can fulfill in advancing sustainability and attaining climate change adaptation and mitigation objectives. Additional influential aspects that have contributed to the advancement of urban sustainability include the release of the new urban plan and the integration of urban sustainability into policy frameworks like the Sustainable Development Goals. Goal 11 of sustainable development expressly advocates for the establishment of cities and human settlements that are inclusive, safe, resilient, and sustainable (Sharifi, 2021). The process of defining urban sustainability directly influences the identification and extraction of its indicators. Urban sustainability has been variably defined with diverse criteria and emphases. Sustainability definitions prioritize the improvement of long-term human well-being by achieving a balance between three key aspects: reducing resource consumption and environmental harm, optimizing resource utilization efficiency, and promoting equality and democracy (Huang *et al.*, 2015). In 1995, the European Environment Agency set five objectives for urban sustainability. These goals are to reduce the use of natural resources, effectively manage urban flows, safeguard the health of urban residents, ensure equal access to resources and services, and preserve cultural and social diversity (Stanners, 1995). According to the United Nations Center for Human Settlements (1997), a sustainable city achieves sustainable social, economic, and physical development and has sustainable natural resources (Ayeni and Settlement, 1997). Urban sustainability refers to a dynamic process that aims to establish and sustain a continuous relationship between ecosystem services and human well-being through cooperation. (*Wu et al., 2014*).

Technology and urban sustainability

Recent developments in urban studies have intensified the global need to improve environments through technology. The use of technology improves urban infrastructure, increases livability, and promotes sustainability. While the concept of using technology in city management dates back to the late 1950s and early 1960s, the widespread recognition of these technologies' potential is evident today (Huang, 2021). Zhou *et al.*, (2022) highlighted the significance of urban planning in achieving sustainable development objectives, particularly those directly linked to urban settings. Currently, the implementation of sensors collecting big data that change land use, transportation patterns, real estate investments, and energy use has accelerated the technology application (Sanchez *et al.*, 2023). Conversely, smart city programs are placing greater emphasis on incorporating resilience into the resolution of associated problems. Direct your attention towards climate change. Strategic alignment is crucial. This strategic alignment addresses the challenges presented by climate change and emphasizes the importance of smart cities in adjusting to these environmental changes. Smart cities utilize technological advancements to enhance efficiency and comfort while also bolstering their ability to tackle the pressing environmental issues brought about by climate change. By harnessing technology and utilizing data, cities can adjust to the increasing demands of their inhabitants and develop

urban places that are not only habitable but also well-prepared for the future (Agboola and Tunay, 2023). Using today's technology can help cities overcome many problems and guide their planning toward sustainability. These techniques help cities achieve a decent standard of living while preserving ecosystems and natural resources. Technology enhances production processes by addressing various threats that could hinder cities' competitiveness in land use and urban transport, urban waste management, air quality, cultural heritage preservation, sustainable water management, and sustainable energy. These techniques are known as green technologies, which are the only tools to help the sustainability of cities and provide a suitable quality of life for residents (Laffta and Al-Rawi, 2018). Nonetheless, developing technologies such as AI, Internet of Things (IoT), Machine Learning, Deep Learning, and Artificial Neural Networks are employed to generate, enhance, and oversee the efficacy of intelligent and sustainable development globally. Son *et al.*, (2023) view artificial intelligence as a highly promising technology for intelligent and sustainable urban planning. People commonly use AI applications like social media, emails, and search engines daily, but there is extensive potential for AI applications in sustainable development and urban planning. This includes various aspects such as land use, zoning and licensing, environmental planning, and transportation (Sanchez *et al.*, 2023). AI can aid urban planners in developing optimal and fair networks to manage the growing traffic and public transit demands. It can assist urban designers in addressing and developing specific environments, as well as fostering more streamlined communities. In addition, AI can forecast and evaluate the quality of indoor air in urban areas. It can publish findings on pollution levels, concentrations of fossil fuel particles, and future projections. These insights are valuable for informing city administrations and policymakers (Quan, 2022). In addition, we can utilize Geographic Information Systems (GIS) on the Internet to publish maps and assist citizens in comprehending suggested designs. Developing plans and enhancing planners' capacity to serve the community relies on public awareness of plans and debates. Planners' effectiveness in addressing chronic urban problems is heavily dependent on their ability to use efficient tools and planning support systems (Laffta and Al-Rawi, 2018).

MATERIALS AND METHODS

This applied research employs a qualitative data collection approach and seeks to answer the following question: What factors should be considered to achieve urban sustainability? This method seeks to develop a model and a data-oriented method that reaches concepts and categories through data and seeks to present a model with an inductive method where there is no variable in it. We used the literature study, research background, information banks, and surveying as data collection tools. In the qualitative approach, we conducted semi-structured interviews and manually analyzed the results. In this research, the interviews were conducted through semi-structured interviews to answer questions such as how, why, what, where, who, and when. The codes extracted from the 13th interview have reached a saturation state, and conducting more interviews did not add new codes to the previous codes. This number of samples was enough for the interview section. The statistical population of the research consists of the 13 managers, academic staff, specialists, and experts of the 5th district of Tehran municipality. The criteria for selecting experts include those with at least seven years of executive and managerial experience in this field. To select experts to conduct interviews, judgmental purposeful sampling was used. Some interviews were audio recorded where the interviewees permitted, and sometimes notes were taken by the researcher during the interview. After conducting each interview, the collected data were sorted and saved in Word file format. This research employed the theme analysis technique to scrutinize the data gathered from the interviews. Theme analysis is a method to determine, analyze, and express the patterns (themes) in the data. This method not only organizes the data and provides detailed descriptions, but it also can interpret various aspects of the research topic. The process of analyzing the theme is recursive, involving frequent transitions between the outlined steps. In addition, theme analysis is a process that takes place over time. To check the validity, the codes produced in a form were provided to four of the interviewees. Finally, we confirmed the validity of the results by summarizing the evaluation of the participants. Furthermore, two theme analysis experts supervised the various stages of coding, conceptualization, category extraction, and theory formulation. To

calculate the retest reliability, among the conducted interviews, several sample interviews were selected and the specified codes were compared in two-time intervals for each of the interviews. In this study, two interviews were selected as samples and re-coded with an interval of one month. Considering that the retest reliability rate is 84% (Table 1) and this value is more than 60%, the coding reliability is acceptable. Qualitative data obtained from the interviews were also analyzed by the open and axial coding methods. Open coding involves coding everything, resulting in the identification of numerous codes, irrespective of their interrelationships. At this stage, through the collection of open codes, the codes are completed with the researcher's notes and formulated to be presented to others. The next stage, known as central coding, involves the integration of codes through their classification, followed by selective coding that describes the relationships between the codes.

RESULTS AND DISCUSSION

In the present study, the researcher read all the data obtained from the interviews once before he started coding the data. After acknowledging the data, the coding stage begins, and the creation of codes depends more on the researcher's view of the data; However, reviewing and categorizing all the codes is one of the key points at this stage. We conducted open interviews, asking 10 questions about urban sustainability, and employed two stages of central and selective coding. In short, the interview questions are:

1) In your opinion, what is the definition of urban sustainability?

2) What factors lead to urban sustainability?

3) What was the impact of the progress of science and technology on urban sustainability?

4) What plans and strategies does the municipality have in mind to achieve urban sustainability?

5) What policies should be implemented to improve access to public services in cities?

6) How can we strengthen the connection between people and the urban environment?

7) What strategies are effective to reduce pollution and improving air quality in cities?

8) How can we help the development of sustainable public transport in cities?

9) What successful experiences are there in the field of urban sustainability that can be inspiring?

10) How can the improvement of urban infrastructure be justified considering economic aspects?

In this section, 13 managers, academic staff, specialists, and experts of the 5th district of Tehran municipality were interviewed using semi-structured in-depth interviews. Before initiating the qualitative analysis, it is crucial to arrange the data to facilitate a simple analysis. For this purpose, interviews have been analyzed in tabular format. After listening to the interview text and checking the notes, the general concept of the interview was obtained. Table 2 demonstrates the sample of spoken evidence from which we extracted the primary codes.

After doing the coding, the researchers classified the different codes into the form of potential themes and sorted all the coded data summaries into

Table 1: Reliability percentage by test-retest method

interview	Total number of codes	Number of agreements	Number of disagreements	Retest reliability percentage
1	72	30	23	83
2	80	34	34	85
total	152	64	57	84

Table 2: Verbal evidence from interviews for initial coding

Oral evidence	Primary code
In my opinion, to achieve the goals of sustainable development in the city, factors such as using renewable energy sources, creating more green spaces such as parks and rooftop gardens, and improving public transportation to reduce vehicle emissions can be mentioned.	-Equipped with renewable energy production system -Use of green infrastructure
By carrying out targeted and digital advertising, people can be encouraged to ride bicycles and walk, and it is necessary to build bicycle paths and streets suitable for pedestrians.	- Construction of walking and cycling paths - Using digital advertising to reach the target

specified themes. Researchers start analyzing their codes and consider combining different codes to form an overall theme. At this stage, the researchers form the main themes from some of the primary codes, create sub-themes from others, and remove the rest. The first stage involves reviewing and correcting the sub-themes, while the second stage considers their validity. In this part, some of the codes were removed or replaced, while some remained intact. Table 3 reveals the final results.

The researcher defines and revises the themes presented for analysis once they have created a satisfactory map of themes, and then analyzes the data within them. The results of the interviews define urban sustainability in the form of social, economic, environmental, technological, and managerial

Table 3: Urban sustainability sub-themes

Row	main theme	Sub-theme	Primary codes
1	Social dimension	Social equality	- Minimizing the socio-economic gap between the rich and the poor - Equal access to municipal services - Predicting affordable housing - Providing suitable social services for vulnerable social groups
		Quality of life in the city	- People interaction programs - Ensuring access to recreational sites - Reduction of carbon emissions - Avoiding wasting time in daily commuting - Increase healthcare
2	Economic dimension	Economic Growth	- Ensuring that the average household income meets the minimum needs of the family - Using job opportunities
		Affordability	- Ensuring the affordability of basic services - Reduction of poverty and unemployment - Ability to save
		Access to financial matters	- Ensuring access to financial resources for deprived urban citizens - Promoting business through bank loans - Ensuring collateral-free financing for the urban poor
3	Environmental dimension	Sustainable transportation	-Public transportation facilities - Vehicles based on renewable energy
		Sustainable service	-Reducing unnecessary trips - Construction of walking and cycling paths - Redesign of public spaces for less use of private cars
		Sustainable Energy	- Equipped with renewable energy production system - Use of clean energy - Low emissions of greenhouse gases
4	Technology dimension	Artificial intelligence capabilities	- Intelligent cleaning system -Intelligent traffic management - Intelligent transportation system - Intelligent garbage collection system - Intelligent drainage and sewage system
		Geographical information systems capabilities	- Identification of land uses and zoning - Development of smart growth of cities Urbanization control - The success of planners in fighting chronic urban problems
		Green technology	-Investment in low-carbon technology -Using green infrastructure as a hedge against the risks of climate change - Reduction of waste and pollutants
5	Management dimension	Sustainable strategy	- Paying attention to opportunities and comprehensive challenges -Understanding sustainability risks - Coordination with internal and external developments
		Human resource planning	- Training of human resources - Development of effective communication -Strengthening positive relationships between individuals and communities - Strengthening governance - Citizen cooperation and participation
		Urban marketing	- Promotion of products, services, and brands especially in urban areas - Creating targeted campaigns - Using digital advertising to reach the target audience

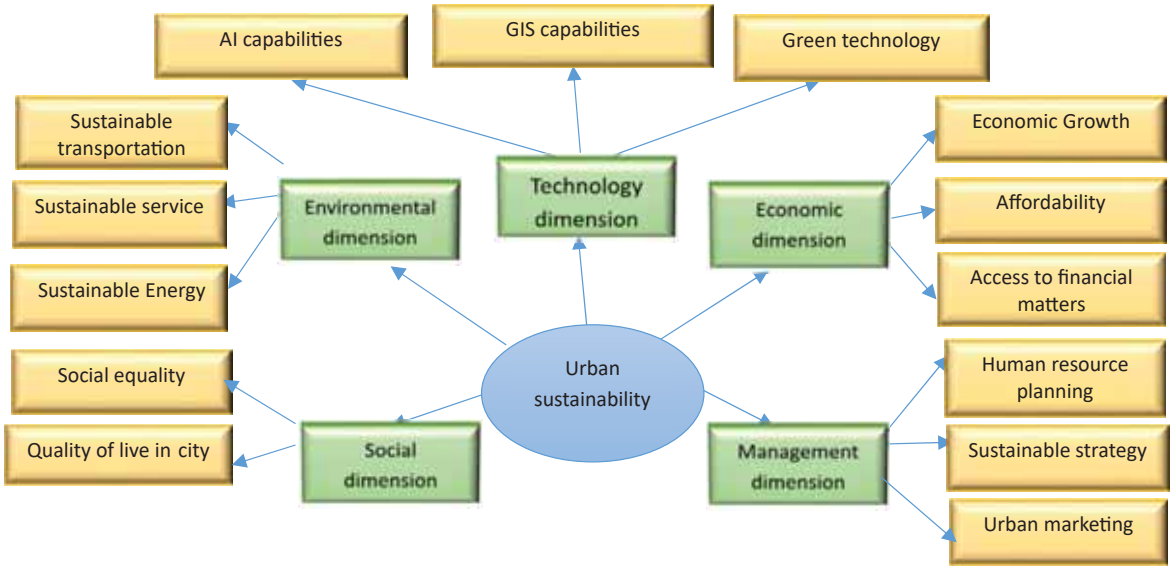


Fig.1: Urban sustainability model

themes (Fig. 1).

In the current research, the dimensions of urban sustainability have been investigated with a detailed perspective, and the result of this research led to the identification of social, economic, environmental, technological, and management dimensions that were discussed in detail.

1) The first dimension is the social dimension, which is characterized by the concepts of social equality and quality of urban life. The social dimension of urban sustainability refers to the well-being and quality of life of a city's residents, as well as the fair distribution of resources and opportunities in the urban environment (Larimian and Sadeghi, 2021). Furthermore, in research (Mouratidis *et al.*, 2024), the social dimension of urban sustainability refers to the ways that cities and communities can promote social equality, cohesion, and inclusion among their population. It comprises a wide range of factors, including access to essential services such as housing, health care, education, and transportation, as well as opportunities for meaningful employment, social interaction, and civic participation. In the current research, one of the key elements of the social dimension of urban sustainability is social equality. This entails ensuring that all members of society have access to basic services such as affordable housing, education, health care, and transportation. By addressing issues of social equity, cities can help reduce poverty, inequality, and social exclusion, which are the main obstacles to sustainable development. In addition, promoting social equity can help foster social cohesion and a sense of community among residents, which is critical to creating resilient and inclusive cities. In addition, the social dimension of urban sustainability includes considerations of social welfare and quality of life. This entails ensuring that residents have access to affordable health care, recreational facilities, green spaces, and other amenities that contribute to their physical and mental well-being. By investing in social infrastructure and services that enhance residents' quality of life, cities can create healthier, happier, and more resilient communities that are better equipped to deal with complex 21st-century challenges such as carbon emissions.

2) The second dimension is the economic dimension, which includes economic growth, financial strength, and access to financial matters. One of the key economic aspects of urban sustainability is creating jobs and opportunities for residents. A sustainable city must have a thriving economy that provides many job opportunities for its residents and ensures that they can support themselves and their families (Zeng *et al.*, 2022). This requires a diverse and resilient economy that can adapt to changing

conditions and market forces. By fostering innovation and entrepreneurship, cities can create new industries and job opportunities that help sustain economic growth in the long term (Caragliu and Del Bo, 2019). Economic growth is a key indicator of urban sustainability because it reflects the overall health and vitality of an urban economy. An urban economy that promotes sustainable growth equally distributes its benefits to all members of society. Creating diverse economic opportunities, investing in infrastructure and innovation, and promoting a suitable business environment can achieve this. A sustainable urban economy also needs financial stability and flexibility. This includes the ability of local governments to effectively manage finances, maintain balanced budgets, and invest in long-term projects that support sustainable development. Financial capability also includes the ability of residents and businesses to withstand economic shocks and downturns through savings, insurance, and access to social safety nets. Access to financial resources is another critical aspect of urban sustainability. To promote economic growth and development, individuals and businesses must have access to the financial resources needed for investment, innovation, and growth. This includes access to capital for small and medium enterprises, affordable credit for various people, especially the disadvantaged, and support for innovative and sustainable projects. Lack of access to finance can impede economic growth and perpetuate inequality by leaving those unable to finance behind.

3) The third dimension is the environmental dimension, which is defined by sustainable transportation, sustainable services, and sustainable energy. In this regard, Beck and Ferasso (2023) introduced one of the key dimensions of urban sustainability, the environmental dimension, which focuses on ensuring that urban development does not harm the natural environment and that cities can reduce and adapt to the effects of water changes. The environmental dimension of urban sustainability focuses on minimizing the negative impact of urban development on the environment and promoting the health and well-being of both people and ecosystems. Besides, Wu *et al.*, (2022) showed that the environmental dimension of urban sustainability includes various issues, including air and water quality, biodiversity protection, waste control, and green spaces. Burning fossil fuels for transportation and energy production often causes air pollution, one of the main challenges urban areas face in terms of environmental sustainability. Poor air quality can have serious effects on the health of urban residents and can also contribute to climate change. Hence, to lessen the impact on the environment and air quality, it is important to encourage sustainable modes of transportation and to build sustainable transportation networks. These include public transportation, cycling, walking, and carpooling. Also, encouraging the use of electric vehicles or other forms of clean energy vehicles can further reduce greenhouse gas emissions and promote a healthier urban environment. Also, by promoting energy and water-saving measures can reduce the consumption of resources and minimize the urban footprint on the environment. Transitioning to renewable energy sources such as solar, wind, and hydropower can help urban areas reduce their dependence on fossil fuels and reduce greenhouse gas emissions.

4) We identified the fourth dimension, known as the technology dimension. This dimension encompasses the capabilities of artificial intelligence, geographic information systems, and green technology. Urban sustainability's technology dimension refers to the use of advanced technology and innovative solutions to deal with urban challenges and promote sustainable development. This dimension focuses on using technology to improve the efficiency of urban systems, reduce resource consumption, and minimize environmental impacts. Cities commonly use technologies like smart grids, renewable energy systems, energy-efficient buildings, and advanced transportation systems to enhance their sustainability. The concept of smart cities is one of the key aspects of urban sustainability's technology dimension. Smart cities use technology and data to improve the quality of life for residents, improve urban infrastructure, and create more resilient and sustainable urban environments. Smart city initiatives often involve the use of sensors, data analytics, and artificial intelligence to optimize resource allocation, reduce energy consumption, and improve public services. In addition to smart city solutions, the technological dimension of urban sustainability also includes the adoption of green technologies and practices. Green technologies, such as solar panels, wind turbines, and green building materials, lead to lower carbon emissions, higher energy efficiency,

and highly sustainable living. By incorporating green technologies into urban infrastructure and buildings, cities can significantly reduce their environmental impact and contribute to a more sustainable future (Laffta and Al-Rawi, 2018). AI has the potential to provide innovative solutions for various challenges facing cities, which plays an important role in promoting urban sustainability. Artificial intelligence enables the optimization of energy distribution and consumption in urban areas. The use of machine learning algorithms that can examine usage patterns, forecast demand, and optimize the operation of smart grids can make energy management more effective and sustainable. AI-powered systems can also monitor traffic conditions, predict delays, and adjust traffic lanes accordingly. Artificial intelligence technologies can be used to improve waste collection and recycling processes. For example, sensors equipped with artificial intelligence can optimize waste collection routes, leading to lower fuel consumption and lower emissions. In addition, artificial intelligence can help identify recyclable materials and sort them more effectively in recycling facilities (Son *et al.*, 2023).

5) Finally, the fifth dimension is the management dimension, which in this research is defined by factors such as sustainable strategy, human resource planning, and urban marketing. The managerial dimension of urban sustainability plays an important role in achieving sustainable goals (Zeng *et al.*, 2022). It includes planning, coordinating, and implementing policies, strategies, and initiatives aimed at promoting sustainable urban development (Beck and Ferasso, 2023). Effective management of these activities is necessary to ensure that cities can grow and develop in a sustainable and resilient manner against future challenges. A sustainable strategy should outline specific actions and initiatives that cities will take to promote urban sustainability, taking into account the opportunities and overall challenges. This necessitates cooperation among diverse parties, encompassing government agencies, enterprises, non-profit organizations, and community groups. Cities may ensure that their long-term growth is ecologically conscious, socially inclusive, and economically sustainable through the implementation of a sustainable strategy. Human resource planning is an essential component of urban sustainability management (Beck and Ferasso, 2023). Cities must invest in their human capital by attracting, training, and retaining a diverse and skilled workforce, as well as developing effective communications. This includes professionals with expertise in sustainability, environmental management, urban planning, and other related fields. HR planning also includes promoting diversity and inclusion in the workplace, ensuring equal opportunities for all employees, and fostering a culture of innovation and collaboration. By investing in their human capital, cities can create the capacity to effectively deal with sustainability challenges and become flexible, adaptive, and inclusive urban communities. Finally, urban marketing plays an important role in promoting and communicating urban sustainability initiatives to residents, businesses, investors, and tourists. Effective city marketing entails branding the city as a sustainable and livable destination, highlighting its unique features and attractions, and engaging with stakeholders through a variety of communication channels. This includes social media, websites, events, and campaigns that raise awareness of sustainability issues, showcase best practices, and inspire action. By engaging in urban marketing, cities can attract investment, talent, and visitors, build a positive reputation, and strengthen their competitive advantage in the global marketplace.

CONCLUSION

This study concludes that the managers of Tehran municipality can address the root causes of poverty, inequality, and social exclusion and create a fairer and more sustainable urban environment by focusing on social equality and inclusivity. Urban planners, policymakers, and residents need to prioritize the social dimension of urban sustainability in their decision-making processes to create cities that promote well-being and quality of life for all residents. Tehran municipal managers can also create a strong economic foundation that supports their long-term sustainability goals by focusing on creating jobs and opportunities for residents and using resources and infrastructure efficiently. Cities must prioritize economic sustainability in their decision-making and planning processes to ensure they can thrive in a complex and uncertain world. Sustainable cities must prioritize the accountable consumption of land and water resources to ensure they can meet the current and future generations' demands. It requires investing in sustainable infrastructure

and technologies, like renewable energy sources and well-organized transportation systems, that can help minimize waste and reduce the city's carbon footprint. By investing in sustainable practices, cities can reduce their operating costs and improve their overall economic competitiveness. Several indicators can be used to measure the economic dimension of urban sustainability. These include Gross Domestic Product (GDP) growth, per capita income, unemployment rate, poverty level, inflation rate, and access to financial services. By tracking these indicators over time, policymakers can gain valuable insight into the health and vitality of their city's economy and make informed decisions about how to promote sustainable economic development. Also, cities can create a more resilient and sustainable urban environment for current and future generations by prioritizing environmental protection. Through sustainable measures, including quality enhancement, waste management, biodiversity conservation, and green space development, cities can reduce their environmental impact and create a healthier and more livable urban environment. Furthermore, the construction of green spaces such as parks, gardens, and green roofs plays a vital role in the environmental dimension of urban sustainability. Green spaces facilitate moderating the urban heat island effect, provide wildlife habitat, and enhance air quality. They also offer residents a place to relax, exercise, and connect with nature, which contributes to their overall health and well-being. In addition, cities can address urban challenges, increase resource efficiency, and create livable and sustainable urban environments by using advanced technologies, smart city solutions, and the use of AI, and green technologies. Accepting technology as a key factor in urban sustainability is necessary to build flexible, efficient, and environmentally friendly cities that can align with present and future generations' requirements and aid in urban planning and design. It can also help urban planners and architects design more sustainable and environmentally friendly cities. By analyzing large amounts of data, AI can help identify optimal locations for green spaces, renewable energy facilities, and sustainable infrastructure. Finally, by engaging in urban marketing, cities can attract investment, talent, and visitors, build a positive reputation, and strengthen their competitive advantage in the global marketplace. It is suggested that future research should investigate the mutual effects of the participation of citizens and non-governmental organizations in the planning and implementation of urban sustainability projects and evaluate the impact of climate change on the environmental sustainability of cities. Also, it is suggested that this research takes place in other geographical areas and its results are compared with the current research.

AUTHOR CONTRIBUTIONS

All authors have an equal share in all parts of the paper.

ACKNOWLEDGMENTS

The authors would like to thank all managers and experts of Tehran District 5 Municipality for their cooperation and support. Also, the authors would like to thank the editor and the two anonymous reviewers for their constructive comments on improving an early version of this paper

CONFLICT OF INTEREST

The authors declare no potential conflict of interest regarding the publication of this work. In addition, the ethical issues, including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, and redundancy have been completely witnessed by the authors.

OPEN ACCESS

PUBLISHER NOTE

Tehran Urban Research & Planning Centre (TURPC) takes a neutral position about claims on disputed territories, place names, international boundaries, jurisdiction in published maps, and institutional affiliations. TURPC is committed to retracting a paper after its publication if it becomes apparent that there are serious problems in its content in terms of research and publication ethics (https://www.ijhcum.net/journal/process?ethics).

ABBREVIATIONS (NOMENCLATURE)

5w1h	*What, Who, Where, Why, and How*
AI	*Artificial intelligence*
GIS	*Geographic information systems*
IoT	*Internet of Things*
GDP	*Gross Domestic Product*

REFERENCES

Agboola, O. P.; Tunay, M. (2023). Urban resilience in the digital age: The influence of Information-Communication Technology for sustainability. J. Cleaner Prod., *428* (139304): 1-14 **(14 pages)**.

Ayeni, B.; Settlement, U. N. C. f. H. (1997). Regional Development Planning and Management in Africa: A Retrospective and Prospective Review. *United Nations Center for Human Settlement (Habitat)(ed.), Regional Development Planning and Management of Urbanization: Experiences of Developing Countries. Nairobi: U.N. for H.S*, 7-62**(56 pages)**.

Beck, D.; Ferasso, M. (2023). Bridging 'stakeholder value creation'and 'urban sustainability': the need for better integrating the environmental dimension.Sustainable Cities Soc., *89* (104316): 1-14 **(14 pages)**.

Berry, E. M.; Dernini, S.; Burlingame, B.; Meybeck, A.; Conforti, P. (2015). Food security and sustainability: can one exist without the other? Public Health Nutr., *18*(13): 2293-2302 **(10 pages)**.

Caragliu, A.; Del Bo, C. F. (2019). Smart innovative cities: The impact of Smart City policies on urban innovation.Technol. Forecasting Social Change., *142:* 373-383**(11 pages)**.

Das, N.; Gangopadhyay, P.; Alam, M. M., Mahmood, H.; Bera, P., Khudoykulov, K.; Dey, L.; Hossain, M. E. (2024). Does greenwashing obstruct sustainable environmental technologies and green financing from promoting environmental sustainability? Analytical evidence from the Indian economy. *Sustainable Dev.*, *32*(1): 1069-1080 **(12 pages)**

Deng, S. (2021). Exploring the relationship between new-type urbanization and sustainable urban land use: Evidence from prefecture-level cities in China. *Sustainable Comput.: Inf. Syst.*, *30* (100446): 1-22 **(22 pages)**.

Fernández-Aguilar, C.; Brosed-Lázaro, M.; Carmona-Derqui, D. (2023). Effectiveness of Mobility and Urban Sustainability Measures in Improving Citizen Health: A Scoping Review. Int. J. Environ. Res. Public Health., *20*(3): 1-21 **(21pages)**

He, X.; Zhou, Y.; Yuan, X.; Zhu, M. (2024). The coordination relationship between urban development and urban life satisfaction in Chinese cities-An empirical analysis based on multi-source data. *Cities.*, *150:* 1-14 **(14 pages)**.

Huang, L.; Wu, J.; Yan, L. (2015). Defining and measuring urban sustainability: a review of indicators. Landscape Ecol., *30:* 1-19 **(19 pages)**.

Huang, Z. (2021). AI in Urban Planning: 3 Ways it will Strengthen how we Plan for the Future. *September. Accessed October.*

Karal, F. S.; Soyer, A. (2024). A systematic literature review: Setting a basis for smart and sustainable city performance measurement. *Sustainable Dev.*, *32*(1): 1-19 **(19 pages)**.

Kirschner, F.; Lanzendorf, M. (2020). Parking management for promoting sustainable transport in urban neighbourhoods. A review of existing policies and challenges from a German perspective Transport Rev., *40*(1): 54-75 **(22 pages)**.

Laffta, S.; Al-rawi, A. (2018). Green technologies in sustainable urban planning. In *MATEC Web of Conferences.*, 162: 05029 **(7 pages)**.

Larimian, T.; Sadeghi, A. (2021). Measuring urban social sustainability: Scale development and validation. Environ. Plann. B: Urban Anal. City Sci., *48*(4): 621-637 **(17 pages)**.

Lăzăroiu, G.; Ionescu, L.; Andronie, M.; Dijmărescu, I. (2020). Sustainability management and performance in the urban corporate economy: a systematic literature review. Sustainability., *12*(18): 1-13 **(13 pages)**.

Li, F.; Yigitcanlar, T.; Nepal, M.; Nguyen, K.; Dur, F. (2023). Machine learning and remote sensing integration for leveraging urban sustainability: A review and framework. Sustainable Cities Soc 104653: 1-14 **(14 pages)**.

Liu, L. (2021). Green urban environmental sustainability and health sport based on MapReduce fitness big data and ZigBee technology. Environ. Technol. Innovation., *23*:1-19 **(19 pages)**.

Liu, Y.; Dong, F. (2021). How technological innovation impacts urban green economy efficiency in emerging economies: A case study of 278 Chinese cities. *Resources, Resour. Conserv. Recycl.*, *169*: 1-13 **(13 pages)**.

Liu, Y.; Xie, Y.; Zhong, K. (2024). Impact of digital economy on urban sustainable development: Evidence from Chinese cities. *Sustainable Dev.*, *32*(1): 307-324 **(18 pages)**.

Mouratidis, K. (2021). Urban planning and quality of life: A review of pathways linking the built environment to subjective well-being. *Cities.*, *115*: 1-12 **(12 pages)**.

Mouratidis, K.; Hofstad, H.; Zeiner, H. H.; Sagen, S. B.; Dahl, C., Følling, K. E; Olsen, B. O. (2024). Assessing urban social sustainability with the Place Standard Tool: Measurement, findings, and guidance. *Cities.*, *148*: 1-16 **(16 pages)**.

Omole, F. O.; Olajiga, O. K.; Olatunde, T. M. (2024). Sustainable urban design: a review of eco-friendly building practices and community impact.*Eng. Sci. Technol.*, *5*(3): 1020-1030 **(11 pages)**.

Pineschi, L. (2024). Cultural Heritage, Sustainable Development and Human Rights: The Need for an Integrated Approach. In *Cultural Heritage, Sustainable Dev. Hum* 3-12. Routledge **(10 pages)**.

Puchol-Salort, P.; O'Keeffe, J.; van Reeuwijk, M.; Mijic, A. (2021). An urban planning sustainability framework: Systems approach to blue green urban design. Sustainable Cities Soc., *66:* 1-14 **(14 pages)**.

Quan, S. J. (2022). Urban-GAN: An artificial intelligence-aided

computation system for plural urban design. *Environ. Plann. B: Urban Anal. City Sci.* , *49*(9): 2500-2515 **(16 pages)**.

Rieder, E.; Schmuck, M.; Tugui, A. (2022). A scientific perspective on using artificial intelligence in sustainable urban development. *Big Data. Cognit. Comput.*, *7*(1):,1-20 **(20 pages)**.

Sanchez, T. W.; Shumway, H.; Gordner, T.; Lim, T. (2023). The prospects of artificial intelligence in *urban planning.Int. J. Urban Sci*., *27*(2): 179-194 **(16 pages)**.

Sharifi, A. (2021). Urban sustainability assessment: An overview and bibliometric analysis. *Ecol. Indic*., *121*: 1071021, 1-14 **(14 pages)**.

Son, T. H.; Weedon, Z.; Yigitcanlar, T.; Sanchez, T; Corchado, J. M.; Mehmood, R. (2023). Algorithmic urban planning for smart and sustainable development: Systematic review of the literature. *Sustainable Cities Soc*., 104562:1-29 **(29 pages)**.

Stanners, D. (1995). Europe's environment. *The Dobris Assess.*, 48-55 **(8 pages)**.

Umoh, A. A.; Adefemi, A.; Ibewe, K. I.; Etukudoh, E. A.; Ilojianya, V. I.; Nwokediegwu, Z. Q. S. (2024). Green architecture and energy efficiency: a review of innovative design and construction techniques. *Eng. Sci. Technol..,* 5(1): 185-200 **(16 pages)**.

Vardopoulos, I.; Papoui-Evangelou, M.; Nosova, B.; Salvati, L. (2023). Smart 'tourist cities' revisited: culture-led urban sustainability and the global real estate market. *Sustainability.*, *15*(5): 4313. **(26 pages)**.

Wu, J.; Xiang, W. N.; Zhao, J. (2014). Urban ecology in China: Historical developments and future directions. *Landscape Urban Plann*., *125*: 222-233 **(12 pages)**.

Wu, M.; Yan, B.; Huang, Y.; Sarker, M. N. I. (2022). Big data-driven urban management: Potential for urban sustainability. *Land*, *11*(5): 680-695 **(16 pages)**.

Ye, L.; Pan, S. L.; Wang, J.; Wu, J.; Dong, X. (2021). Big data analytics for sustainable cities: An information triangulation study of hazardous materials transportation. *Bus. Res*., *128*: 381-390 **(10 pages)**.

Zeng, X.; Yu, Y.; Yang, S.; Lv, Y.; Sarker, M. N. I. (2022). Urban resilience for urban sustainability: Concepts, dimensions, and perspectives. *Sustainability.*, *14*(5): 2481-2502 **(27 pages)**.

Zhang, M.; Zhang, D.; Xie, T. (2024). Balancing urban energy considering economic growth and environmental sustainability through integration of renewable energy.*Sustainable Cities Soc*., *101*: 1-14 **(14 pages)**.

Zhou, K.; Kong, F.; Yin, H.; Destouni, G.; Meadows, M. E.; Andersson, E.; Su, J. (2024). Urban flood risk management needs nature-based solutions: a coupled social-ecological system perspective. *npj Urban Sustainability.*, *4*(1):1-12 **(12 pages)**.

Zhou, M.; Ma, Y.; Tu, J.; Wang, M. (2022). SDG-oriented multi-scenario sustainable land-use simulation under the background of urban expansion. *Environ. Sci. Pollut. Res.*, *9*(48): 72797-72818 **(22 pages)**.

HOW TO CITE THIS ARTICLE

Allafjafari, E.; Asayesh, F.; Rostamian, M., (2025). Towards building a sustainable future with the tech revolution.Int. J. Hum. Capital Urban Manage., 10(2): 317-328.

DOI: 10.22034/IJHCUM.2025.02.08

URL: https://www.ijhcum.net/article_718977.html

Int. J. Hum. Capital Urban Manage., 10(2): 329-344, Spring 2025

International Journal of Human Capital in Urban Management
(IJHCUM)

Homepage: http://www.ijhcum.net/

CASE STUDY

Integrating sustainable urban development and student housing to enhance urban social welfare (case study: Ho Chi Minh City)

N.V. Lai[1], P.T. Tran[2,*]

[1] Faculty of Political Theory, University of Finance – Marketing, Ho Chi Minh City, Vietnam

2 Faculty of Political Science and Law, Ho Chi Minh City University of Technology and Education, Ho Chi Minh City, Vietnam

ARTICLE INFO

Article History:
Received 15 July 2024
Revised 01 September 2024
Accepted 21 October 2024

Keywords:
Inclusive growth
Social welfare
Student housing
Sustainable urban development
Urban planning
Vietnam

ABSTRACT

BACKGROUND AND OBJECTIVES: Ho Chi Minh City, Vietnam's largest urban center, is experiencing rapid urbanization, which, combined with a growing student population, has led to an increased demand for student housing. This study aims to assess the current state of student housing in Ho Chi Minh City, focusing on the gap between housing supply and demand in the context of the city's urban development and sustainability goals.

METHODS: A mixed-methods approach was utilized to analyze the student housing landscape in Ho Chi Minh City. Qualitative data were obtained through secondary document analysis, including a review of scholarly articles, government reports, and statistical data. Quantitative data were collected via an online survey of 88 first- and second-year students at the Ho Chi Minh City University of Technology and Education, designed to capture a broad range of housing experiences and preferences. This comprehensive approach allowed for a thorough understanding of the needs and challenges associated with student housing in the city.

FINDINGS: The analysis revealed that 51.1% of students preferred renting rooms, while 48.9% chose to stay in university dormitories. A significant portion of students (44.3%) spent less than 1 million VND per month on housing, often sharing with 2-4 roommates to reduce costs. The survey indicated that students primarily relied on social media (61.4%) and referrals (53.4%) for finding housing. Issues of security and safety were highlighted, with only 45.5% of dormitory residents and 31.8% of off-campus residents reporting satisfaction with their housing security and safety.

CONCLUSION: The findings provide valuable insights for policymakers and urban planners in addressing the student housing shortage in Ho Chi Minh City. The study emphasizes the need to integrate sustainable practices into housing development, such as implementing green building standards and enhancing safety measures. Encouraging partnerships between universities, government bodies, and private developers is crucial for creating sustainable, affordable, and secure housing solutions that meet the needs of the growing student population amidst the city's ongoing urban expansion.

DOI: 10.22034/IJHCUM.2025.02.09

NUMBER OF REFERENCES	NUMBER OF FIGURES	NUMBER OF TABLES
38	9	2

*Corresponding Author:
Email: *tpphuong@hcmute.edu.vn*
Phone: +842838968641
ORCID: 0009-0005-9638-7880

Note: Discussion period for this manuscript open until July 1, 2025 on IJHCUM website at the "Show Article.

INTRODUCTION

The initiation of Resolution No. 06-NQ/TW by the Politburo on January 24, 2022, marks a significant shift in Vietnam's approach to urban development, aiming for completion by 2030 with a strategic vision extending to 2045. This resolution outlines a comprehensive agenda to accelerate urbanization and foster sustainable urban networks across the nation. The objective is to integrate cities into dynamic, globally interconnected urban systems. The resolution mandates a holistic approach to urban planning, including construction, management, and sustainable development policies. It emphasizes the need for modern, synchronized urban infrastructure that supports rapid, effective, and sustainable economic growth. Additionally, it prioritizes enhancing urban living standards by ensuring residents' access to adequate housing and social infrastructure. This approach also advocates for the development of modern, green, and smart urban architectures that reflect and promote Vietnam's unique cultural identity. Ho Chi Minh City (HCMC), Vietnam's largest urban center, plays a crucial role in this developmental trajectory due to its position as a key economic hub in the Southern region. The city's rapid growth is supported by governmental directives such as Decision No. 1570/QĐ-TTg (November 27, 2006) and Decision No. 589/QĐ-TTg (May 20, 2008), which have shaped its general and construction planning up to 2025, with projections extending towards 2050. These directives provide a framework for managing HCMC's extensive urban landscape, which includes 24 administrative units—19 districts and five suburban districts—covering a total area of 209,554.47 hectares. As of 2006, the population of HCMC was 6,424,519, but this figure grew to 10,187,671 by 2015, as reported by The Atlas of Urban Expansion, exceeding earlier population projections. The city's urban footprint also expanded significantly, with its built-up area increasing by 48,418 hectares from 1999 to 2015, reflecting an average annual growth rate of 10% (Atlas of Urban Expansion, 2016) (Figs. 1 and 2).

HCMC's urbanization rate now exceeds 80%, with in-migration contributing significantly to this growth, accounting for about 1.8 million people or 28.9% of the city's population. This demographic shift is a hallmark of urbanization trends observed in major cities worldwide. In response to these dynamics, the Department of Planning and Architecture of the HCMC government released the "Ho Chi Minh City Urban Planning Information" in 2020, which includes a land use plan on a 1/2000 scale, covering all 24 districts (Department of Planning and Architecture, 2020) (Fig. 3). The city's economic structure has shifted markedly from its traditional agricultural roots to a focus on industrial, commercial, service, and tourism sectors.

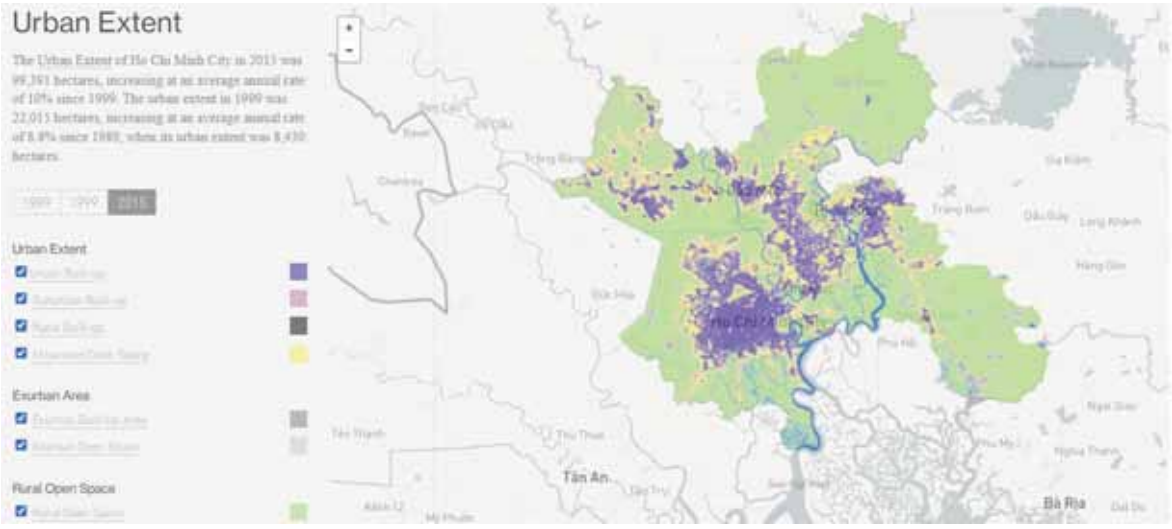


Fig. 1: The urban extent of Ho Chi Minh City in 2015 (Atlas of Urban Expansion, 2016)

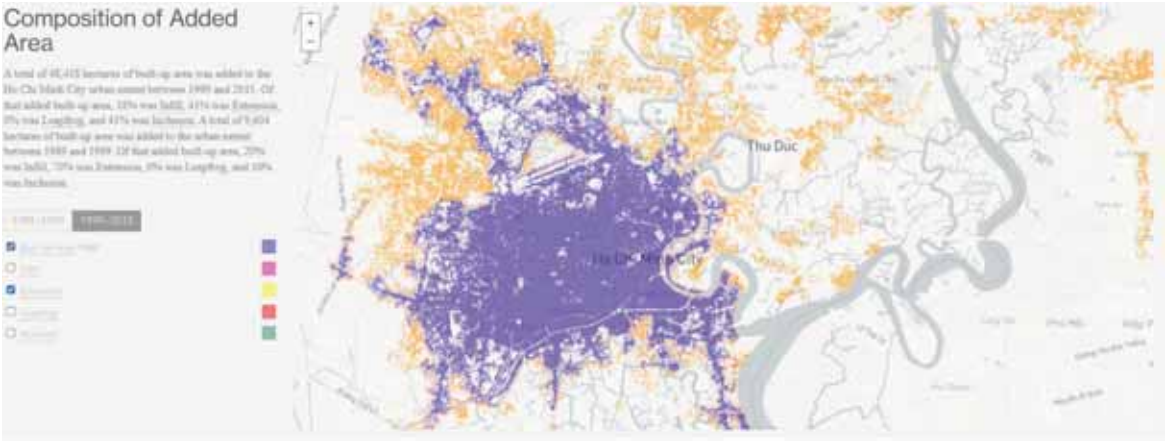


Fig. 2: Composition of added areas to the Ho Chi Minh Urban Extent in 2015 (Atlas of Urban Expansion, 2016)

Fig. 3: Ho Chi Minh City Urban Planning Information (Department of Planning and Architecture, 2020)

A critical aspect of HCMC's rapid urbanization is the corresponding growth in its student population, which reached 600,000 in 2023, representing 27.97% of the national student body. The student population in HCMC is increasing annually by 10-13% (Minh Hiep, 2023; Ministry of Education and Training, 2022). This demographic shift underscores the vital role students play in the urban fabric of HCMC. The demand for student housing has become a pressing issue as this population growth is not matched by adequate accommodation facilities. HCMC is home to more than 60 universities and colleges, including institutions with tens of thousands of students such as Vietnam National University - Ho Chi Minh City (VNU-HCM), Industrial University of Ho Chi Minh City (IUHCMC), Ho Chi Minh City University of Technology and Education (HCMUTE), Ton Duc Thang University, and others. However, the dormitory accommodation capacity at these institutions is severely limited. For instance, IUH can accommodate only 2,800 students in its dormitories despite having a student population of up to 80,000. Similarly, HCMUTE offers only 2,416 dormitory seats for its 37,000 students (HCMUTE Dormitory Management Board, 2022a; Ngoc Thuy, 2023). Other institutions face similar constraints, with dormitory accommodation rates generally falling

below 10% of the total student body. An exception is VNU-HCM, which provides 38,000 dormitory seats across its six member universities and two dependent faculties, catering to nearly 90,700 students (VNU-HCM Dormitory Management Center, 2022). The strategic importance of VNU-HCM is highlighted by the Prime Minister's approval of its construction zone planning through Decision No. 409/QD-TTg on March 21, 2014. This planning effort is integral to HCMC's and Vietnam's broader educational and developmental goals. Spanning 643.7 hectares on the border of HCMC and Binh Duong province, VNU-HCM is set to become a leading hub for education, scientific research, and technological innovation. The university system aims to be among Asia's elite, with a target to accommodate 65,000 students by 2030. The expansive VNU-HCM campus includes a Dormitory Management Center covering 42.08 hectares, with 47 buildings that range from five to sixteen stories (VNU-HCM Dormitory Management Center, 2024) (Fig. 4). In July 2023, detailed construction plans for this project at a 1/2000 scale were submitted to the Ministry of Construction (VNU-HCM, 2023).

Addressing the student housing challenge extends beyond mere accommodation provision. It involves creating supportive environments conducive to learning, personal growth, and overall well-being. The scarcity of adequate student housing not only affects individual health and financial stability but also poses a significant challenge to HCMC's sustainable development goals. Current urban planning initiatives and educational infrastructure expansions have exacerbated the challenge of providing sufficient student housing. This study identifies a notable gap in the academic literature regarding the intersection of student housing and sustainable urban development in HCMC, signaling an urgent need for further investigation. Exploring the complex interplay between urban planning policies, housing market dynamics, and student accommodation options is crucial to understanding this issue. Such an investigation will encourage stakeholders to develop innovative, sustainable practices to address the student housing crisis and improve urban livability in HCMC. This research contributes to the relatively narrow field of multidisciplinary studies on sustainable urban development from the perspective of a rapidly urbanizing city in a developing nation. Furthermore, it offers valuable insights that apply to similar urban contexts globally. Overall, this study aims to assess the current state of student housing, examine the impact of urban planning policies on housing affordability and quality, and propose potential solutions. By employing a mixed-methods approach—comprising qualitative document analysis and quantitative survey data—this research provides a comprehensive understanding of the housing challenges faced by students in HCMC. The research survey was conducted from October to December 2023 in various residential areas of HCMC, focusing on capturing the experiences and preferences of students regarding their housing conditions. This comprehensive analysis is intended to guide policymakers, urban planners, and stakeholders in developing effective strategies to enhance student housing infrastructure and support sustainable urban development in HCMC.

Literature review

The intersection of urbanization, housing dynamics, socio-economic disparities, and environmental management in HCMC creates a complex landscape that significantly influences sustainable urban development. Central to this landscape are the specific housing needs of the city's growing student population, a demographic that reflects the broader challenges and aspirations of urbanization in developing regions. This literature review synthesizes critical research findings on these topics, identifies gaps in the existing knowledge base, and establishes the foundation for this study's contributions to the discourse on sustainable urban living in HCMC. The urbanization process in HCMC has been a crucial aspect of Vietnam's overall development strategy, as highlighted by Ban Mai (2023). The rapid urban expansion has significant implications for housing and urban planning, particularly as the city faces challenges in accommodating its increasing population, including a large influx of students. Seo and Kwon (2017), Hoang-Thi *et al*. (2021), and Nguyen-Tien *et al*. (2019) emphasize the importance of understanding housing preferences in the context of urbanization to promote sustainable development. They argue that migration patterns play a vital role in shaping housing choices, which is essential for policymakers to consider when crafting inclusive and sustainable housing strategies. Further, Mertes *et al.* (2015) and Vo (2007) discuss the environmental

Fig. 4: Adjusted detailed construction subdivision planning project of VNU-HCM (VNU-HCM, 2023)

challenges that accompany rapid urbanization, such as water management and infrastructure development. Their work highlights how urban growth impacts the environment and the need for sustainable practices to manage these effects. Kien *et al*. (2016), Tang *et al*. (2007), and Nguyen *et al*. (2007) delve into the socio-economic inequalities that affect urban settings, revealing the link between these disparities and sustainable living conditions. They advocate for a comprehensive approach to urban planning that addresses these socio-economic challenges, ensuring that development is both equitable and sustainable. In terms of economic dynamics, Primasari and Ardhyanto (2017) explore the tension between commercial development and heritage conservation, noting that property investments significantly influence the construction industry and urban development. This dynamic poses a challenge for maintaining adequate housing, including for students, while fostering economic growth and preserving cultural heritage. Gillen (2015) further explores this by examining the cultural dynamics in HCMC, particularly how rural imaginaries influence urban environments and the struggle to balance development with heritage conservation. Additionally, Ha (2023), Nguyen *et al.* (2023), Nguyen and Nguyen (2024), and Phung *et al.* (2024) investigate the enduring influence of ideologies on urban health risks, civil advocacy, and the education of youth, adding another layer to the discussion on sustainable urban development. When specifically addressing student housing needs, Seo and Kwon (2017) provide valuable insights into creating environments conducive to learning and personal growth. Their research, alongside the investigation of Nguyen *et al*. (2024) into the student housing market in HCMC underscores the importance of addressing these needs to enhance urban life quality and support sustainable

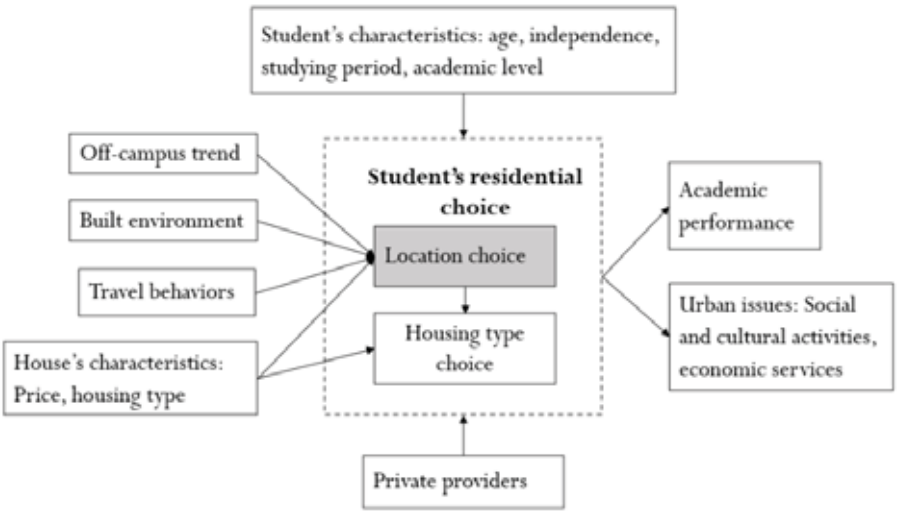


Fig. 5: Student's residential choice and relevant factors (Nguyen et al., 2024)

development goals. Their analysis considers various factors influencing student housing choices, including academic levels and transportation needs (Fig. 5). These studies collectively highlight the opportunities and challenges HCMC faces in achieving sustainable urban development, particularly in meeting the diverse needs of its students. The literature reveals a comprehensive understanding of the factors influencing sustainable urban development in HCMC. However, significant gaps remain, especially concerning student housing. While current research outlines the broad impacts of urbanization, there is a need for more focused studies on the specific housing preferences, challenges, and opportunities the HCMC student population faces. This study aims to fill that gap, providing new insights that contribute to the academic discourse and inform policy and practice in sustainable urban development and student housing strategies in HCMC. By examining these aspects, the current research extends the narrative, providing a critical reference point for future studies on urban living and planning dynamics in rapidly developing cities.

Conceptual framework

Understanding needs is fundamental to various disciplines, including psychology, economics, and sociology. These needs, whether material or spiritual, are essential for human development and societal progress (Tang *et al.*, 2007). Housing, as defined by the Housing Law (2014), encompasses construction projects aimed at meeting the living needs of families or individuals (Khuong & Nguyen, 2017). Sustainable development, as articulated by Seo and Kwon (2017), involves meeting current needs without compromising future generations' ability to meet their own. Le (2024) outlines that sustainable urban development requires an integrated approach that balances economic, social, and environmental aspects, ensuring harmony between urban and rural areas (Phan *et al.*, 2010). In the context of education, the Higher Education Law (2012) defines students as individuals engaged in learning and research at higher education institutions. This legal framework is complemented by Resolution No. 06-NQ/TW, which underscores the importance of social security, welfare, and urban order, including provisions for free residence rights and the integration of rural migrants into urban areas (Bui, 2020). A study examining urbanization policies impacting sustainable development in Vietnam identified several criteria, including urban education levels, social infrastructure, and community participation in urban planning (Phung *et al.*, 2024; Thai *et al.*, 2022). Nguyen *et al.* (2024) further explore the student housing market in HCMC, analyzing various factors that influence student residential choices and preferences, such as academic levels and transportation use. Their findings offer valuable insights for policymakers on improving student housing, transportation, and

services in HCMC and other Southeast Asian cities with similar contexts. Addressing student housing needs from a planning and sustainable development perspective involves considering affordability, security, transportation, and access to amenities. By focusing on these aspects, urban planners and policymakers can develop housing solutions that cater specifically to students' needs, contributing to a more inclusive and sustainable urban environment. Overall, this literature review establishes the foundational understanding necessary to investigate the intricate dynamics of student housing within the broader context of sustainable urban development in HCMC. By filling the gaps identified in the current literature, this study aims to provide actionable insights that support the formulation of effective policies and strategies for sustainable urban growth in developing cities.

MATERIALS AND METHODS

This study employs a mixed-methods approach to comprehensively address the complex dynamics of sustainable urban development and student housing needs in HCMC. By integrating both qualitative and quantitative research methods, the study aims to provide a well-rounded understanding of the subject matter, offering valuable insights for policymakers, urban planners, and other stakeholders involved in the city's development.

Qualitative research approach

The qualitative component of the study focuses on secondary document analysis as the primary method. This approach involves an extensive review of various types of documents, including scholarly articles from scientific journals, books, government reports at multiple levels, and statistical data available from official websites. The objective of this comprehensive literature review is threefold:

• *Identification and analysis of Research Problems*: By reviewing existing studies, the research identifies significant gaps in knowledge related to urban development and student housing in HCMC. This process helps formulate relevant and timely research questions that guide the study.

• *Data compilation*: The review facilitates the collection and synthesis of existing theoretical and practical insights concerning urban development and housing needs. This provides a robust foundation for the study's empirical investigation.

• *Development of Theoretical and Methodological Frameworks*: Through the analysis of secondary sources, the study identifies and refines potential theoretical frameworks and methodological tools. These frameworks and tools are then adapted to effectively address the specific research questions posed by this study.

Quantitative research approach

Following the qualitative analysis, the study employs quantitative methods to gather empirical data that further elucidate the current state of student housing in HCMC.

• *Survey Methodology*: The quantitative component involves an online survey targeting first- and second-year students at the HCMUTE. The survey includes a mix of closed, open, and semi-open questions designed to capture a wide range of responses about student housing needs, preferences, and challenges.

• *Sample Size and Composition*: The survey was conducted with a sample size of 88 participants, chosen to ensure a representative cross-section of the student population. This sample size was carefully selected to reflect the diverse experiences and housing situations of students, providing a reliable basis for analyzing housing needs within the context of HCMC's urban development.

• *Data collection and analysis*: Data were collected through online questionnaires administered via Google Forms. The collected data were systematically compiled and analyzed to conclude the housing needs and preferences of students about HCMC's urban development and sustainability objectives. The analysis was designed to reveal patterns and insights that could inform sustainable housing policies and practices.

By integrating both qualitative and quantitative findings, the study provides a nuanced understanding of the housing needs of students in HCMC. This dual-methodology approach not only highlights the current housing situation but also contributes to the broader discourse on sustainable urban development, offering practical recommendations for enhancing urban social welfare in a rapidly growing city.

RESULTS AND DISCUSSION

HCMC, a major hub of economic, cultural, political,

and social activities in the Southern region of Vietnam, faces a growing demand for housing due to its rapid urbanization and increasing student population. The city's educational infrastructure, including numerous higher education and vocational institutions, attracts students from across the country, thereby escalating the dynamics of the housing market. Students, particularly those from distant provinces with limited financial means, encounter significant challenges in finding affordable and secure accommodation. The limited capacity of school dormitories forces many students to seek external rentals, which are often scarce and expensive due to high demand. Consequently, students face inflated rental prices, which puts additional financial strain on them and may adversely affect their academic performance and overall well-being.

Housing price and quality for students in HCMC

The research reveals that the majority of students in HCMC, who often rely on part-time jobs or family support, struggle to find affordable housing that meets their diverse needs, including proximity to educational institutions, security, cleanliness, and a quiet environment, all within a limited budget. A survey conducted with 88 students at the HCMC University of Technology and Education indicates that students primarily seek housing through social media (61.4%) and referrals (53.4%), with a significant number also utilizing the university's website (48.9%) (Table 1).

The scarcity of affordable housing options compels students to navigate a highly competitive market. Rental prices vary widely, reflecting the diverse accommodation needs of students and the broader workforce. This variability in housing prices is exacerbated by the city's rapid population growth, which increases by approximately 1 million every five years, further intensifying the demand for housing (Eco Green-Saigon, 2023). The data show a nearly even split between students opting for room rentals (51.1%) and those residing in university dormitories (48.9%). This distribution highlights the need for flexibility in housing options, as many students prefer external rentals for the convenience and privacy they offer. In terms of budget allocation, a substantial portion of students (44.3%) spend less than 1 million VND/month on housing, while others allocate up to 5 million VND/month, depending on their financial circumstances. The study found that room sharing is a common strategy, with 63.6% of students living with 2-4 roommates to manage costs. The HCMC University of Technology and Education offers two dormitory facilities with 313 rooms (Figs. 6 and 7), accommodating a combined total of over 2,416 students, even for international students (i.e., Lao students), with rental fees ranging from 290,000 to 390,000 VND/month (HCMUTE Dormitory Management Board, 2022a). These dormitories not only provide affordable housing but also foster a sense of community and support among students. The university's investment in these facilities, supported by government and societal resources, reflects a broader commitment to improving the quality of student life and aligning with sustainable urban development goals.

The burgeoning demand for student housing in HCMC, particularly in the context of rapid urbanization and infrastructure development in Thu Duc City (Fig. 8), highlights the need for innovative management models and investment in dormitory services. The emphasis on green, smart dormitory initiatives aligns with the city's sustainability goals, creating an ecosystem that supports the well-being and academic success of students. This dynamic landscape presents an opportunity for strategic partnerships and investments, underscoring the role of educational institutions in leading the way toward sustainable urban development.

Table 1: Channels for students to search for housing

No.	Channels for searching for housing	Quantity	Percentage (%)
1	Referred by a relative	47	53.4
2	Leaflets and advertising papers	16	18.2
3	Social networks (TikTok, Facebook, Instagram, etc.)	54	61.4
4	Housing rental applications	25	28.5
5	School website	43	48.9
6	Relatives' house, own house	4	4.44

Fig. 6: HCMUTE dormitory facility I (01 Vo Van Ngan Street)

Fig. 7: HCMUTE dormitory facility II (Le Van Viet Street)

Security and safety in urban housing: A focus on HCMC

In alignment with Resolution No. 06-NQ/TW issued on January 24, 2022, by the Politburo, Vietnam is focused on advancing urban development through improved security, safety, and overall urban order. This resolution emphasizes the importance of integrating digital technologies into urban management, enhancing environmental quality, and strengthening international cooperation to foster the development of green, sustainable, and smart cities. In HCMC, particularly within the rapidly growing area of Thu Duc City, the need for heightened security and safety in housing is especially critical. Thu Duc City, characterized by a diverse and dense population of immigrants, industrial workers, and university students, presents unique challenges in maintaining a safe living environment that meets the varied needs of its residents. For students, in particular, security is a vital consideration when selecting housing, as a secure environment directly impacts their ability to focus on their academic pursuits without the distraction of safety concerns. Recognizing the importance of this issue, the HCMUTE has implemented comprehensive dormitory regulations. These regulations, consisting of 16 articles, are designed to educate students on dormitory operations and outline the consequences of violating these rules. Such measures are essential for maintaining a secure housing environment, as evidenced by survey data indicating a significant level of student satisfaction regarding housing security and safety. A survey conducted to evaluate

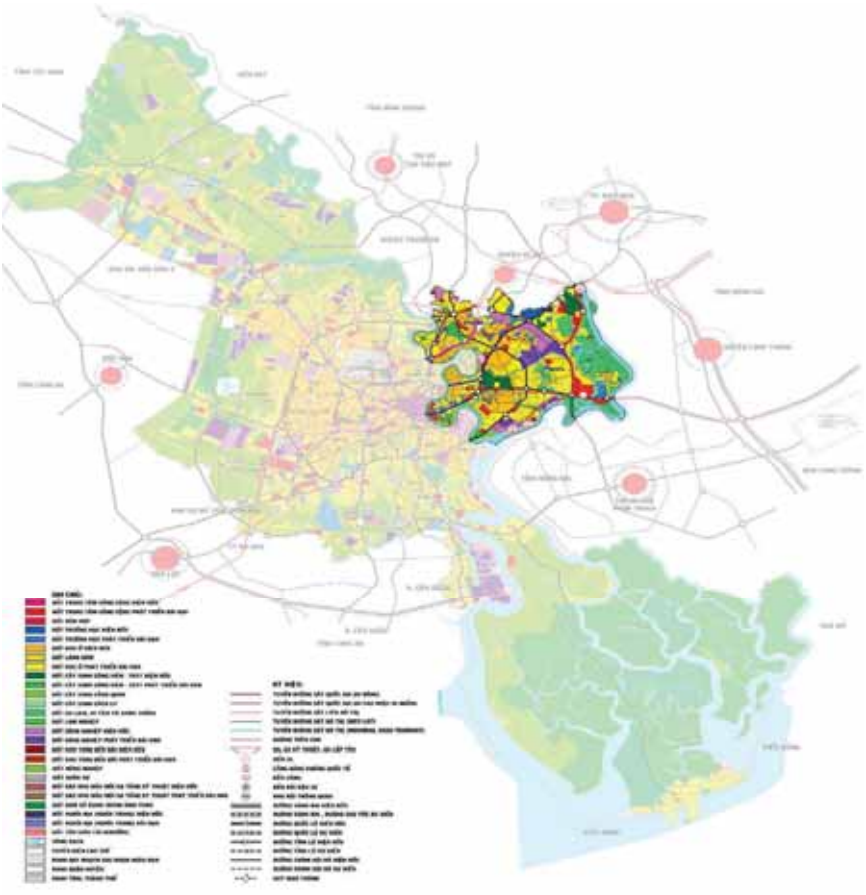


Fig. 8: Thu Duc City (People's Committee of Thu Duc City, 2022)

student satisfaction with the security and safety of their dormitory residences showed that 45.5% of students were satisfied with their housing's security and safety, 25% felt the security was average, 26.1% were delighted with their housing, and 3.4% were dissatisfied with the security and safety provided. While dormitories offer a managed and relatively secure living environment, external housing options often present a different set of challenges due to the lack of strict oversight characteristic of institutional accommodations. Despite this, many students are drawn to external rentals for their convenience and proximity to personal activities, which are often more accessible than dormitory-based living. Survey data further indicates varying levels of satisfaction with security and safety among students living outside university dormitories. Of those surveyed, 31.8% of students expressed satisfaction with the security and safety of their off-campus residences, 44.3% reported being very satisfied, and 14.8% were extremely satisfied. However, 5.7% of students chose not to express an opinion, and 3.4% indicated dissatisfaction with their current accommodation's security and safety. Although the overall satisfaction rate concerning security and safety in student housing is relatively high, the dissatisfaction expressed by a small segment of students suggests there are areas for improvement in urban planning and housing management strategies. These findings highlight that while significant progress has been made in ensuring the security and safety of urban housing in HCMC, especially for students, there is still a need for more effective management and enhancement of urban living conditions to fully meet the needs and expectations of all residents. Addressing these challenges requires a concerted

effort from educational institutions, such as the HCMUTE, working in conjunction with broader urban planning initiatives. By focusing on security and safety as integral components of sustainable urban development, these efforts can foster a safe, secure, and supportive living environment for students and all urban residents, ultimately contributing to the city's overall sustainability and quality of life.

Student transportation preferences and proximity to the university

Transportation significantly influences student accommodation choices, with many students prioritizing proximity to their educational institutions to minimize commuting time and effort. Our analysis shows a varied range of distances from the university among the student population: 47.7% live within a 500m to 2km radius, 18.2% reside less than 500m away, 11.4% are located 2km to 5km from the campus, and 22.7% live more than 5km away. This distribution reflects the diverse preferences and needs of students regarding their daily commutes. The traffic plan for Thu Duc City, projected until 2040 (Fig. 9), indicates that the People's Committee of Thu Duc City has strategically planned for the transportation needs of its residents, including the substantial student population within the university village. The placement of dormitories in strategic locations provides significant advantages, as they are situated near major public transportation routes and thoroughfares. This strategic positioning facilitates easier access for students to both the university and other parts of the city. The HCMUTE operates two primary dormitory facilities: one is immediately adjacent to the campus, while the other is located approximately 4km away. These dormitories are well-positioned to leverage the city's existing public transport networks, including bus routes 56, 141, and 61-1, enhancing the convenience and feasibility of daily commutes for students residing in these facilities. For students living in the dormitory closest to the campus or nearby rental accommodations (such as those on Hoang Dieu Street, Street No. 6, and Huu Nghi Street), walking is often the most viable and preferred mode of transportation due to the short distance to the university. This preference highlights the importance of proximity to educational institutions in reducing the need for mechanized transportation and fostering healthier, more sustainable commuting habits. For students living in the second dormitory facility or external rentals further from the university, motorcycles are a commonly chosen mode of transportation. This option is especially prevalent among students whose families can afford it, as motorcycles provide greater flexibility and time efficiency, particularly for those living outside the immediate reach of public transport routes or the university campus.

The transportation preferences observed among students at the Ho Chi Minh City University of Technology and Education underscore a strong inclination toward accommodations that are close to the university, emphasizing the critical role that location plays in student housing decisions. Public transportation and walking are favored for their convenience and alignment with sustainable living practices. However, motorcycles remain a popular choice for those residing farther from campus, offering a practical solution that balances the need for time efficiency with the limitations of public transit. This analysis highlights the importance of considering transportation accessibility in urban planning and university housing policies to adequately support the academic and everyday needs of students, ensuring that student housing strategies align with broader goals for sustainable urban development.

Environmental considerations and amenities in student housing

In the context of the HCMC University of Technology and Education, the provision of amenities within student dormitories underscores a significant commitment to ensuring a conducive living and learning environment. Facilities are designed to cater to the daily and academic needs of students, featuring private bathrooms, study desks, communal study rooms, and internet services tailored to accommodate the demands of academic pursuits. Furthermore, the university's efforts to create a holistic environment are evident in the provision of laundry services, canteens, sports areas, and bicycle parking, enhancing the quality of student life within the dormitory premises (HCMUTE Dormitory Management Board, 2022b). Each floor at the dormitory is equipped with cool, clean self-study rooms for students to work on assignments and pass subjects together, and Wi-Fi systems are installed according to each room's needs. Students can

Fig. 9: Thu Duc City's Transportation Plan up to 2040 (People's Committee of Thu Duc City, 2022)

subscribe to the VNPT network. An 8-person room can subscribe to a package for 300,000 VND/month, with a 6-month payment including two additional months free. The university has built a separate sports and exercise area for dormitory students to exercise, improve their health, and relax after school hours. Amenities include badminton courts, volleyball courts, and an integrated sports area. Our analysis indicates a strong preference among students for housing options close to the university, primarily due to the convenience it offers in terms of commuting and accessing campus facilities. The distribution of student accommodations reveals a pattern where a majority reside within a 2km radius of the university, highlighting the importance of location in housing choice. Additionally, the availability of public transport options and recreational amenities in nearby areas, such as sports fields and entertainment venues, significantly influences student housing decisions. Specifically, 70.9% chose their housing because it is close to the university, easy to commute to, and near dining and entertainment services and sports; 68.4% chose their housing due to good security and safety conditions; 62.0% chose their housing for the convenience of commuting with public transport and green infrastructure. In addition, students also choose their housing based on the surrounding environment being suitable mainly because it's a student living area, clean housing with many trees, and beautiful cafes (ranging from 41.8% to 44.3%). Choosing housing because of the complexity of nearby amenities like parks, shopping centers, and services helps reduce commuting and enhances social interaction among residents, which is also a choice for students (Table 2).

Choosing housing close to school helps students save time and transportation costs. This also facilitates students' participation in academic and social activities on campus. For students working part-time, living close to their workplace helps them limit travel time and energy, enhancing their ability to balance work and study. Living near shops, restaurants, and other amenities creates convenience in daily life. Students can easily shop, dine, and be entertained without needing to travel far. The housing needs of students are always a concern.

Table 2: Housing convenience linked to the environment and amenities

No.	Measuring housing convenience associated with environment and utilities	Quantity	Percentage (%)
1	Close to school, easy to move around, close to food, entertainment, and sports services	56	70.9
2	Security and safety conditions	54	68.4
3	Clean and hygienic conditions	33	41.8
4	There are many trees, beautiful cafes	34	43.0
5	Convenience for travel with public transportation and green infrastructure	49	62.0
6	The surrounding environment is suitable because it is mainly a student living area	35	44.3
7	Complex with nearby amenities such as housing - parks - shopping centers - services - helps minimize travel - enhances social interaction between residents	21	26.6
8	Free hours	38	48.1
9	Other reasons (living with parents, relative's house)	7	9.0

The HCMC University of Technology and Education is one of the largest universities in HCMC, with a student body of over 30,000. The demand for student housing is significant, especially for students from other provinces. However, besides the dormitories of facilities one and two, the housing supply in the surrounding area needs to meet the demand, leading to negative consequences such as increased living costs. As our analysis shows, 33% of students pay for housing at a price range from one to 3 million VND/month, 14.8% of students pay for housing at a range of 3-5 million VND/month, and 8% of students pay over 5 million VND/month for housing. This cost exceeds many students' financial capabilities, especially those in difficult circumstances. The surrounding environment and available amenities play a pivotal role in students' housing choices, affecting their well-being and academic engagement. Proximity to the university not only saves time and transportation costs but also facilitates participation in extracurricular activities, thereby enriching the student experience. Conversely, inadequate housing conditions, characterized by cramped living spaces and poor sanitation, can adversely affect students' health, leading to increased stress and diminished academic performance. The demand for student housing, particularly for those from other provinces, far exceeds the supply in the vicinity of HCMUTE, resulting in elevated living costs and compromised living conditions for many students. This mismatch between supply and demand highlights the need for strategic planning and investment in student housing to ensure affordability, safety, and convenience, aligning with the broader goals of sustainable urban development. Sustainable urban planning principles, including efficient water and energy management and the development of green infrastructure, offer a framework for addressing the challenges associated with student housing. Incorporating amenities such as water recycling systems, solar power, and energy-efficient appliances can reduce operational costs and environmental impact. Furthermore, enhancing public transport connectivity and creating green spaces not only improves the aesthetic appeal of urban areas but also supports the well-being of the student population. The analysis of environmental factors and amenities in student housing at HCMUTE reveals a complex interplay between student preferences, housing availability, and the impact of living conditions on student life. To address the challenges in meeting student housing demand and ensuring a sustainable living environment, a concerted effort from administrators, policymakers, and investors is required. Adhering to urban planning and development standards that prioritize green living, safety, and sustainability will be crucial in fostering a conducive academic and living environment for students.

Some recommendations

According to the resolution of the Politburo No. 06-NQ/TW dated January 24, 2022, on planning, construction, management, and sustainable development of urban Vietnam until 2030, vision towards 2045, the task group emphasizes enhancing the quality of planning and planning management to meet the needs of urban development, firstly by improving the quality of planning consultancy, appraisal, and approval of planning. The quality of architecture, urban planning, and construction planning needs to be harmoniously integrated from the research phase to the implementation of

urban planning, design, architectural management, and urban landscape, ensuring the city has a regional identity and sustainable development. Simultaneously, effectively building and implementing national projects and programs on urban development in Vietnam to respond to climate change, disaster prevention, and epidemics; renovating, rearranging, reconstructing, and upgrading urban areas; developing smart cities; and building new rural areas in line with urbanization orientation. Developing new urban models suitable for reality, focusing on urban development models oriented towards transportation (TOD). Researching and developing criteria for identifying and developing urban areas with prominent specific positions and functions such as for university development, innovation centers, border economy, industry, islands, ports, airports... and issuing appropriate development mechanisms and policies. From the perspective of urban planning and development, the housing needs and choices of students contribute to

(1) Promoting socio-economic development, creating a large demand for the real estate market. Real estate businesses will invest in student housing, creating many jobs and income for workers. Additionally, the housing needs of students also contribute to the development of related service industries, such as catering, entertainment, etc.

(2) Creating a conducive living and learning environment will enable students from different regions and ethnicities to study and develop. Living and studying together will give students opportunities to interact and learn from each other, facilitating integration into the community and contributing to improving the quality of the country's human resources.

(3) Providing employment and income for local people.

Addressing student housing needs in the context of sustainable urban planning and development requires a combination of specific measures like new housing construction and long-term urban planning policies to ensure that student housing needs are met sustainably and effectively. Therefore, we recommend the following solutions:

Develop specific housing areas for students: Establish housing areas dedicated to students near universities and colleges. This helps reduce pressure on the general housing market and creates a suitable living environment for students with the necessary amenities and services. Increase the construction of dormitory systems to provide quality housing for students, minimizing the situation where students cannot find accommodation and have to accept places of poor quality, not ensuring security and safety.

Develop social housing: Construct social housing projects for low-income groups, including students. This can be achieved through support from the government or non-profit organizations to provide affordable housing.

Encourage the development of student housing through incentives: Such as preferential tax rates, special credit, or financial support for investors building student housing. Enhance public transportation: Invest in public transport infrastructure to connect student housing areas with schools and other city amenities. This helps reduce traffic pressure and facilitates student commuting.

Encourage intelligent and energy-efficient housing: Construct housing with innovative designs, using energy-saving technologies and resource recycling to reduce students' environmental impact.

Promote sustainable urban planning policy. Ensure that sustainable urban planning schemes are applied, including identifying specific housing areas for students and environmental protection measures.

Organize advisory rooms and clubs to support students in finding accommodation: These rooms and clubs not only inform students about accommodation information and assist in registration but also promote essential skills to help students adapt to living independently.

Students: should proactively gather information, search, and carefully consider before choosing accommodation. Additionally, it's necessary to cultivate the skills and knowledge needed for independent living in a new environment. Authorities and relevant organizations should conduct reviews, inspections, and checks on security, compliance with electrical safety regulations, fire prevention and fighting, and construction permits for private rental houses.

CONCLUSION

The study provides a detailed analysis of the current state of student housing in HCMC, highlighting significant gaps in supply and demand and their implications for sustainable urban development. The findings underscore the importance of integrating student housing into broader urban planning efforts

to promote sustainability and social welfare. To address the student housing crisis effectively, it is essential to adopt a multi-faceted approach that includes increasing investment in affordable and sustainable housing, enhancing public transportation infrastructure, and developing innovative housing solutions that cater to the diverse needs of the student population. By doing so, HCMC can support the well-being and academic success of its students while advancing its sustainable urban development goals. Future research should explore the long-term impacts of student housing policies on urban sustainability and social welfare, as well as the potential for scaling successful models to other rapidly urbanizing cities in developing countries. By continuing to investigate these critical issues, researchers can provide valuable insights that inform policy and practice and contribute to the creation of more sustainable and inclusive urban environments.

AUTHOR CONTRIBUTIONS

N.V. Lai conducted the literature review, experimental design, analyzed and interpreted the data, prepared the manuscript text, and manuscript edition. P.T. Tran performed the experimental design, analyzed and interpreted the data, manuscript editing, and supervision. Both authors have read and approved the final manuscript.

ACKNOWLEDGEMENT

The authors extend heartfelt gratitude to the editors of *IJHCUM* for the opportunity provided. Additionally, sincere appreciation is conveyed to the anonymous reviewers for their invaluable feedback, which significantly improved the manuscript.

CONFLICT OF INTEREST

The authors declare no potential conflict of interest regarding the publication of this work. In addition, the ethical issues, including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, and redundancy have been completely witnessed by the authors.

ABBREVIATIONS (NOMENCLATURE)

HCMC	Ho Chi Minh City
HCMUTE	Ho Chi Minh City University of Technology and Education
HUB	Ho Chi Minh University of Banking
IUHCMC	Industrial University of Ho Chi Minh City
UEH	University of Economics Ho Chi Minh City
VND	Vietnamese Dong
VNPT	Vietnam Posts and Telecommunications Group
VNU-HCM	Vietnam National University - Ho Chi Minh City

REFERENCES

Atlas of Urban Expansion. (2016). *Ho Chi Minh City*. Atlas of Urban Expansion.

Ban Mai. (2023). Student housing model: great opportunity for investors. VnEconomy.

Bui, T. N. (2020). A study of factors influencing the price of apartments: evidence from Vietnam. *Management Science Letters.*, 10: 2287-2292 (**6 pages**).

Department of Planning and Architecture. (2020). *Ho Chi Minh City*

urban planning information. Ho Chi Minh City Government.
Eco Green-Saigon. (2023). *Update the latest room rental prices in Ho Chi Minh City in 2023*. Eco Green-Saigon.
Gillen, J. (2015). Bringing the countryside to the city: practices and imaginations of the rural in Ho Chi Minh City, Vietnam. *Urban Studies*, 53(2): 324-337 (**14 pages**).
Ha, T. H. (2023). President Ho Chi Minh's people's ideology and implications for civil advocacy in Ho Chi Minh City today. *Journal of Ethnic Studies.*, 12(1): 1-6 (**7 pages**).
HCMUTE Dormitory Management Board. (2022a). *HCMUTE's dormitory: general introduction*. Ho Chi Minh City University of Technology and Education.
HCMUTE Dormitory Management Board. (2022b). *HCMUTE's dormitory: sevices outside unit*. Ho Chi Minh City University of Technology and Education.
Hoang-Thi, P.-T.; Kung, S.-F.; Chang, H.-S. (2021). Factors impacting workers housing decisions in Ho Chi Minh City. *Asian Journal of Environment-Behaviour Studies.*, 6(20): 15-28 (**14 pages**).
Khuong, M. N.; Nguyen, P. C. (2017). Factors affecting tourist destination satisfaction and return intention – a study in Ho Chi Minh City, Vietnam. *Journal of Economics Business and Management.*, 5(2): 95-102 (**8 pages**).
Kien, V. D.; Minh, H. V.; Giang, K. B.; Dao, A.; Tuan, L. T.; Ng, N. (2016). Socioeconomic inequalities in catastrophic health expenditure and impoverishment associated with non-communicable diseases in urban Hanoi, Vietnam. *International Journal for Equity in Health.*, 15(1): 169 (**11 pages**).
Le, H. K. (2024). *Developing a sustainable national urban system in the period of industrialization and modernization of the country*. Vietnam Urban Planning and Development Association.
Mertes, C.; Schneider, A.; Sulla-Menashe, D.; Tatem, A. J.; Tan, B. (2015). Detecting change in urban areas at continental scales with MODIS data. *Remote Sensing of Environment*, 158: 331-347 (**17 pages**).
Minh Hiep. (2023). *Improve the quality of party development work among students*. Ho Chi Minh City Party Committee.
Ministry of Education and Training. (2022, Sep 30th). *Higher education statistics for the 2021 - 2022 school year*. Ministry of Education and Training.
Ngoc Thuy. (2023). *Student housing: open segment*. Bridge Invesment Magazine.
Nguyen-Tien, T.; Lundkvist, Å.; Lindahl, J. F. (2019). Urban transmission of mosquito-borne flaviviruses - a review of the risk for humans in Vietnam. *Infection Ecology & Epidemiology.*, 9(1): 1660129 (**10 pages**).
Nguyen, B.; Albrecht, J.; Vroman, S.; Westbrook, M. D. (2007). A quantile regression decomposition of urban–rural inequality in Vietnam. *Journal of Development Economics.*, 83(2): 466-490 (**35 pages**).
Nguyen, N. T.; Bui, H. T. H.; Cao, D. T. K. (2024). Residential zones of students around a university in Ho Chi Minh City: characteristics and preferences. *International Journal of Built Environment and Sustainability.*, 11(1): 49-58 (**10 pages**).
Nguyen, P. T.; Nguyen, Q. T. (2024). The philosophy of human emancipation in Ho Chi Minh's ideas and its contemporary relevance in Vietnam. *Kalagatos.*, 21(1): eK24009 (**15 pages**).
Law on higher education, (2012).
Housing law, (2014).
Nguyen, T. Q.; Nguyen, V. T.; Nguyen, T. P. (2023). Ho Chi Minh's thoughts on the education of the young Vietnamese generation today. *Perspektivy nauki i obrazovania.*, 62(2): 562-577 (**16 pages**).
People's Committee of Thu Duc City. (2022). *Thu Duc City - general planning until 2040*. People's Committee of Thu Duc City.
Phan, H. Y. T.; Yano, T.; Phan, H. A. T.; Nishimura, T.; Sato, T.; Hashimoto, Y. (2010). Community responses to road traffic noise in Hanoi and Ho Chi Minh City. *Applied Acoustics.*, 71(2): 107-114 (**8 pages**).
Phung, A. T.; Nguyen, Q. T.; Le, C. Q. (2024). Changing trends of the peasantry under the impact of the current rural urbanization process in Vietnam. *ISVS e-journal.*, 11(2): 39-47 (**9 pages**).
Primasari, L.; Ardhyanto, A. (2017). Commercial property development and heritage conservation in Ho Chi Minh City's district one. Prosiding Seminar Heritage IPLBI 2017.
Seo, D.; Kwon, Y.-S. (2017). In-Migration and housing choice in Ho Chi Minh City: toward sustainable housing development in Vietnam. *Sustainability.*, 9(10): 1738 (**17 pages**).
Tang, H.; Dibley, M. J.; Sibbritt, D.; Binh, P. N. T.; Trang, N. H. H. D.; Hanh, T. T. M. (2007). Overweight and obesity are rapidly emerging among adolescents in Ho Chi Minh City, Vietnam, 2002–2004. *International Journal of Pediatric Obesity.*, 2(4): 194-201 (**8 pages**).
Thai, T. T.; Duong, M.; Vo, D. K.; Dang, N. T. T.; Huynh, Q. N. H.; Tran, H. (2022). Cyber-victimization and its association with depression among Vietnamese adolescents. *Peerj.*, 10: e12907 (**16 pages**).
VNU-HCM. (2023). *Construction zoning project of Vietnam National University - Ho Chi Minh City*. Ministry of Construction.
VNU-HCM Dormitory Management Center. (2022). *Ho Chi Minh City National University dormitory will welcome 38,000 students in the new school year*. Vietnam National University - Ho Chi Minh City (VNU-HCM).
VNU-HCM Dormitory Management Center. (2024). *Dormitory Management Center: introduction*. VNU-HCM Dormitory Management Center.
Vo, P. L. (2007). Urbanization and water management in Ho Chi Minh City, Vietnam: issues, challenges and perspectives. *Geojournal.*, 70(1): 75-89 (**15 pages**).

HOW TO CITE THIS ARTICLE

Lai, N. V.; Tran, P. T., (2025). Integrating sustainable urban development and student housing to enhance urban social welfare (case study: Ho Chi Minh City). Int. J. Hum. Capital Urban Manage., 10(2): 329-344.

DOI: 10.22034/IJHCUM.2025.02.09

URL: https://www.ijhcum.net/article_717131.html

Int. J. Hum. Capital Urban Manage., 10(2): 345-360, Spring 2025

International Journal of Human Capital in Urban Management
(IJHCUM)

Homepage: http://www.ijhcum.net/

CASE STUDY

Evaluation and selection of hydro power plant location using the Analytical Hierarchy Process-TOPSIS method

N. Amani

Department of Civil Engineering, Chalous Branch, Islamic Azad University, Chalous, Iran

ARTICLE INFO

Article History:
Received 05 July 2024
Revised 08 August 2024
Accepted 11 October 2024

Keywords:
Environmental impact assessment
Hydropower plant siting
Cost analysis
Green energy production
Optimal location selection

ABSTRACT

BACKGROUND AND OBJECTIVES: The strategic choice of where to locate a hydropower plant affects both the facility's financial performance and the long-term sustainable growth of the surrounding area. This study aims to evaluate the accurate location planning of power plant establishment for electricity production in western Mazandaran.
METHODS: The Analytical Hierarchy Process is used to assess feasibility, identify the optimal location, and determine the most suitable type of green energy plant. Cost analysis is also conducted to identify the location minimizing energy consumption and associated risks. Finally, recommendations for the most suitable location are presented. Based on this, 6 cities located in the west of Mazandaran province have been selected as case studies. The research was conducted between 2020 and 2023. This research involved preparing a topographic map and using software to determine green locations for electricity production in western Mazandaran, based on a 15-year return period. A comparison is made between the electricity generation system from green energy and the electricity generation system from fossil sources. This comparison examines net production cost, sensitivity analysis, and environmental pollution for both green and fossil fuel systems. The feasibility and effectiveness of a green energy system are then evaluated based on geographical conditions and year-round electricity consumption profiles. Finally, using the Analytical Hierarchy Process hierarchical analysis results, we identify the most optimal location for equipment installation, considering economic efficiency, geographical conditions, and year-round electricity consumption.
FINDINGS: The findings reveal that downstream areas with a low slope are best suited for green and sustainable energy production due to their hydrological characteristics and potential for a sustainable supply chain. While eastern regions have high hydropower potential, construction costs are also high. The total cost for a green and sustainable power plant is 2.2 billion Tomans, while sustainable and uneconomical options cost 14 billion Tomans and 24.3 billion Tomans, respectively. Finally, to propose optimal locations for green and sustainable power plants, three precise coordinates for points A, B, and C have been identified.
CONCLUSION: This study identifies 40 potential locations for green and sustainable power plants, with additional locations identified for sustainable and non-economic options. Cost and time comparisons show significant advantages for green and sustainable plants. Three specific locations (A, B, and C) with precise coordinates are recommended for further development. This research concluded that eastern areas in the west of Mazandaran, particularly near rivers, are generally well-suited for constructing hydropower plants.

DOI: 10.22034/IJHCUM.2025.02.10

NUMBER OF REFERENCES	NUMBER OF FIGURES	NUMBER OF TABLES
48	12	5

*Corresponding Author:
Email: *nima.amani@iau.ac.ir*
Phone: +989112229484
ORCID: 0009-0009-5905-957X

Note: Discussion period for this manuscript open until July 1, 2025 on IJHCUM website at the "Show Article.

INTRODUCTION

Based on scientific predictions, energy consumption and production are expected to increase rapidly in the future (Amani *et al.*, 2021; Amani and Rezashoroush, 2020). The high use of electric air conditioners and coolers contributes to rising temperatures. This, in turn, led to intermittent power cuts for Iranian residents in the first half of the year, causing significant discomfort. On the other hand, the ever-increasing number of consumers due to the continuous construction of towns, private villas, apartments, and large buildings in the west of Mazandaran exacerbates this problem every year. The rate of government-funded power plant development simply cannot keep pace with the rapid growth of private constructions (Amani, 2024; Rao *et al.*, 2023). In the meantime, due to a lack of government budget allocation for developing the transmission network, the electricity company assigns the cost of preparing and implementing transformers, switchboards, and poles to the owners of these constructions in exchange for electricity concessions. These items are then paid for by the owners of the electricity company, just like any other consumer. While renewable energy offers very low operating costs compared to non-renewable fuels, its initial investment costs are significantly higher. In most cases, further studies are needed to optimize and reduce these upfront costs (Tahami *et al.*, 2016). Despite the obvious benefits and merits of renewable energy sources, their adoption has been slower due to the abundance and cheapness of fossil fuels. However, as mentioned, fossil fuels pose two significant challenges: they are a finite resource, and their use causes environmental pollution (Amani and Kiaee, 2020). Therefore, it's crucial to find solutions that minimize the costs of installing, commissioning, and operating renewable energy equipment while maximizing energy production. This optimization can be achieved by collecting and analyzing meteorological data specific to the equipment deployment location within a building site or town (Papp *et al.*, 2018). By doing this, we can ensure efficient electricity generation using renewable energy sources (Sasse and Trutnevyte, 2019; Singh *et al.*, 2024). This research compares the feasibility and optimal locations for green energy sources for electricity production in the west of Mazandaran (Fig. 1). Net production cost, sensitivity analysis, and environmental pollution are each analyzed in this comparison. The feasibility and effectiveness of the proposed green energy system are then evaluated by considering geographical conditions and electricity consumption profiles. Overall, we will examine the technical and economic feasibility and optimal location for a viable green energy system. A review of domestic and foreign studies on power plant development reveals a focus primarily on the economic and technical aspects of constructing and locating energy plants, particularly in northern Iran, which has high renewable energy potential. Notably, these studies haven't addressed the integration of renewable energy sources. Table 1 shows the closest research conducted in the study area. All valid research in the field of feasibility for building hydroelectric power plants in the northern regions of Iran and other regions of Iran and the world are reviewed in Table 1. The most important new gap in these studies is related to the lack of investigation into the optimal location considering the feasibility of power plant construction based on time-cost variables, the absence of evaluation and feasibility assessment of locations using topographic maps of the region, and the failure to choose the best location in terms of construction duration and total cost while considering sustainable development. The aim of the current study is a distinct innovation by addressing the feasibility and optimal location of renewable energy, along with an economic comparison to non-renewable options. This study was carried out in the West of Mazandaran, Iran in 2020-2023.

MATERIALS AND METHODS

This research employs a descriptive-analytical approach to determine suitable locations based on green energy parameters. Meteorological data from stations in western Mazandaran will be used to analyze relevant variables. As a case study, the research focuses on six cities in the region: Noor, Nowshehr, Chalous, Abbas Abad, Tonekabon, and Ramsar. Ultimately, the study seeks to identify the most suitable location for a clean energy power plant in the west of Mazandaran. The western region of Mazandaran, with its geographical location, weather conditions, and numerous rivers, possesses suitable water potential for electricity generation through hydroelectric power plants. Due to the Alborz mountain range and the Mazandaran Sea, the western part of Mazandaran Province features

Table 1: Research literature related to the research topic

References	Objective and Methods	Site location analysis	Financial Techincal analysis
Khazaei *et al.,* (2024)	Climate change is likely to significantly affect hydropower generation in the future. It was important to assess the impacts of climate change on hydropower plants for their optimal and cost-effective design. This article proposed a modeling framework for assessing climate change impacts on a potential hydropower plant in Iran.		✓
Carere *et al.,* (2022)	The paper examined the technical and economic feasibility of a fully renewable power system. By employing a proposed model and analyzing various scenarios, the study provided insights into the system's operational feasibility.		✓
Malhan and Mittal (2021)	To meet its goal of generating 6,000 megawatts of electricity from small and micro hydropower projects by 2022, the Indian government introduced the Small Hydro Power (SHP) scheme. To assess the feasibility of these projects, precise investment cost estimates were crucial in the initial planning stages.		✓
Basrei *et al.,* (2018)	This study investigates the financial impacts of expanding renewable energies on Iran's economic growth. It examines the existing relationship between non-renewable energies, economic growth, and their financial consequences. The analysis employs the autoregressive models with lags method.		✓
Shayamehr and Mohammadi (2018)	This study conducts an economic analysis of a 10-megawatt solar power plant in the Lamard Special Economic Zone using Comfar software. It will evaluate the desirability of the guaranteed electricity purchase rate, considering four different scenarios involving foreign and domestic investments in the zone.		✓
Katal and Fazelpour (2018)	This study seeks to evaluate and validate the suitability of Iran's current power plants using observational data and a Multi-Criteria Decision-Making Analysis approach.	✓	
Asadi *et al.,* (2016)	Examining the competitiveness of geothermal electricity compared to conventional methods of electricity production in Iran.		✓
Zema *et al.,* (2016)	A simple method was proposed to site turbines and choose their power output, evaluate costs and incomes, and provide useful indications for Micro Hydro Power (MHP) plant design in existing irrigation systems.	✓	✓
Rahi and Kumar (2016)	This paper proposed refurbishment and uprating for existing hydropower plants which had been drawing the attention of hydropower experts for quite some time. In the present research work, a case study was undertaken for economic analysis.		✓
Bitar *et al.,* (2015)	The study compared these alternatives based on two years of electricity production, considering construction, mechanical and electrical equipment, operation and maintenance, and investment costs. The most cost-effective and technically suitable option for the mini hydropower plant was determined through this analysis.		✓
Motahary *et al.,* (2014)	Economic evaluation of wind power plants with the "equalized cost" method as the most acceptable economic method to compare different types of electricity generation .technologies		✓
Leitao (2014)	This study conducts a comprehensive evaluation of the relationships between three key variables: carbon dioxide emissions, renewable energy consumption, and economic growth. The analysis will encompass data from several different countries.		✓
Bolourian *et al.,* (2013)	Comparing the total cost of renewable and non-renewable power plants.		✓
Banaei *et al.,* (2013)	Planning support policies for wind power plants taking into account Iran's economic conditions to provide a suitable support solution for the development of wind power.		✓
Saberi *et al.,* (2013)	Economic evaluation of the use of wind energy using the MIRR method from the perspective of stakeholders and private sector partners.		✓
Ocal and Aslan (2013)	This study investigates the potential link between renewable energy consumption and economic growth in Turkey. Specifically, it focuses on whether economic growth drives increased renewable energy consumption.		✓
Khati Dizabadi *et al.,* (2013)	The feasibility of using wind turbines and their process in comparison with other fossil fuel power plants and the numerical calculation of the different effects of the construction of wind and fossil power plants in their production cost.		✓
Lean and Smyth (2013)	An evaluation of the relationship between energy consumption and economic growth in Malaysia revealed that fossil fuels play a primary role in the country's long-term economic growth.		✓
Tuguu (2013)	This study evaluates the consumption of different energy sources, including both renewable and non-renewable options, and its impact on productivity growth in Turkey. The analysis will consider both long-term and short-term perspectives.		✓

Table 1: Research literature related to the research topic

References	Objective and Methods	Site location analysis	Financial Techincal analysis
Tajziehchi *et al.*, (2013)	This study aimed to quantify the hidden costs of electricity generation from large dams on communities and the environment. To achieve this, we analyzed the Alborz Dam in Iran using the SIMPACTS software.		✓
Jamali *et al.*, (2013)	This research explored how climate change affected hydropower production in Iran's Karkheh River Basin. By simulating different climate scenarios, the study assessed the potential changes in electricity generation from this major Middle Eastern river.	✓	
Pao and Fu (2013)	Evaluating the relationship between economic growth and consumption of renewable energy in Brazil.		✓
Yildirim *et al.* (2012)	This study evaluates how energy consumption in residential, commercial, and industrial buildings relates to the adoption of renewable energy sources.		✓
Al-Boye *et al.*, (2011)	An economic evaluation of the construction of different wind power plants in the world market to be used in the Moaleman region of Semnan province from an economic point of view.		✓
Menegaki (2011)	An evaluation of the relationship between economic growth and renewable energy in 27 European countries from 1997 to 2007 found that renewable energy consumption had a limited impact on gross domestic product (GDP) in Europe during that period.		✓
Esso (2010)	A long-term assessment of energy consumption and economic growth in sub-Saharan African countries revealed significant relationships between the variables.		✓
Kovacevic and Wesseler (2010)	Comparison of Three Energy Production Methods: A Private Cost Analysis.		✓
Neij (2008)	Production evaluation of different energies with statistical technique from the perspective of investors.		✓
Hosseini and Farozbakhsh (2004)	Economic analysis of the construction of wind power plants.		✓
Roth and Ambs (2004)	Comparing 14 different technologies using the equalized cost method, the results showed that adding the cost of external effects increases the freedom of choice.		✓
Khalji and Safai (2003)	Investigating the wind power plants installed in Iran from a technical and economic point of view using the calculation of the present value of the price of electricity produced from wind, heat, and gas power plants, and considering the social cost of three important environmental pollutants, along with the fact that wind power plants are more affordable than conventional power plants under similar conditions.		✓
El-Kordy *et al.*, (2002)	Analysis of the useful life of electric power generation using the LCC model in Egypt.		✓
Tahvonen and Salo (2001)	This study applies the Benchmark growth model to analyze the transition from non-renewable to renewable energy sources in Finland across different economic development levels. It explores the rationale behind a hybrid energy system that utilizes both renewable and non-renewable resources.		✓

rivers with favorable discharge, slopes, and multiple branches (Enayati *et al.*, 2013). These rivers exhibit slopes exceeding 30% in mountainous areas above 500 meters in elevation. Mazandaran Province boasts 140 rivers with 60 main streams, predominantly located in the western region with steeper gradients. In terms of annual rainfall, this region significantly surpasses other parts of the country, receiving 1400 mm compared to 700 mm in eastern Mazandaran, thereby providing ideal conditions for the optimal location of a hydroelectric power plant (RWCM, 2020). Based on the location, discharge, and catchment area of the rivers in western Mazandaran, the target area for this research was selected. This region encompasses six main cities, all of which were included in the study. Data collection employed a mixed-methods approach, combining library and field methods. Field data includes interviews with experts and statistical surveys of experts from the Renewable Energy and Energy Efficiency Organization and Regional Water Companies in Iran. Library resources include topographic maps (slope, rivers,

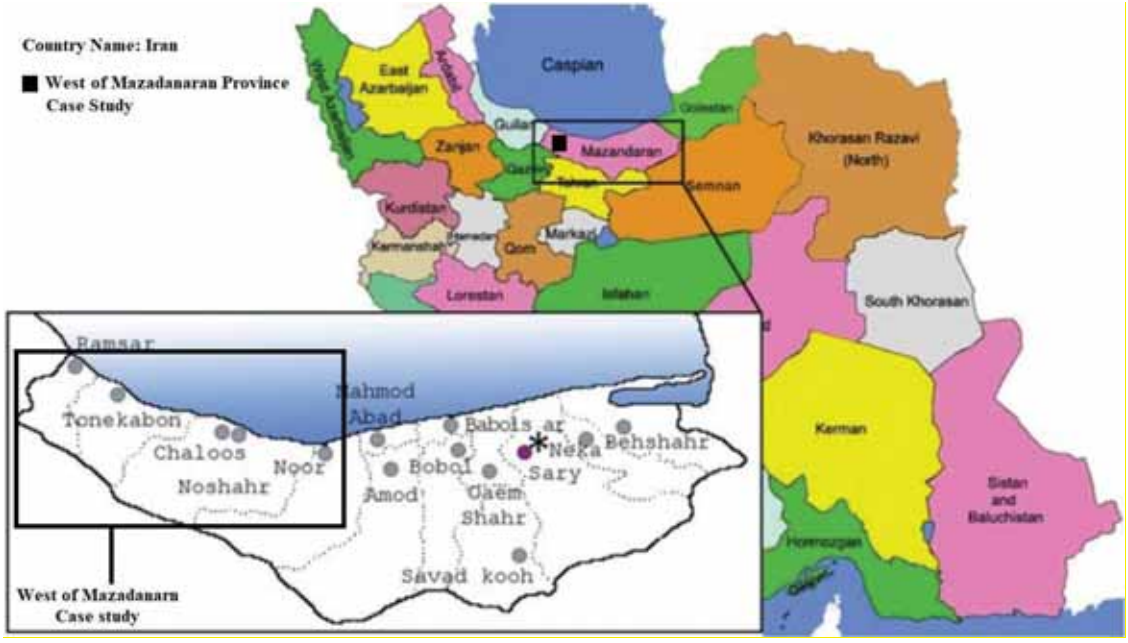


Fig. 1: Geographical location of the study area in the west of Mazandaran, Iran

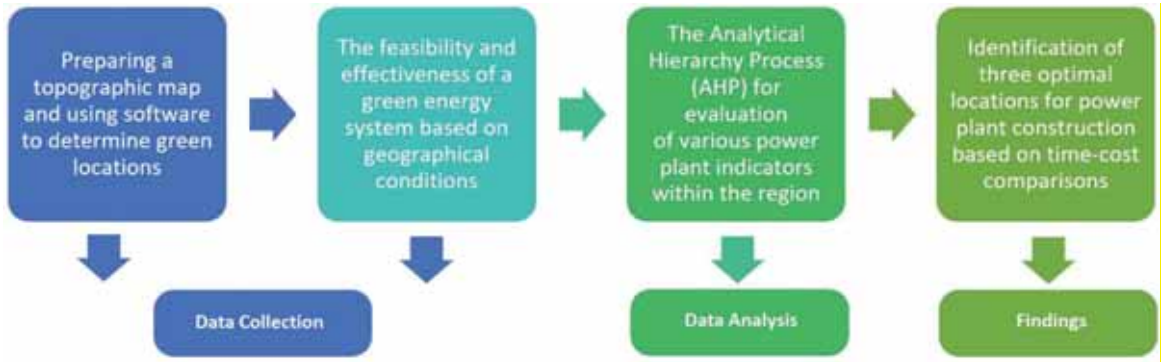


Fig. 2: Research framework

land use position, geological classification, maximum daily precipitation, runoff production of rainfall, and flood risk) and weather data of the study area. This research utilized a topographic map and software to identify potential green energy production sites in the west of Mazandaran, Iran. The analysis considered a 15-year return period. Subsequently, the AHP method was employed to evaluate various power plant indicators within the region. The steps of the research are illustrated in Fig. 2.

Additionally, a cost approach was used to identify the optimal location that minimizes energy consumption and associated risks. Recommendations for the most suitable location are presented. Fig. 3 displays information about the mountainous and plain areas in the west of Mazandaran, along with rainfall data. Slope basin characteristics and potential discharge from other areas are crucial data points for further analysis in this research (Alizadeh, 2015; Zahedi and Bayati Khatibi, 2020). To assess slope, vegetation, and land use within the study area, 1:50,000 topographic maps were obtained from the

geographic organization of Mazandaran province (Fig. 4).

Fig. 5 illustrates the maximum rainfall for six studied stations across 5, 10, and 15-year return periods. The data was recovered and optimized using the IDW model with minimal software errors (Kahruditali, 2014).

Fig. 5 illustrates that maximum annual precipitation occurs in the northwestern and northeastern portions of western Mazandaran, while

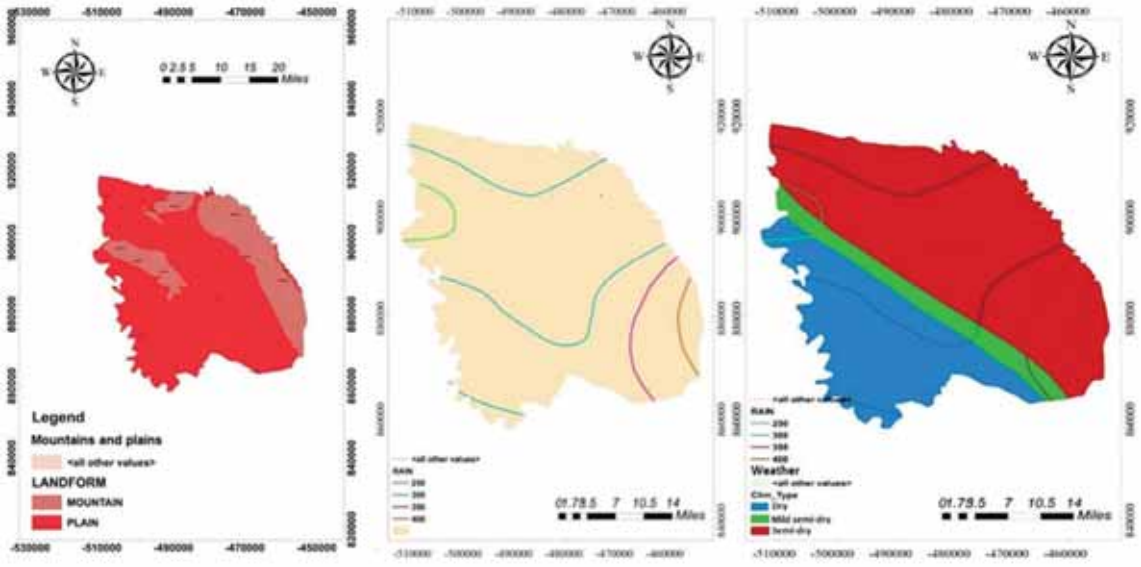


Fig. *3*: Zoning regulations in mountainous and plain areas: weather conditions and precipitation compared to neighboring cities

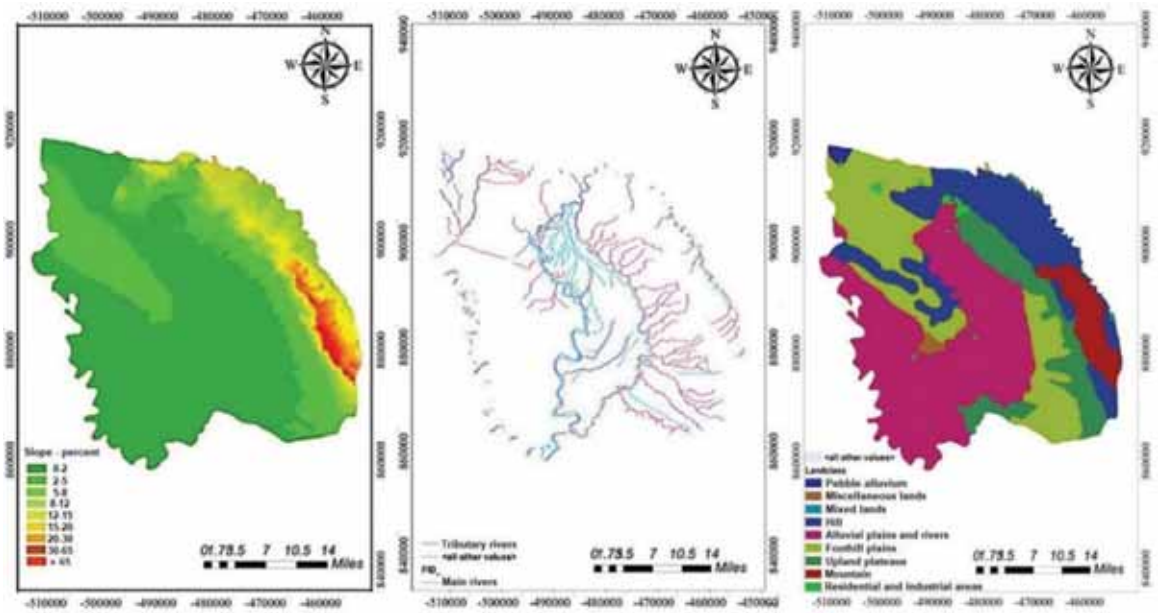


Fig. *4*: Slope map, rivers, land use position, and geological classification of western Mazandaran

the southern half experiences minimum rainfall. To calculate runoff in this region, the following formula is employed, where Q represents runoff amount, S represents water infiltration amount, and P represents precipitation amount. All values are calculated in millimeters (Mahdavi, 2014).

$$Q = \frac{(P-.2S)}{P+.8S} \quad (1)$$

Fig. 6 confirms the earlier observation of higher runoff coinciding with the eastern areas of the basin, which also receive the highest rainfall. Notably, the maps reveal that the northern upstream areas in the eastern part of western Mazandaran belong to hydrological group D due to specific vegetation characteristics. This group D classification translates to the highest runoff generation (Mahdavi, 2014).

The AHP method is employed to assess the feasibility and identify the optimal location for a power plant in the west of Mazandaran province, along with the most suitable type of plant. AHP provides a robust model for evaluating and ranking various data sets, making it ideal for selecting the best option among available choices. This study utilizes data and information extracted from topographic maps. All relevant criteria are analyzed, compared, and

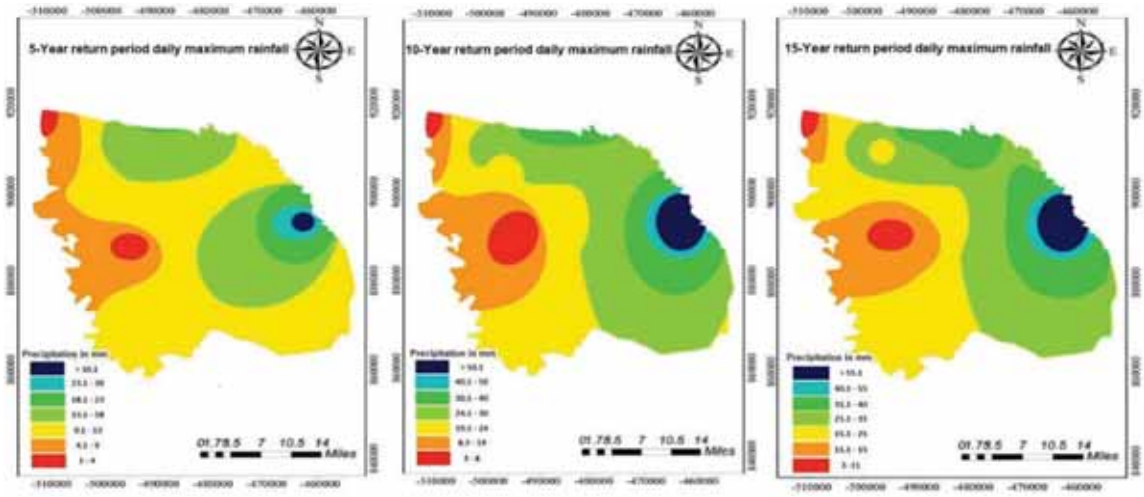


Fig. 5: Map of maximum daily precipitation in western Mazandaran for various return periods

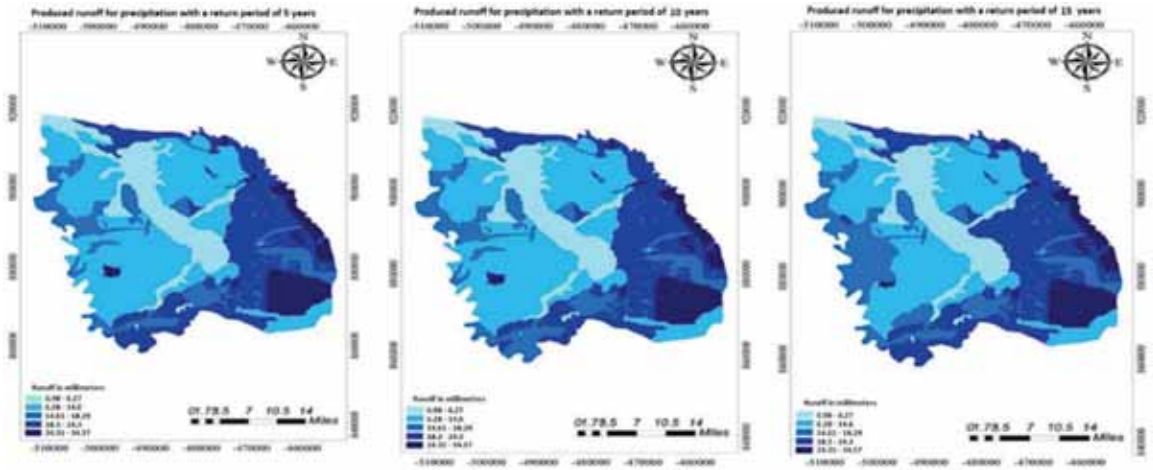


Fig.6: Map of runoff production of rainfall in different periods

ranked within a software environment. Following the weighting of data, the criteria are then classified and presented to relevant experts for scoring and ranking potential locations. Experts evaluate the spatial data using a Likert scale ranging from 0 (lowest impact) to 5 (highest impact). To determine the optimal location, information layers are calculated based on a specific formula and compared with each other. This analysis generates a map highlighting points with the greatest potential for green and sustainable energy production (Mahdavi, 2014). Fig. 7 presents a 15-year flood potential map for three return periods: 5, 10, and 15 years. The map is generated using the previously mentioned formula. The analysis reveals that flood-prone areas are concentrated in the eastern region of western Mazandaran, which coincides with the areas of the highest slope (Figs. 5 and 6). Additionally, these regions are dominated by forests, pastures, specific plains, green hills, and floodplain vegetation. These characteristics contribute to increased flood risk. In contrast, the downstream or southern areas of the western province exhibit the lowest flood potential according to the map. This aligns with their classification as hydrological group type A, indicating minimal runoff.

RESULTS AND DISCUSSION

Optimal and green siting for power plant development through information layer integration

To locate the production of power plants, it is necessary to combine the layers of slope, river, precipitation, production runoff, permeability, vegetation cover, wind speed, solar energy, and availability of facilities. Before combining, it is necessary to determine the weight of each layer. Table 2 presents a pairwise comparison of the layers conducted on an hourly scale. The final weight of each layer is provided in the last column. These pairwise comparisons were performed by 10 experts with over 25 years of experience in the field of power

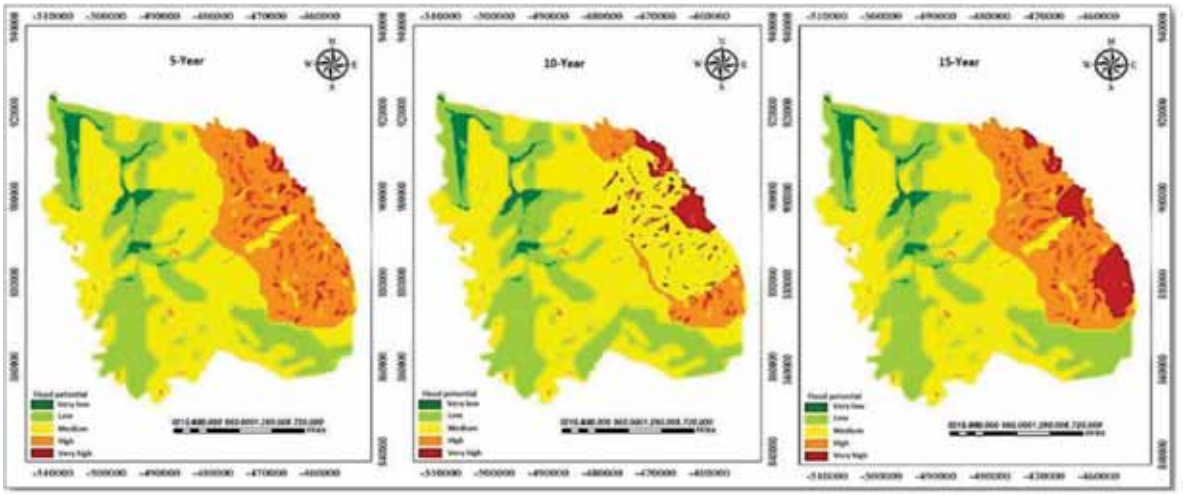


Fig. 7: Flood risk map and location of layers

Table 2: Pairwise comparison of layers

Criterion	Slope	River	Rain	Production runoff	Permeability	Vegetation	Wind blow	Solar energy	Weight
Slope	1	1.9	1	1	3	3	3	2	0.1139
River	9	1	7	5	7	5	1.2	1.2	0.5961
Rain	1	1.7	1	1	3	3	1.2	1	0.1174
Production runoff	1	1.5	1.3	1	3	3	1.4	1.2	0.1083
Permeability	1.3	1.7	1.3	1.3	1	1	1.3	1.4	0.0485
Vegetation	1.3	1.5	1.3	1.3	1	1	1.3	1.2	0.0541
wind blow	1.3	2	2	4	3	3	1	1.3	0.0092
Weight	1.2	2	1	2	4	2	3	1	0.0054

plants and clean energy production. The comparison was based on data from Figs. 3 to 7, and utilized the Likert scale within the Delphi technique.

Since the inconsistency rate of paired comparison is low at 0.096 (less than 0.1), there is no need to revise judgments. To combine the layers, we multiply the weights of each layer and then average them. This method is illustrated in Fig. 8. The results indicate that eastern regions are generally suitable for electricity production, especially near rivers. However, in the western regions, particularly the western part of Mazandaran province, building a power plant would be less affordable due to high costs (Fig. 8).

The next step is to identify isomorphic points. Based on 4 types of characteristics of resistance, ease of carrying materials, low cost, and efficiency, the points are then combined with the nearest neighbor algorithm. The theory of experts, based on geographical data in Fig. 9, determined the coefficients specified. Table 3 shows the coefficients

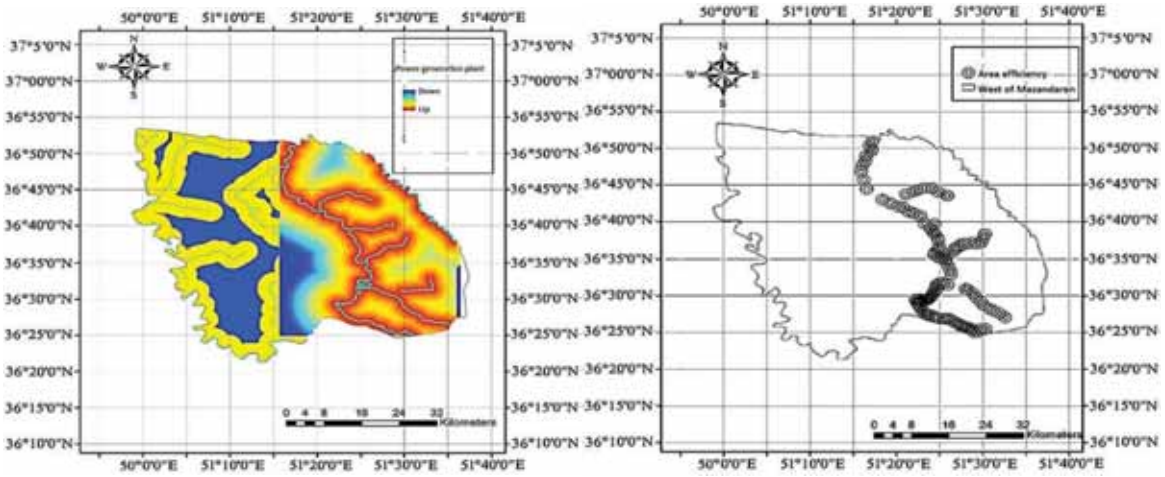


Fig. **8**: Combining the layers to determine the optimal location for the establishment of a power plant in the west of Mazandaran; Identification of power plant points based on the efficiency of the area in 100 points

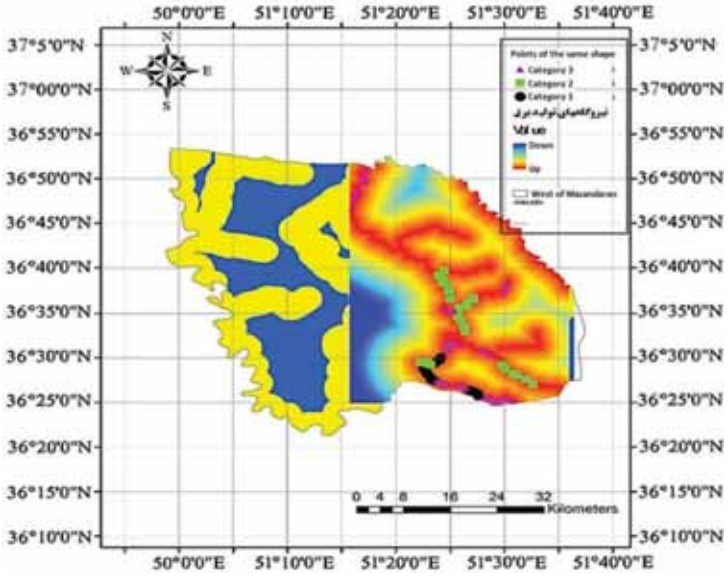


Fig. **9**: Identifying similar points

comparison of features and isomorphic points based on data of Figs. 8 and 9.

The characteristics of isomorphic points of category 1 are very high resistance, very low material requirements, low cost, and high efficiency, making them ideally suited for high-consumption power generation plants. Category 2 points exhibit high resistance, require moderate materials, have a moderate cost, and offer relatively high efficiency, making them compatible with sustainable power generation plants. Finally, category 3 points have low resistance, very easy material requirements, very low cost, and high efficiency, aligning well with green and sustainable power plants. Based on these comparisons and using the nearest neighbor algorithm, we have estimated the locations for non-economic, sustainable, and green & sustainable power plants (blue, wind, and solar). The results are shown in Fig. 10. In the northeastern, central-eastern, and southeastern regions, we identified 40, 30, and 20 points, respectively, suitable for green & sustainable power plants. Their latitude and longitude coordinates are listed in Table 4 based on data from Fig. 10.

Field investigation of proposed locations for the construction of power plants (hydro, wind, and solar)

In the final stage, we examined the cost and profitability of each of the three proposed power plants (hydro, wind, and solar). Based on the results of the previous section, the most suitable option is the green and sustainable electricity generation plant (third category). Considering the region's hydropower potential, three experts from the Renewable Energy and Energy Efficiency Organization estimated the design, construction, implementation, and operation costs in billions of Tomans. We will aggregate these results using averaging in the next stage. The results are shown in Table 5.

The results show that the total cost for the green

Table 3: Comparison of similar points

Number of power plants	Resistance	Ease of carrying materials	Low cost	Performance
Points of the same shape (Category 3)	2	5	5	3
Points of the same shape (Category 2)	4	3	3	4
Points of the same shape (Category 1)	5	2	2	4

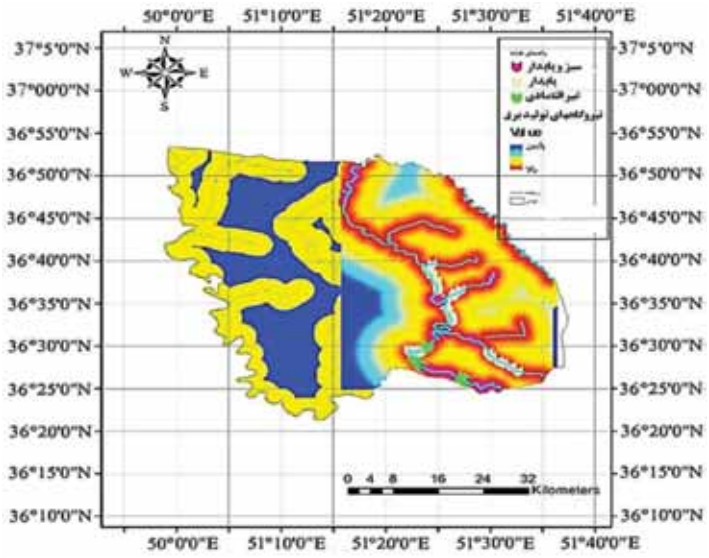


Fig. **10**: Determining the points of green and sustainable power plants, sustainable power plants, and non-economic power plants

Table 4: Longitude and latitude coordinates of power plants in three green and sustainable, sustainable and non-economic conditions

Green and sustainable power plants			Sustainable power plants			Non-economic power plants		
No.	Latitude	Longitude	No.	Latitude	Longitude	No.	Latitude	Longitude
1	36.534919	51.921874	1	36.525974	51.914652	1	36.510695	51.917441
2	36.534772	51.921701	2	36.526112	51.914995	2	36.507384	51.923364
3	36.534528	51.921635	3	36.528078	51.915767	3	36.511902	51.914995
4	36.534095	51.921745	4	36.524043	51.912678	4	-	-
5	36.533851	51.921721	5	36.522939	51.911991	5	-	-
6	36.533741	51.921686	6	-	-	6	-	-
7	36.609193	51.561344	7	-	-	7	36.583492	51.514158
8	36.608228	51.558984	8	-	-	8	36.579081	51.512699
9	36.606988	51.556194	9	-	-	9	36.576944	51.508923
10	**36.606342**	**51.556516**	10	-	-	10	36.573387	51.379635
11	36.605756	51.557396	11	36.602512	51.517549	11	36.569045	51.376374
12	36.604172	51.558490	12	36.599549	51.516991	12	36.564839	51.375215
13	36.614540	51.516924	13	36.597172	51.516690	13	36.560083	51.373627
14	36.613455	51.516157	14	36.594519	51.516433	14	36.556946	51.371009
15	**36.612454**	**51.515406**	15	36.590970	51.517291	15	36.736591	50.771148
16	36.611224	51.514394	16	36.620522	51.392905	16	36.730882	50.752437
17	36.610363	51.514158	17	36.617836	51.391103	17	36.731553	50.735443
18	36.609338	51.514351	18	36.615778	51.388829	18	36.798287	50.692009
19	36.643080	51.411134	19	36.612472	51.388615	19	36.796913	50.687932
20	36.640290	51.410447	20	36.611059	51.386984	20	36.792823	50.684799
21	36.639077	51.409900	21	36.767768	50.813816	-	-	-
22	36.638224	51.409675	22	36.759930	50.815875	-	-	-
23	36.636761	51.409567	23	36.754566	50.809524	-	-	-
24	36.633335	51.408998	24	36.749126	50.796254	-	-	-
25	36.631415	51.408226	25	36.745619	50.786941	-	-	-
26	**36.630425,**	**51.404600**	26	36.815777	50.712694	-	-	-
27	36.629400	51.403248	27	36.814093	50.709175	-	-	-
28	36.626899	51.399729	28	36.812650	50.705527	-	-	-
29	36.833124	50.794589	29	36.810176	50.704240	-	-	-
30	36.821654	50.798366	30	36.807703	50.702738	-	-	-
31	36.814371	50.801799	-	-	-	-	-	-
32	36.806675	50.804546	-	-	-	-	-	-
33	36.794991	50.808837	-	-	-	-	-	-
34	36.781793	50.813301	-	-	-	-	-	-
35	36.843579	50.749387	-	-	-	-	-	-
36	36.839458	50.745696	-	-	-	-	-	-
37	36.833481	50.736684	-	-	-	-	-	-
38	36.828810	50.733079	-	-	-	-	-	-
39	36.823176	50.727328	-	-	-	-	-	-
40	36.818882	50.720762	-	-	-	-	-	-

Table 5: Costs of design, implementation, and operation of all types of power plants based on billions of Tomans (1 $ = **46000** Tomans)

Power Plant	Design and Construction			Implementation			Operation			Year		
	Expert 1	Expert 2	Expert 3	Expert 1	Expert 2	Expert 3	Expert 1	Expert 2	Expert 3	Expert 1	Expert 2	Expert 3
Green and Sustainable	1	2	1.5	1.2	1	1.3	0.5	0.5	0.4	1.5	1	1
Sustainable	4.5	4	4	5	4	5	5	6	5	3	2.5	3
Non-economic	6	5.5	6.5	10	9	9.5	10	8	8.5	3	4.5	4

Final Results	Design and Construction	Implementation	Operation	Year
Green and Sustainable	1.5	1.16	0.4	1.1
Sustainable	4.1	4.6	5.3	2.8
Non-economic	6	9.5	8.8	3.8

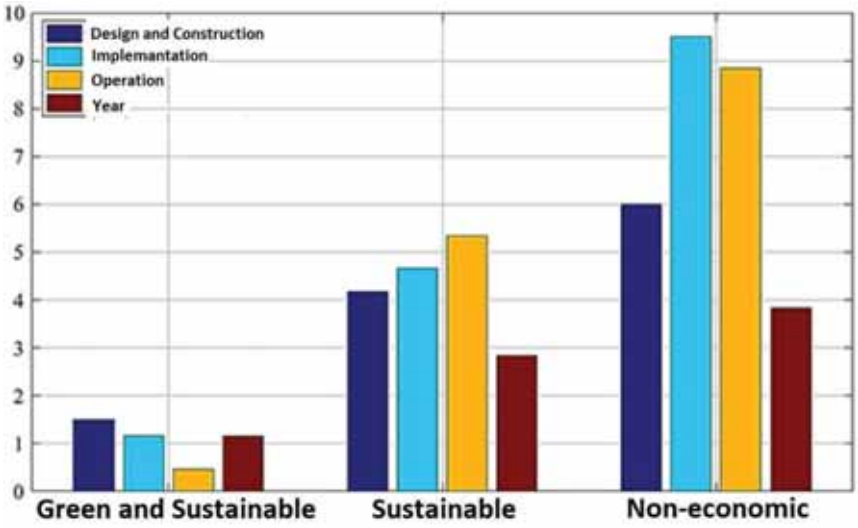


Fig. 11: Cost and time values for power plants

and sustainable power plant is 2.2 billion Tomans, while the sustainable and non-economic options cost 14 billion and 24.3 billion Tomans, respectively. Similarly, the green and sustainable power plant has a construction time of 1.1 years, compared to 2.8 years and 3.8 years for sustainable and non-economic options, respectively. Fig. 11 presents a chart comparing the costs and timelines for these power plants. The colors represent different stages: deep blue for design and construction, light blue for implementation, yellow for operation, and crimson for the required time (years). The chart shows the breakdown for green (most sustainable), sustainable, and non-economic power plants.

In conclusion, considering the region's potential and based on expert opinions, hydropower has proven to be the most suitable option among hydro, wind, and solar power plants. Fig. 12 shows the recommended and optimal locations for hydropower plants to produce green and sustainable electricity. These 3 points include their specific geographical coordinates. Point A is located in the Nour region, point B in the Nowshahr region, and point C in the Chalous region.

CONCLUSION

Based on the analysis done in this study, the conclusions are as follows:

No.	Latitude	Longitude
A	36.606342	51.556516
B	36.612454	51.515406
C	36.630425,	51.404600

Fig. 12: Location coordinates of optimal power plants (green and sustainable) for the field visit

1) Analysis of flood potential maps indicates the highest risk in eastern areas of western Mazandaran province;

2) Downstream areas have a low slope (less than 5 degrees) and are classified as hydrological group A with low runoff. While this can contribute to flooding, it also makes these areas well-suited for green and sustainable energy production plants, facilitating a sustainable supply chain;

3) Eastern regions are generally suitable for electricity production, especially near rivers. However, building power plants in the west of Mazandaran is less affordable due to high costs;

4) Identified Locations: 40 potential locations for green and sustainable power plants (hydro, wind, and solar) in the northeastern, central-eastern, and southeastern regions. An additional 30 sustainable power plants and 20 non-economic power plants are in these areas.

5) Cost and Time Comparison:

• 2.2 billion tomatoes for green and sustainable plants.

• 14 billion tomatoes for sustainable plants.

• 24.3 billion Tomans for non-economic plants.

Construction timelines are also shorter for green and sustainable plants (1.1 years) compared to sustainable (2.8 years) and non-economic options (3.8 years).

6) Recommended Locations: To recommend optimal locations for green and sustainable power plants, three points (A, B, and C) with precise coordinates have been identified.

AUTHOR CONTRIBUTIONS

N. Amani: Conceptualization, Methodology, Visualization, Investigation, Validation, Supervision, Writing - review & editing, Data curation, Software, Validation,Writing – original draft.

ACKNOWLEDGEMENT

This study was done at the Department of Civil Engineering, Islamic Azad University, Chalous Branch, as a research project.

CONFLICT OF INTEREST

The author declares that there is no conflict of interest regarding the publication of this manuscript.

In addition, the ethical issues, including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, and redundancy have been completely observed by the authors.

OPEN ACCESS

PUBLISHER NOTE

ABBREVIATIONS

AHP	Analytical Hierarchy Process
$	US Dollar
GDP	Gross Domestic Product
HPP	Hydro Power Plant
IDW	Inverse Distance Weighted
P	Precipitation Amount
Q	Runoff Amount
S	Water Infiltration Amount

REFERENCES

Al-Boye, M.; Salamati, A.; Kipour, R., (2011). Economic evaluation of wind power plant construction. 1th Conference on New Approaches in Energy Conservation, Tehran. (In Persian)

Alizadeh, A., (2015). Principles of Applied Hydrology. 40th edition, Imam Reza International University Press, Mashhad, Iran. (In Persian)

Amani, N., (2024). Sustainable construction of green school building using energy simulation analysis and modeling. Hybrid Adv., 6(100236): 1-12 **(12 pages).**

Amani, N.; Kiaee, E., (2020). Developing a two-criteria framework to rank thermal insulation materials in nearly zero energy buildings using multi-objective optimization approach. J. Cleaner Prod., 276: 122592, 1-13 **(13 Pages).**

Amani, N.; Reza Soroush, A.A.; Moghadas Mashhad, M.; Safarzadeh, K., (2021). Energy analysis for construction of a zero-energy residential building using thermal simulation in Iran. Int. J. Energy Sect. Manage., 15(5): 895-913 **(19 pages).**

Amani, N.; Reza Soroush, A., (2020). Effective energy consumption parameters in residential buildings using Building Information Modeling. Global J. Environ. Sci. Manage., 6(4): 467-480 **(14 pages).**

Asadi, F.; Karim, M. H.; Feshari, M., (2016). The Competitiveness of geothermal power compared to conventional methods of electricity generation in Iran. Iran. Energy Econ., 5(18): 1-27 **(27 Pages).** (In Persian)

Banaei, M.; Yektai, N.; Olomi Baygi, M.; Ebadi, J., (2013). Planning support policies for wind power plants considering Iran's economic conditions. 1st Iran Wind Energy Conference, Tehran. (In Persian)

Basrei, B.; Abbasi, I.; Kayani, G., (2018). Financial effects of expanding renewable energies on economic growth in Iran. Financ. Econ., 13 (46): 161-182 **(22 Pages).** (In Persian)

Bitar, Z.; Khamis, I.; Alsaka, Z.; Al Jabi, S., (2015). Pre-feasibility study for construction of mini hydro power plant. Energy Procedia, 74: 404-413 **(10 Pages).**

Bolourian, A.H.; Seyed Hosseini, S.M.; Jalali Majidi, M., (2013). Evaluation of the economic aspects of geothermal energy in comparison with wind energy and other renewable energies for the construction of a power plant. 1th National Conference on New and Clean Energy Management, Hamadan. (In Persian)

Carere, F.; Gatta, F.M.; Geri, A.; Lauria, S.; Maccioni, M.; Nati, L., (2022). Technical/economic feasibility of the adequacy of a fully renewable power system: The case study of the Sardinia island. Sustainable Energy Grids Networks., 31: 100726.

El-Kordy, M.N.; Badr, M.A.; Abed, K.A.; Ibrahim, S.M.A., (2002). Economical evaluation of electricity generation considering externalities. Revnewable Energy, 25: 317-327 **(10 Pages).**

Enayati, A.A.; Moradi Qahdrijani, S.H.; Afzali, H.; Kazemnejad, S.M., (2013). Technical and economic evaluation of the construction and operation of a small hydro power plant in the west of Mazandaran. 5th Conference of Power Plants, Ahvaz. (In Persian)

Esso, J.L., (2010). The energy consumption-growth nexus on seven Sub-Sahara African countries. Econ. Bull., 30: 1191-1209 **(19 Pages).**

Hosseini, S.M.H.; Farozbakhsh, F., (2004). Economic analysis of

the construction of wind power plants. 19th International Electricity Conference. (In Persian)

Jamali, S.; Abrishamchi, A.; Madani, K., (2013). Climate change and hydropower planning in the Middle East: implications for Iran's Karkheh hydropower systems. J. Energy Eng., 139(3): 153-160 **(8 Pages).**

Katal, F.; Fazelpour, F., (2018). Multi-criteria evaluation and priority analysis of different types of existing power plants in Iran: An optimized energy planning system. Renewable Energy, 120: 163-177 **(15 Pages).**

Khalji Asadi, M.; Safai, B., (2003). Investigating wind power plants installed in Iran from a technical and economic point of view. 18th International Electricity Conference, Tehran. (In Persian)

Khati Dizabadi, A.; Barmaki Kurdkalai, J.; Mohammadi, M., (2013). Feasibility assessment of using wind turbines and its process compared to other fossil fuel power plants. National Conference on Reforming Production and Consumption Patterns, Kerman. (In Persian)

Khazaei, M.R.; Heidari, M.; Shahid, S.; Hasirchian, M., (2024). Consideration of climate change impacts on a hydropower scheme in Iran. Theor. Appl. Climatol., 155(4): 3119-3132 **(14 Pages).**

Kovacevic, V.; Wesseler, J., (2010). Cost-Effectiveness Analysis of Algae Energy Production in the EU. Energy Policy., 38: 5749-5755 **(7 Pages).**

Lean, H.H.; Smyth, R., (2014). Disaggregated energy demand by fuel type and economic growth in Malaysia. Appl. Energy., 132: 168-177 **(10 Pages).**

Leitao, N.C. (2014). Economic growth, carbon dioxide emissions, renewable energy and globalization. Int. J. Energy Econ., Policy., 4: 391-299 **(9 Pages).**

Mahdavi, M.J., (2014). Applied Hydrology. 5th edition, Tehran University Press, Tehran, Iran.

Malhan, P.; Mittal, M., (2021). Evaluation of different statistical techniques for developing cost correlations of micro hydro power plants. Sustainable Energy Technol. Assess., 43: 100904, 1-9 **(9 Pages).**

Motahary, S.A.; Ahmadian, M.; Abedi, Z.; Ghafarzadeh, H.R.G., (2014). Economic Evaluation of Wind Power Development in Iran Considering the Effect of Energy Price Liberalization Policy. Iran. Energy Econ., 3(10): 179-200 **(22 Pages).** (In Persian)

Menegaki, A.N. (2011). Growth and renewable energy in Europe: a random effect model with evidence for neutrality hypothesis. Energy Econ., 33: 257–263 **(7 Pages).**

Menyah, K.; Wolde-Rufael, Y., (2010). CO2 emissions, nuclear energy, renewable energy and economic growth in the US. Energy Policy., 38: 2911–2915 **(5 Pages).**

Neij, L., (2008). Cost development of future technologies for power generation – a study based on experience curves and complementary bottom-up assessment. Energy Policy., 36: 2200–2209 **(10 pages).**

Ocal, O.; Aslan, A., (2013). Renewable energy consumption–economic growth nexus in Turkey. Renewable Sustainable Energy Rev., 28: 494-499 **(6 Pages).**

Pao, H.T.; Fu, H.C., (2013). The causal relationship between energy resources and economic growth in Brazil. Energy Policy., 61: 793-801 **(11 Pages).**

Papp, G.; Benedek, J.; Varga, P.; Kis, M.; Koppán, A.; Meurers, B.; Leonhardt, R.; Baracza, M.K., (2018). Feasibility study applied to mapping tidal effects in the Pannonian basin–An effort to check location dependencies at μGal level. Geod. Geodyn., 9(3): 237-245 **(9 Pages).**

Rahi, O.P.; Kumar, A., (2016). Economic analysis for refurbishment and uprating of hydro power plants. Renewable Energy., 86: 1197-1204 **(8 Pages).**

Rao, C.K.; Sahoo, S.K.; Yanine, F.F., (2023). A literature review on an IoT-based intelligent smart energy management systems for PV power generation. Hybrid Adv., 5: 100136, 1-18 **(18 Pages).**

Roth, I.F.; Ambs, L.L., (2004). Incorporating externalities into a full cost approach to electric power generation life-cycle costing. Energy., 29(12-15): 2125-2144 **(19 Pages).**

RWCM., (2020). Regional Water Company of Mazandaran, Statistical Information of Mazandaran Province.

Saberi, A.; Saberi, H.; Saberi, B., (2013). Economic evaluation of wind energy use using the MIRR method from the perspective of shareholders and private sector partners, 1th Iran Wind Energy Conference, Tehran. (In Persian)

https://civilica.com/doc/ 201678

Sasse, J.P.; Trutnevyte, E., (2019). Distributional trade-offs between regionally equitable and cost-efficient allocation of renewable electricity generation. Appl. Energy., 254: 113724, 1-9 **(9 Pages).**

Shayamehr, S.; Mohammadi, F., (2018). Economic analysis of a 10 megawatt solar power plant using Comfar software and checking the desirability of guaranteed electricity purchase rates - a case study of Lamard Special Economic Zone. National Conference of New Sciences and Technologies in Water, Energy and Environment, Tehran. (In Persian)

Singh, R.; Dogra, S.; Dixit, S.; Vatin, N.I.; Bhardwaj, R.; Sundramoorthy, A.K.; Perera, H.C.S.; Patole, S.P.; Mishra, R.K.; Arya, S., (2024). Advancements in thermoelectric materials for efficient waste heat recovery and renewable energy generation. Hybrid Adv., 100176, 1-20 **(20 Pages).**

Tahami Pour, M.; Abedi, S.; Karimi Baba Ahmadi, R.; Ebrahimi Zadeh, M., (2016). The Investigation of renewable energy effects on Iranian per capita real economic growth. Iran. Energy Econ., 5(19), 53-77 **(25 Pages).** (In Persian)

Tahvonen, O.; Salo, S., (2001). Economic growth and transitions between renewable and nonrenewable energy resources. Eur. Econ. Rev., 45: 1379-1398 **(19 Pages).**

Tajziehchi, S.; Monavari, S.M.; Karbassi, A.R.; Shariat, S.M.; Khorasani, N., (2013). Quantification of social impacts of large hydropower dams-a case study of Alborz Dam in Mazandaran province, northern Iran. Int. J. Environ. Res., 7(2): 377-382 **(6 Pages).** (In Persian)

Tugcu, C.T., 2013. Disaggregate Energy Consumption and Total Factor Productivity: A Cointegration and Causality Analysis for the Turkish Economy. Int. J. Energy Econ. Policy., 3: 307-314 **(8 Pages).**

Yildirim, E.; Sarac, S.; Aslan, A., (2012). Energy consumption and economic growth in the USA: Evidence from renewable energy. Renewable Sustainable Energy Rev., 16: 6770-6774 **(5 Pages).**

Zahedi, M.; Bayati Khatibi, M., (2020). Hydrology. 6th edition, Samt Press, Tehran, Iran.

Zema, D.A.; Nicotra, A.; Tamburino, V.; Zimbone, S.M., (2016). A simple method to evaluate the technical and economic feasibility of micro hydro power plants in existing irrigation systems. Renewable Energy., 85: 498-506 **(9 Pages).**

HOW TO CITE THIS ARTICLE

Amani, N., (2025). Evaluation and selection of hydro power plant location using the Analytical Hierarchy Process-TOPSIS method. Int. J. Hum. Capital Urban Manage., 10(2): 345-360.

DOI: 10.22034/IJHCUM.2025.02.10

URL: https://www.ijhcum.net/article_716509.html

Int. J. Hum. Capital Urban Manage., 10(2): 361-370, Spring 2025

International Journal of Human Capital in Urban Management
(IJHCUM)

Homepage: http://www.ijhcum.net/

CASE STUDY

The impact of organizational work-family culture on the family supportive supervisor behavior

I. Kavindi[1], S. Thewahettige[1], A. Dissanayake[2], R. Weerarathna[1,*], C. Kuruppu[1], N. Jayasuriya[1], K. Chandeepani[1], S. Liyanage[1]

[1] *SLIIT Business School, Sri Lanka Institute of Information Technology, Malabe, Sri Lanka*

[2] *Marketing, Strategy & Entrepreneurship Department, University Canada West, British Columbia, Canada*

ARTICLE INFO

Article History:
Received 21 June 2024
Revised 12 November 2024
Accepted 31 December 2024

Keywords:
Family supportive supervisor behavior
Human resources
Managerial support
Organizational time demand
Organizational work-family culture

DOI: 10.22034/IJHCUM.2025.02.11

ABSTRACT

BACKGROUND AND OBJECTIVES: Supervisory activities and interactions with employees affect employee performance. Moreover, every organization tries to enhance the supervisor's supportive behavior in the work environment. Consequently, the main aim of this study is "to determine the impact of organizational work-family culture on the family-supportive supervisor behavior of employees in Sri Lanka's footwear industry". Based on a thorough review of existing literature and industry challenges, the study identifies organizational work-family culture as the independent variable and family-supportive supervisory behavior as the dependent variable.

METHODS: The study sampled 377 employees from a population of 20,000 footwear workers in Sri Lanka. Adopting a positivist research philosophy, the study grounded in existing knowledge, is set to achieve its aims and framework. A quantitative research approach was employed for both data collection and analysis, utilizing deductive methods to systematically investigate the research objectives. A survey research study was conducted and the data were gathered from respondents within a defined cross-sectional period, ensuring a broad representation of the target population.

FINDINGS: The study found that the supportive supervisory behavior of employees in Sri Lanka's footwear sector was influenced by organizational family culture as 52% of the Organizational Work-Family Culture of employees working in the Sri Lankan footwear industry.

CONCLUSION: It can be concluded that if the organization has a better working environment, the supervisors in the working environment help their employees manage their family responsibilities over work responsibilities. Thus, companies should create an employee recognition program, accept, and use employee feedback, and be flexible to improve supervisors' family-supportive behavior.

NUMBER OF REFERENCES	NUMBER OF FIGURES	NUMBER OF TABLES
30	1	4

*Corresponding Author:
Email: *ranitha.w@sliit.lk*
Phone: +94718395248
ORCID: 0000-0002-3871-1241

Note: Discussion period for this manuscript open until July 1, 2025 on IJHCUM website at the "Show Article.

INTRODUCTION

Organizations globally are competing to retain and satisfy employees, acknowledging that human resources are their most valuable assets. Employee satisfaction boosts organizational productivity and performance (Bartlett & Ghoshal, 2002). However, recent studies show that the majority of employees struggle to manage work-related stress caused by a variety of factors, such as excessive workload, unrealistic employee expectations, inefficiencies and laziness of coworkers, work-life imbalance, employer disagreements, lack of support from supervisors, and working environment issues (Ferrara, 2018). Among these, supervisory behavior and the work environment emerge as pivotal in managing employee stress and encouraging retention. Therefore, most Human Resource (HR) executives are debating the Family Supportive Supervisor Behavior (FSSB) concept. FSSB refers to supervisors' activities demonstrating concern and support for their employees or subordinates' families (Hammer *et al.*, 2009). Especially, it has been identified that family-friendly bosses understand their employees' needs and strive to balance work and family life. Thus, supervisors who implement family-friendly actions can influence the level of mental contentment and performance of the employees who are under their supervision (Walsh *et al*., 2019). It can, therefore, be inferred that managing supervisor behavior effectively can serve as a strategic HR approach for organizations to enhance employee satisfaction and improve overall performance. Even though FSSB is a preferred approach for employee satisfaction and improving employee performance, most organizations face problems in this regard due to lousy supervisor and employee interactions (Haas, 2020). Most supervisors lack the necessary knowledge and training to become supportive of their workers' personal and professional lives (Leitão *et al*., 2019). Furthermore, many supervisors achieve organizational goals by rewarding or punishing employees (Mansaray, 2019), and some try to violate employees' privacy, which exacerbates work-life conflicts (Van Dyne *et al.*, 2003). The work environment has become stressful for many employees due to the heavy workload, unsupportive managers and coworkers, rigid work schedules, and tight deadlines (Tamunomiebi & Mezeh, 2021). It has been further revealed that most employees are dissatisfied with their pay scale, promotion procedure, and career development support from the organization (Parvin & Kabir, 2012). Past researchers suggested that there should be more studies on FSSB in different specific cultural and contextual factors of occupations (Bouleh *et al*., 2022). This has been endorsed by Rahim *et. al.,* (2022), reflecting the need for more studies in Organizational Work-Family Culture (OWFC). Similarly, there is increasing scholarly attention to some social trends, such as the changing nature of work and work-life issues (Powell *et al*., 2019). Nevertheless, a research gap exists in implementing FSSB strategies within industries, including Sri Lanka's footwear sector. Many studies have revealed a lack of comprehensive investigation of the relationship between OWFC and FSSB across diverse cultural and occupational contexts and further reveal an empirical gap. Thus, existing literature focuses on general organizational environments, with limited attention to specific industries such as the Sri Lankan footwear industry. The current study focuses on the Sri Lankan footwear industry, a sector with substantial economic and employment significance, where supervisory support is critical to managing employees effectively. The Sri Lankan footwear industry is projected to earn United States Dollars ($) 59.86 million in 2023. Meanwhile, recent data reveals that in 2013, the footwear, luggage, and handbags sector employed approximately 13.8 thousand women and 8.1 thousand men (Ganbold, 2021). It was further discovered that the footwear industry's whole manufacturing process was focused on technology and staff output capability (Fernando *et al*., 2005). Thus, it demonstrates that employees are the most influential factor in the footwear industry, and supervisor support is needed to manage employees' activities. As the footwear industry is ready for long-term growth, it confirms the need for organizations to retain skilled employees as well. Hence, the purpose of this study is to determine the impact of OWFC on FSSB in Sri Lanka's footwear industry, providing insights into how organizational culture shapes supervisory practices. The paper is organized into five sections. First, discusses the literature review, highlighting key concepts and their interrelations. Second, outlines the methodology employed in the study, detailing the research design and data collection methods. What follows, presents the results and discussion, offering an in-depth analysis of the findings. Finally, concludes

with practical implications, recommendations, and directions for future research, emphasizing the relevance of OWFC in encouraging FSSB and improving employee outcomes.

Literature review

Family-supportive supervisor behavior

Employees may leave their jobs, become dissatisfied, and get into other situations (Hammer *et al.*, 2006, 2009). FSSB is founded on the idea that supervisors may enable staff to fulfill their family and professional obligations more successfully by modeling family-supportive behaviors. This FSSB concept mainly focuses on the employee's family role and how to deal with both work and family roles. (Hammer *et al*., 2009). A family support supervisor can balance employees' work and family responsibilities and communicate with an employee about an employee's desires. (Pan, 2018). This study identified positive consequences of family-supportive supervisor conduct, including increased job satisfaction, improved task performance, and less work-family conflict (Kailasapathy & Jayakody, 2018). FSSB is characterized as proactive management that assists staff members in juggling their work and family responsibilities (Alshutwi, 2018). Due to its favorable effects on employees' work-life balance and professional outcomes, FSSB has gained much attention as an informal supervisor assistant (Hammer *et al*., 2013; Matthews *et al.*, 2014).

OWFC

The importance of work-family culture cannot be overstated for any of the people working for the organization. It is significant for people who work there and their family members and other loved ones (Bernhardt & Bünning, 2022). Most recent studies aimed to determine how an unsupportive organization's working culture may have contributed to a lower overall level of satisfaction with one's ability to maintain a healthy work- life balance (Bernhardt & Bünning, 2022; Mauno *et al*., 2005; Zeng *et al*., 2020). In the previous research, the primary focus was on the behavior of family-supportive supervisors and the role of family-supportive organizational culture among the workers at a financial credit company. Family-friendly organizational culture moderates the relationship between the family-friendly behavior of supervisors and employees' level of job engagement (Rofcanin *et al.*, 2017). Furthermore, managerial characteristics were considered one aspect of the organizational consequences. As a result, it was established that management characteristics affect the family-friendly behavior of supervisors (Straub, 2012). One of the latest studies showed how family work conflicts and organizational work-family cultures affect the supportive behaviors of supervisors toward families. The findings showed that if the work-family culture of the organization is at a higher level, then the work-family conflicts experienced by the supervisors do not have a detrimental effect on the subordinates. In addition, it has been ascertained that an OWFC affects the FSSB. It is possible to conclude that previous research indicated a connection between OWFC and FSSB (Pan *et al*., 2021). Furthermore, the same study aimed to determine the causal relationship between family-supportive behavior and organizational climate. In another study, study findings suggested that the organization's work-family atmosphere significantly impacted the behavior of family-supportive supervisors in IT companies (Han & McLean, 2020). Recently, much discussion has been about how companies, as employers, should help employees with their family obligations. A family-supportive supervisor boosts company performance and benefits both the supervisor and the employees. Thus, a similar study examined whether supervisors' views on employee family responsibility affect employees' intrinsic motivation and the desire to leave their jobs. Prior research reveals that supervisors support employees with family duties increased intrinsic motivation. Most workers also state that family-friendly management makes them less likely to depart. In other words, the organization should have a strong family culture to achieve this goal through increased management support. Hence, it was derived that a solid family culture in an organization enhanced the FSSB (Marescaux *et al*., 2020). The above-mentioned study was carried out to create a model for measuring FSSB. Consequently, the element known as work-family management was addressed, which explained that a friendly workplace with flexible supervision and coworkers would boost the FSSB (Hammer *et al*., 2009). Hence, most preceding studies found a favorable association between OWFC and FSSB. Accordingly, the study's first hypothesis was developed as follows and can be shown in Fig. 1 as a conceptual framework.

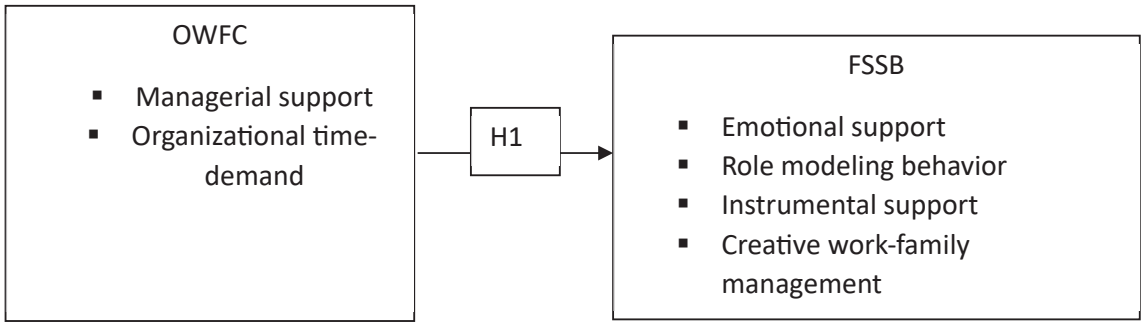


Fig. 1: Conceptual framework (source: developed by authors (2023))

*Hypothesis 1: A positive relationship exists between the organizational work-family culture and their FSSB***.**

MATERIALS AND METHODS

Survey design and data collection

This study adopted a quantitative research design guided by the philosophy of positivism, as it aligns with the objective nature of quantitative studies. A deductive approach was employed, leveraging prior research, theories, and models to verify and support the results. The research was conducted as a cross-sectional study, with data collected at a single point in time over a brief timeframe. The target population for this study consisted of 20,000 employees currently working in the Sri Lankan footwear manufacturing industry. Using a simple random sampling technique, a sample of 377 employees was selected to ensure unbiased representation. A total of 377 questionnaires were distributed, and all were returned completed, achieving a 100% response rate. Primary data were collected through printed questionnaires designed specifically for the study. The collected data were analyzed using the Statistical Package for Social Sciences (SPSS) software. Descriptive statistics were used to summarize the data, while correlation and regression analyses were performed to examine relationships among variables and test hypotheses.

Measures

Organizational work-family culture

This study was used to build measurements about OWFC (Thompson *et al*., 1999). Ten (10) items were used to measure the construct anchored on a five-point Likert scale as in the original scale. In this study, two dimensions were used under OWFC: managerial support and organizational time demand. Sample items include: *"My supervisors care about my career development"* (Managerial support*), "I am always able to attend the work on time and leave on time"* (Organizational time demand).

Family-supportive supervisor behavior

This study was used to build measurements about FSSB (Hammer *et al*., 2009). Fourteen (14) items were used to measure the construct anchored on a five-point Likert scale as in the original scale. This study used four dimensions under OWFC: Emotional support, Role-modeling behavior, Instrumental support, and Creative work-family management. Sample items include: *"My supervisor is willing to listen to my problems in juggling work and nonwork life"* (Emotional support), *"My supervisor is a good role model for work and nonwork"* (Role modeling behavior), *"I can depend on my supervisor to help me with scheduling conflicts if I need it"* (Instrumental support), "*My supervisor thinks about how the work in my department can be organized to jointly benefit employees and the company"* (Creative work-family management).

RESULTS AND DISCUSSION

Demographic analysis

According to the study findings, the first question about the age of the employees revealed that 82.2% of workers are between the ages of 21 and 30, while 10.3% are between the ages of 31 and 40. Furthermore, 6.6% of respondents are between the ages of 41 and 50. Furthermore, the remaining study sections stated they are at least 51 years old.

Table 1: Reliability analysis

Variable	Cronbach's Alpha value	Number of questions
Organization's work-family culture	.854	10
Family supportive supervisors' behavior	.711	14

Table 2: Results of the validity test

Variable	KMO value	Number of questions
OWFC	.753	10
FSSB	.523	14

Table 3: Model summary

R-value	R Square value	Adjusted R Square value
.718[a]	.515	.514

As such, it is fair to assume that most employees who participated in the survey were still in their twenties. Furthermore, the study gender analysis (Second question) revealed that 32.6% of workers are male, while 67.4% are female. As a result, it is reasonable to conclude that most employees who took part in the survey were female. Furthermore, the third question was focused on the marital status of employees, and the study found that 50.9% of workers are single, while 49.1% are married. Therefore, it is fair to assume that most study participants were single employees. According to the fourth question analysis, only 40.6% of employees' spouses work, while 59.4% are unemployed. In addition, 59.4% of single employees claimed their spouses are unemployed. As a result, one can reasonably conclude that the vast majority of employees' partners who participated in the research are unemployed. Furthermore, the study collected information about employees' children and revealed that only 41.9% of married workers had children, while 58.1% did not have children.

Reliability analysis

Reliability analysis was used to calculate the internal consistency of variables such as OWFC and FSSB. The Cronbach's alpha value was employed to determine internal consistency, and 0.7 was the threshold value as per Table 1. Accordingly, the study result shows that OWFC-related Cronbach's alpha value is 0.854, which means that a group of test questions about OWFC is closely linked. Moreover, a group of test questions about the OWFC is closely linked. Further, the FSSB of the organization was assessed with 14 questions, and the reliability value was indicated as 0. 711. Hence, it can be concluded that the internal consistency of the supervisors' family-supportive behaviors in the organization is acceptable.

Validity analysis

The accuracy of responses was determined using the validity result, and in SPSS, the Kaiser-Meyer-Olkin measures of sample adequacy values were utilized. As a result, the Kaiser-Meyer-Olkin (KMO) test for work-family culture has a high internal validity of 0.753. Furthermore, the FSSB-related KMO value is 0.523, indicating those supervisors' responses to family-supportive behaviors have acceptable internal validity. The results of the validity test are shown in Table 2.

Regression analysis

The study's model summary table revealed the impact of the independent variable, OWFC on the dependent variable, FSSB. The obtained results of the linear regression analysis are shown in Table 3. Given that the R-squared value of the fitted regression model is 0.515, which indicates that the predicted values fit approximately 52% of the actual values, it was determined to be a satisfactory fit.

Therefore, 52% of OWFC employees working in the Sri Lankan footwear industry can be illustrated by FSSB.

The Analysis of Variance (ANOVA) table, derived

Table 4: ANOVA Table

	Sum of squares	Mean Square	F-ratio	Sig value
Regression	22.168	22.168	398.224	.000[a]
Residual	20.876	.056		
Total	43.044			

Table 5: Coefficient table

	Coefficient (unstandardized)		Coefficient (standardized)	T value	Sig value
	Beta	Standard error	Beta		
Constant	1.622	.099		16.356	.000
Organization's work-family culture	.380	0.022	.656	17.340	.000
Supervisors' workaholism	.117	0.028	.158	4.167	.000

from multiple regression analysis, is shown in Table 4. The information in the table is used to determine whether the model is significant enough to predict the study results. It is considered a significant value in the ANOVA table and should be less than 0.05. As a result, the significant value in the study ANOVA table is.000, less than 0.05. As a result, the study model can be concluded to be sufficiently significant to predict FSSB using independent variables such as the OWFC.

The final table, known as the coefficient table, is used to calculate the effect of the independent variable on the dependent variable. As a result, the study focused on two independent variables: OWFC. Table 5 demonstrates the impact of OWFC on FSSB by emphasizing the significant values of.000 respectively. OWFC impacts FSSB, according to the coefficient values, because the significance value is less than .05. Hence, the study hypothesis is accepted, and it can be concluded that a "positive relationship exists between the organizational work-family culture and their FSSB."

Discussion

Sri Lanka's footwear industry employees' FSSB was hypothesized to be related to their OWFC. Most employees are neutral regarding the effect of their OWFC on their FSSB, as determined by the descriptive analysis. Consequently, the OWFC influences most FSSB among footwear industry employees. In addition, the regression analysis results indicate that the significance value is.000, less than the significance threshold of 0.05. Consequently, organizational work-family culture positively influences family-supportive behaviors. Consequently, the study's first hypothesis was confirmed as OWFC positively influences the family-supportive behavior of employees in the Sri Lankan footwear industry. In line with prior research, the primary focus of this investigation was the behavior of family-supportive supervisors and the role of family-supportive organizational culture among the workers at a financial credit company. The present study's findings indicated that a family-friendly organizational culture moderates the relationship between the family-friendly behavior of supervisors and employees' level of engagement in their jobs. In addition, another study indicated the impact of organizational consequences on the behavior of family-supportive supervisors. In addition, managerial characteristics were considered one aspect of the organizational consequences. Accordingly, it was established that management characteristics affect the family-friendly behavior of supervisors (Straub, 2012). One of the most recent studies aimed to determine the influence that family work conflicts and organizational work-family cultures have on the supportive behaviors of supervisors towards families. The findings showed that if the work-family culture of the organization is at a higher level, then the work-family conflicts experienced by the supervisors do not have a detrimental effect on the subordinates. In addition, it has been that an organization's work-family culture affects the supervisors' family-supportive behavior. In line with the above, it is possible to conclude that previous research indicated a connection between organizational work-family culture and supervisors'

family-supportive behaviors (Pan *et al.*, 2021). The study's findings suggested that the organization's work-family atmosphere significantly impacted the behavior of family-supportive supervisors in IT companies (Han & McLean, 2020). Recently, much talk has been about how companies should help employees with their family obligations. A family-supportive supervisor boosts company performance and benefits both the supervisor and the employees. Thus, a study examined whether supervisors' views on employee family responsibility affect employees' intrinsic motivation and their desire to leave their jobs. Thus, supervisors supporting employees with family duties increased intrinsic motivation. Most workers also say that family-friendly management makes them less likely to depart. The organization should have a strong family culture to achieve this goal through increased management support. Hence, it was derived that a strong family culture in an organization enhances the Family's Supportive Supervisor's Behavior (Marescaux *et al.*, 2020). The above-mentioned study was carried out to create a model for measuring family-supportive supervisor behavior. Consequent to the study findings, the element known as work-family management was addressed, which explained that a friendly workplace with flexible supervision and coworkers will boost the family-supporting supervisor behavior (Hammer *et al.*, 2009). The results of the current study support those earlier findings and indicate an impact of organizational work-family culture on family-supportive behavior. Therefore, it is possible to conclude that previous research indicated a connection between organizational work-family culture and supervisors' family-supportive behaviors.

Managerial implications

The study found that organizational work-family culture influences FSSB. Thus, an employee recognition program was created because top performers should be rewarded. The notion is that valued employees will perform well in such a setting. It will also inspire their teammates to work harder, creating a healthy workplace competition that boosts production. Moreover, it is recommended to accept and make use of feedback provided by employees. However, the bulk of top management opposes employee input. Much support is essential from the top management to embed into their corporate strategy. Thus, they should change how they handle employee feedback, from one way to one that is both ways. Always remember that employees are actively working to improve the company's performance. Additionally, top management should address employee issues and see them as opportunities to solve them. This way, when a favorable work environment is facilitated, employee loyalty will boost and desire to work for the company. Further, creating a flexible working environment is the recommended solution. Management must be flexible with employees. Most studies also found that all employees struggle to balance work and personal life. Thus, managers must identify and address their employees' issues by cultivating a conducive work culture where both parties are respected and recognized. One method is providing flexible hours.

Limitations and direction for future research

This study aims to determine the influence of organizational work-family culture on the family-supportive supervisor behavior of workers in the footwear industry in Sri Lanka. In line with research objectives, ~~we~~ researchers restricted the study to the footwear industry in Sri Lanka. In addition, the quantitative method was utilized throughout the study's data collection and analysis stages. Moreover, the research was conducted using a cross-sectional approach and during a short period. The research only considered OWFC. As a result, ~~the~~ FSSB is influenced by many different factors that are independent of one another. In addition, the data collection method consisted solely of an English-only questionnaire formatted in a structured format. Potential misunderstandings and language barriers may have affected the responses provided by the workers in the footwear industry. In addition, there is a paucity of research on the effects of supervisor workaholism and OWFC on FSSB, making it challenging to collect the relevant literature for the study. The present study can guide researchers in the future in applying this study to various industries. However, as the present study was a case study, to some extent, it may not be generalized. In addition, the study is quantitative; however, the same study could be conducted in the same context by using the qualitative methodology. In addition, it is possible to consider it as one of the additional factors that influence the supervisors' family's supportive behavior. In addition, the

research can be carried out as a longitudinal study by employing the observation method to gather the required information.

CONCLUSION

This study highlights the critical role of FSSB in enhancing organizational performance, particularly within Sri Lanka's footwear industry. Recognizing that supervisors often perceive employees as mere machines, leading to diminished productivity and overall performance, the research underscores the importance of fostering FSSB. Findings conclusively revealed that OWFC significantly influences employees' perceptions and experiences of FSSB in this sector. This research contributes to the growing discourse in human resource management, emphasizing the necessity of supportive supervisory behaviors for sustainable organizational growth.

AUTHOR CONTRIBUTIONS

I. Kavindi, S. Thewahettige, and K. Chandeepani were responsible for data collection, analysis, and interpretation, as well as preparing Tables and Figures, and the final manuscript. A. Dissanayake, R. Weerarathna, C. Kuruppu, and N. Jayasuriya contributed to the literature review, created additional Tables, and edited the manuscript. A. Dissanayake and R. Weerarathna conceptualized the research design and conducted additional quantitative analysis. C. Kuruppu and N. Jayasuriya assisted with the literature review and manuscript preparation. S. Liyanage performed the literature review and manuscript preparation.

ACKNOWLEDGEMENT

We would like to express our deepest and sincere gratitude to Gayendri Karunarathna for proofreading the article and providing the necessary guidance for language editing. We particularly need to thank all participants of the questionnaire surveys and interviews for devoting their valuable time to make this research successful and also Sahan Liyanage for collecting the data.

CONFLICT OF INTEREST

The authors declare no potential conflict of interest regarding the publication of this work. In addition, the ethical issues including plagiarism, informed consent, misconduct, data fabrication and, or falsification, double publication and, or submission, and redundancy have been completely witnessed by the authors.

ABBREVIATIONS (NOMENCLATURE)

ANOVA	Analysis of Variance
FSSB	Family supportive supervisors' behavior
HR	Human Resource
KMO	Kaiser-Meyer-Olkin
OWFC	Organization's work-family culture
SPSS	Statistical Package for Social Sciences

REFERENCES

A Rahim, N. A. A. B.; Omar, K.; Haque, A. U.; Muhammad, H.; Saputra, J.; Hulu, F., (2022). Impacts of work–family culture on employee job performance in achieving sustainable development goals. *Sustainability.*, *14*(12): 7003-7018 **(15 pages)**

Alshutwi, S. (2018). The influences of family supportive supervisor behaviors on the relationships among work-family conflict, stress, and turnover intention in Saudi Arabian registered nurses. Dissertation Abstracts International: Section B: The Sciences and Engineering.

Bartlett, C. A.; Ghoshal, S., (2002). Building competitive advantage through people. MIT Sloan Manag Rev.

Bernhardt, J.; Bünning, M., (2021). The Long Arm of an unsupportive work-family culture in work organizations: Crossover to the partner's work-family balance satisfaction in dual-earner couples. *Appl Res Qual Life.*, *17*(2): 723–750 **(38 pages).**

Bouleh, P. G.; Allen, S. J.; Hammer, L. B., (2022). Family-supportive supervisor behaviors and psychological distress: a secondary analysis across four occupational populations. *Int J Environ Res Public Health.,19*(13), 7845-7859 **(15 pages).**

Dyne, L. V.; Ang, S.; Botero, I. C., (2003). Conceptualizing employee silence and employee voice as multidimensional constructs. *J. Manag. Stud.*, *40*(6): 1359–1392 **(34 pages).**

Fernando, W. M. T. P. J.; Jayathilake, H. P. E. U.; Punchihewa, P. D. P. Y. M. H. K. G., (2005). An analysis of the current status of the footwear industry in Sri Lanka. ERU 2005.

Ferrara, V., (2018). Top reasons for work-related stress in 2018. PALIFE.

Ganbold, S., (2021). *Employment in the footwear, luggage and handbags industry in Sri Lanka 2013 by gender*. Statista Research Department.

Haas, E. J. (2019). The role of Supervisory Support On Workers' Health and Safety Performance. *Health Commun*., *35*(3): 364–374 **(11 pages).**

Hammer, L. B.; Ernst Kossek, E.; Bodner, T.; Crain, T., (2013). Measurement development and validation of the family supportive supervisor behavior short-form (FSSB-SF). *J Occup Health Psychol.*, *18*(3): 285–296 **(12 pages).**

Hammer, L. B.; Kossek, E. E.; Yragui, N. L.; Bodner, T. E.; Hanson, G. C., (2008). Development and validation of a multidimensional measure of family supportive supervisor behaviors (FSSB). *J. Manag.*, *35*(4): 837–856 **(20 pages).**

Hammer, L. B.; Kossek, E. E.; Zimmerman, K.; Daniels, R., (2006). Clarifying the construct of family-supportive supervisory behaviors (FSSB): A Multilevel Perspective. *Exploring the Work and Non-Work Interface.*, 165–204 **(40 pages).**

Han, S. J.; McLean, G. N., (2020). Effects of family-supportive supervisor behaviors and organizational climate on employees. *Eur. J Train Dev.*, *44*(6/7): 659–674 **(16 pages).**

Kailasapathy, P.; Jayakody, J. A., (2017). Does leadership matter? leadership styles, family supportive supervisor behaviour and work interference with family conflict. *The Int J. Hum. Resour. Manag.*, *29*(21): 3033–3067 **(35 pages).**

Leitão, J.; Pereira, D.; Gonçalves, Â., (2019). Quality of Work Life and organizational performance: Workers' feelings of contributing, or not, to the organization's productivity. *Int J Environ Res Public Healt.*, *16*(20): 3803-3821 **(19 Pages).**

Mansaray, H. E., (2019). The role of Human Resource Management in employee motivation and performance-an overview. Budapest International Research and Critics Institute *(BIRCI-Journal): Humanit. soc. sci. commun.*, *2*(3): 183–194 **(12 pages).**

Marescaux, E.; Rofcanin, Y.; Las Heras, M.; Ilies, R.; Bosch, M. J., (2020). When employees and supervisors (do not) see eye to eye on family supportive supervisor behaviours: The role of segmentation desire and work-family culture. *J Vocat Behav.*, *121*: 103471 **(43 Pages).**

Matthews, R. A.; Mills, M. J.; Trout, R. C.; English, L., (2014). Family-supportive supervisor behaviors, work engagement, and subjective well-being: A contextually dependent mediated process. *J Occup Health Psychol.*, *19*(2): 168–181 **(14 pages).**

Mauno, S., Kinnunen, U.; Pyykkö, M., (2005). Does work–family conflict mediate the relationship between work–family culture and self-reported distress? evidence from five Finnish organizations. *J Occup Health Psychol.*, *78*(4): 509–530 **(22 pages).**

Pan, S.-Y.; Chuang, A.; Yeh, Y.-J., (2020). Linking supervisor and subordinate's negative work–family experience: The role of family supportive supervisor behavior. *J Leadersh Organ Stud.*, *28*(1): 17–30 **(14 pages).**

Parvin, M. M.; Kabir, M. M., (2012). Factors affecting employee job satisfaction of pharmaceutical sector. *Aust. J. Bus. and Manage. Res., 01*(09): 113–123 (**11 pages**)

Powell, G. N.; Greenhaus, J. H.; Allen, T. D.; Johnson, R. E., (2019). Introduction to Special Topic Forum Advancing and Expanding Work-Life Theory From Multiple Perspectives. *Acad Manage Rev.,* 44(1): 54–71. **(18 pages).**

Rofcanin, Y.; Las Heras, M.; Bakker, A. B., (2017). Family supportive supervisor behaviors and organizational culture: Effects on work engagement and performance. *J Occup Health Psychol.*, *22*(2): 207–217 **(11 pages).**

Straub, C., (2012). Antecedents and organizational consequences of family supportive supervisor behavior: A Multilevel Conceptual Framework for Research. *Hum. Resour. Manag. Rev.*, *22*(1): 15–26 **(12 pages).**

Tamunomiebi, M. D.; Mezeh, A. A., (2021). Workplace stressors and employee performance: A conceptual review. *Asian J. of Econ., Bus. And Acc*., 58–67 **(10 pages).**

Thompson, C. A.; Beauvais, L. L.; Lyness, K. S., (1999). When work–family benefits are not enough: The influence of work–family culture on benefit utilization, organizational attachment, and Work–Family Conflict. *J Vocat Behav.*, *54*(3): 392–415 **(24 pages).**

Walsh, B. M.; Matthews, R. A.; Toumbeva, T. H.; Kabat-Farr, D.; Philbrick, J.; Pavisic, I., (2018). Failing to be family-supportive: Implications for supervisors. *J. Manag., 45*(7): 2952–2977 **(26 pages).**

Zeng, C.; Permyakova, T. M.; Smolianina, E. A.; Morozova, I. S., (2020). Exploring the relationships between employee burnout, organizational dissent and work-family culture in Russian organizations. *J Intercult Commun Res.*, *49*(2): 119–132 **(14 pages).**

HOW TO CITE THIS ARTICLE

Kavindi, I.; Thewahettige, S.; Dissanayaka, A.; Weerarathna, R.; Kuruppu, C.; Jayasuriya, N.; Chandeepani, K., Liyanage, S., (2025). The impact of organizational work-family culture on the family supportive supervisor behavior. Int. J. Hum. Capital Urban Manage., 10(2): 361-370.

DOI: 10.22034/IJHCUM.2025.02.11

URL: https://www.ijhcum.net/article_719435.html

Int. J. Hum. Capital Urban Manage., 10(2): 371-390, Spring 2025

International Journal of Human Capital in Urban Management
(IJHCUM)

Homepage: http://www.ijhcum.net/

REVIEW PAPER

Utilizing Virtual Reality in the participatory urban policy-making process: A step toward facilitating effective citizen engagement

A. Shakibamanesh [1,*], M. Ghorbanian[2], S. Izadi[1], A. Riahi[1], P. Zeifodini[1]

[1] *Department of Urban Planning and Design, School of Architecture and Urban Studies, Iran University of Art, Tehran, Iran.*

[2] *Department of Landscape Architecture, School of Architecture and Environmental Design, Iran University of Science and Technology, Tehran, Iran.*

ARTICLE INFO

Article History:
Received 10 August 2024
Revised 28 October 2024
Accepted 03 December 2024

Keywords:
Citizen participation
Simulation
Policy-making
Urban Modeling
Virtual reality

ABSTRACT

In traditional participatory urban processes, effective collaboration among designers, citizens, and urban managers is often hindered by inadequate environmental visualization, inefficient communication tools, and limited appeal. These challenges, particularly related to time, cost, and the difficulty of attracting diverse participants, have prompted researchers to explore alternative tools and technologies to enhance citizen involvement. Virtual Reality modeling has emerged as a promising technology for urban design, planning, and management, offering improved ways to visualize spaces, develop creative ideas, and support the realization of urban policies. This research is qualitative and developmental in purpose, and it is classified as a review study with an interpretive perspective. The methods employed include documentary analysis and case studies, with data collected from documents, library resources, and relevant articles in this field. The study draws on theoretical frameworks such as Arnstein's Ladder of Citizen Participation and Healey's Collaborative Planning Theory to examine Virtual Reality's potential in participatory processes. The study addresses the limitations of traditional participatory methods, highlighting how Virtual Reality technology can facilitate more accessible, inclusive, and efficient urban policymaking processes. Despite technological limitations, physical and psychological constraints, ethical concerns, and issues related to privacy and legal matters, the *findings* indicate that virtual Reality offers significant potential in participatory urban processes. By providing immersive simulations, virtual Reality can improve transparency, enhance stakeholder collaboration, and facilitate informed decision-making in urban planning. The technology's ability to engage diverse demographic groups, particularly those reluctant to engage in traditional methods, shows promise for making urban policy discussions more interactive and understandable. Virtual Reality presents a valuable tool for overcoming the limitations of conventional participatory processes and holds promise for enhancing urban policymaking. The study identifies several avenues for future exploration, including improving accessibility, addressing ethical concerns, and developing hybrid engagement models that integrate Virtual reality with traditional methods. Empirical evaluations of Virtual Reality's impact on decision-making and stakeholder engagement are also recommended to optimize its application in urban governance. Its potential benefits make it an important area for further exploration of urban planning and participatory governance.

DOI: 10.22034/IJHCUM.2025.02.12

NUMBER OF REFERENCES

100

NUMBER OF FIGURES

3

NUMBER OF TABLES

2

*Corresponding Author:
Email: a.shakibamanesh@art.ac.ir
Phone: +982632547852
ORCID: 0000-0001-6036-8913

Note: Discussion period for this manuscript open until July 1, 2025 on IJHCUM website at the "Show Article.

INTRODUCTION

In today's world, traditional top-down approaches to urban planning, where governmental authorities make decisions without considering residents' opinions, are increasingly being criticized. In contrast, bottom-up participatory urban planning is emerging as a democratic and sustainable alternative. Today, top-down and bottom-up planning mechanisms shape urban structures and improve urban design and planning practices. Urban designers and managers contribute their expertise, while citizens influence the city's form through their everyday behaviors. Good urban planning requires the collaboration and participation of multiple stakeholders to balance the interests of diverse groups (IAPP, 2019). This study is situated at the intersection of urban planning, participatory design, and emerging technologies. As cities face growing challenges in sustainability, livability, and inclusivity, methods of engaging citizens in urban development processes are evolving. The shift from traditional top-down approaches to more collaborative, bottom-up strategies has aligned with rapid technological advancements, creating new opportunities for citizen participation in urban policymaking. The motivation for this study stems from several key factors. First, while participatory urban planning has gained prominence, traditional methods often fall short in accessibility, inclusivity, and efficiency. We observed that these limitations could be addressed through emerging technologies like Virtual Reality (VR). Second, there is a notable gap in the literature on practical applications of VR in urban policymaking. As urban professionals, we recognized the need for a comprehensive analysis that bridges the technical aspects of VR with the practical needs of urban planners and policymakers. Finally, our experience with the challenges of engaging diverse stakeholders in urban projects highlighted the urgent need for more innovative and effective participatory tools. These factors collectively drive our investigation into the potential of VR modeling in participatory urban policymaking. Participatory design is often defined as a shift in attitude from "designing for the user" to "designing with the user." Participatory design is not merely a method or a set of methodologies; it is more of a mindset and a way of engaging with people (Oksman, 2014). In this approach, citizens play an active role in the urban design and planning process. Their ideas, needs, and desires are collected and considered through public meetings, surveys, workshops, and other participatory methods. The ultimate goal is to create sustainable, livable urban spaces that respond to the real needs of residents. Increased collective participation offers many benefits and is considered a vital tool in urban planning and design, as it addresses many architectural, social, and economic challenges. There is no doubt that sustainable development cannot be achieved without the involvement of stakeholders (Fares *et al*., 2018; Stauskis, 2014). With the rapid advancement of technology, traditional methods of participation—such as meetings, conferences, and interviews—that are predominantly based on various forms of physical contact have gradually lost their popularity and effectiveness in urban design and planning. In urban projects, these methods often fall short in terms of accessibility, inclusivity, and efficiency. "Meetings attended by local community members are usually dominated by a small number of active members who reveal their opinions more than the broader community. Often, these 'activists' have a vested interest in the outcome of planning decisions in competitive market conditions, making it difficult to ensure transparency. The process of organizing numerous meetings, repeated efforts for outreach, and the need to manage the process, including staff, venues, and professional services, makes the process lengthy and costly compared to the outcomes" (Stauskis, 2014). Traditional participatory approaches involve encouraging citizen participation in policy decisions through suggestions and signals that follow a top-down decision-making process. Public services are initially shaped by municipalities, and then citizens engage through a combination of online and offline initiatives that collect their feedback, critiques, and suggestions for service improvement (Castelnovo *et al*., 2016). The concept of in-person participatory design is particularly prevalent in urban planning; however, the challenges it presents—especially in terms of time, cost, and engaging diverse participants—have prompted researchers to seek alternative tools and technologies to assist citizens (Scerri & Attard, 2023). This research draws on several theoretical frameworks, including Arnstein's Ladder of Citizen Participation, which outlines levels of citizen involvement in decision-making processes, and Healey's Collaborative Planning Theory, which emphasizes the importance of inclusive dialogue in

urban planning. These theories provide a foundation for understanding the potential impact of virtual reality on participatory urban policymaking. Considering the limitations of traditional participatory methods, it becomes clear that new technologies may offer effective solutions to these challenges. One of the most important emerging technologies facilitating new participatory methods is VR. VR takes 3D visualization a step forward (Fraser & Bjornsson, 2004; Al-Kodmany, 2002). "The aim of using virtual reality is to enable users to easily participate in public engagement processes without the constraints of time or place, through virtual reality and the internet. VR can seamlessly present interactive proposals for discussion and help identify suggestions and evaluate alternatives" (Fares *et al*., 2018). Therefore, this study seeks to discuss and analyze the key functions and applications of VR modeling in participatory urban policymaking. Given the complex and interdisciplinary nature of VR modeling (involving fields such as electronics, computing, gaming, multimedia, programming, etc.), this research aims to present the key concepts of this field with a practical and applicable perspective for urban professionals. In this context, the study endeavors to clarify the concepts, applications, challenges, and limitations of using VR in the policymaking process, and ultimately, it examines successful examples of using VR in participatory urban policymaking. The main objective of this research is to address the role and impact of virtual reality modeling in facilitating the process of participatory urban policymaking. This study contributes to the growing body of knowledge on technology-enhanced participatory urban planning by providing a comprehensive analysis of virtual reality's potential in this field. By examining the key functions, applications, challenges, and limitations of VR in urban policymaking, this research offers valuable insights for urban professionals aiming to implement more effective and inclusive participatory processes. The findings have the potential to significantly transform how cities engage with citizens in planning and policymaking. The innovation of this work lies in its practical approach to bridging the gap between complex VR technology and urban planning practices, providing urban professionals with actionable insights on implementing VR-based participatory methods. This research was conducted between September 16 and August 21 in Tehran's study center to provide urban professionals with a comprehensive understanding of virtual reality's potential in participatory urban policymaking. Also, this manuscript is extracted from a research project entitled "Utilizing the Operational Capabilities of Virtual Reality Modeling in the Implementation of Urban Policies & Plans," funded by the Tehran Urban Research & Planning Center (TURPC) in 2024.

METHODOLOGY

This research is developmental, aiming to advance knowledge in the field of the role and impact of VR in participatory urban policymaking within urban studies. The qualitative study is categorized as a review study with an interpretive approach to the impact of virtual reality in the process of participatory urban policymaking. The research methods employed include document analysis and case studies, selected from various research approaches. The theoretical framework of this research is deductive, and its temporal scope is cross-sectional. Library documents and related research papers and studies were utilized to gather information. Scientific data mining was conducted to understand the concepts related to virtual reality to facilitate participatory urban policymaking. Furthermore, this study explores the challenges and opportunities associated with the use of VR in urban policy projects. It employs analytical methods to deeply analyze the challenges and potentials of this technology in the policymaking domain. This analytical method provides a logical and dynamic perspective on the potentials and limitations of virtual reality in urban projects. Additionally, a content analysis method is used to further examine and interpret materials and content related to the challenges and opportunities of using virtual reality in urban policymaking projects. Finally, successful examples of using virtual reality in the process of urban policymaking will be reviewed to identify the impact of VR.

Background and theoretical foundations

Public participation and participatory urban design

Public participation leads to a better understanding of the urban development landscape, generating ideas and suggestions based on the knowledge, attitudes, and habits of the people while also increasing their awareness of their role in urban development (Semeraro *et al*., 2020). Public

participation contributes mainly to four beneficiaries: the public, the planners, the local municipality, and the plan itself (Stern and Amir, 2006). Citizens are the primary actors who, more than anyone else, are familiar with the realities and problems surrounding them (Fares *et al*., 2018). As public demands for transparency, accountability, and inclusiveness continue to increase, ensuring that different voices of the public are heard and considered in decision-making is crucial to toining public confidence and improving policy effectiveness (Xiang, 2024). Engaged communities intuitively understand what they truly need, ultimately fostering a sense of belonging among residents. Conversely, design or planning practices conducted by urban planners and architects without community participation can result in significant shortcomings, such as mismatches between the environment and the community, abandonment or underuse of urban spaces, or even the destruction of environmental features (Ismail & Said, 2015). Participatory design is an organized process intended to transform urban spaces into valuable places by involving non-experts, including residents, visitors, or stakeholders, alongside urban planners and designers (IAPP, 2019). Participatory design is often described as a shift in attitude from "designing for the user" to "designing with the user." It is not merely a method or set of methodologies; it is a mindset and an approach to engaging with people (Oksman, 2014). In this approach, citizens play an active role in the urban design and planning process. Their ideas, needs, and desires are collected and considered through public meetings, surveys, workshops, and other participatory methods (Fares *et al*., 2018; Stauskis, 2014). The goal of participatory urbanism is to create sustainable, livable urban spaces that are responsive to the real needs of residents. In this process, citizens' roles include raising awareness, accepting diverse perspectives, fostering a sense of ownership, improving decision-making, and enhancing legitimacy (Falanga, 2020; Mueller *et al*., 2018; Dyer *et al*., 2017). This research is grounded in multiple theoretical frameworks that establish a basis for comprehending the intricacies of participatory urban policymaking. Arnstein's Ladder of Citizen Participation outlines different levels of citizen involvement in decision-making processes, ranging from non-participation to varying degrees of citizen power (Connor, 1988). This framework highlights the importance of meaningful engagement, asserting that true citizen participation goes beyond mere tokenism and facilitates genuine collaboration between citizens and decision-makers (Xiang, 2024; Hidayah *et al*., 2024). Moreover, Healey's Collaborative Planning Theory emphasizes the necessity of inclusive dialogue in urban planning, advocating for the integration of diverse perspectives and values. It suggests that collaborative approaches not only enhance the legitimacy of planning outcomes but also lead to more innovative and context-sensitive solutions (Healey, 2020). By situating this study within these theoretical frameworks, we aim to critically assess how emerging technologies, particularly VR, can enhance participatory practices and mitigate the shortcomings of traditional methods. In doing so, this research seeks to contribute to the broader discourse on participatory urban design, demonstrating how VR can facilitate deeper engagement and better alignment between urban policies and community needs. Recent research on digital leadership offers valuable insights that can be applied to participatory urban design and planning. Just as digital leadership guides organizational transformation and leverages technology to enhance business processes, similar principles can be applied in urban planning contexts. Effective digital leadership in urban planning involves not only implementing new technologies but also fostering a culture of innovation and adaptability. Studies have shown that organizations with strong digital leadership are more likely to develop entrepreneurial initiatives that drive innovation and improve performance (Arabiun *et al*., 2024). In the realm of urban planning, this could translate to more innovative approaches to citizen engagement, such as the implementation of VR in participatory processes. Furthermore, the success of digital leadership in restructuring business strategies and building a culture conducive to digital transformation (Springs, 2024; Arabiun *et al*., 2024) suggests that similar leadership approaches in urban planning could enhance the adoption and effectiveness of new participatory tools and methods. By integrating these concepts of digital leadership with established theories of participatory planning, we can develop a more comprehensive framework for understanding and implementing effective, technology-driven participatory urban design processes.

Transition from traditional to new (electronic) approaches in urban design and planning participation

According to the research by Wang & Lin (2023), in traditional urbanism, people are unable to provide immediate and effective feedback for various reasons. First, the general public is not familiar with abstract concepts in urban design and planning drafts (e.g., building area ratios, density, etc.) and cannot estimate the likely outcomes of urban forms after a plan is implemented. Second, they cannot directly perceive the design outcomes on-site and offer first-hand feedback. Moreover, the successful evaluation of an urban plan often takes considerable time after implementation. As a result, it is desirable to create a platform that allows the public and designers to easily visualize the urban design and planning process and interact with the outcomes based on abstract concepts (Wang & Lin, 2023). In most traditional urban planning processes, the lack of visual representation and communication tools makes it difficult for designers to collaborate with the public and communities. For this reason, traditional participatory processes have become obsolete in most developed countries. With technological advances, even web-based participation may not suffice to meet collective participation demands in urban design and planning processes shortly. In public participation processes, inviting people to gather in a room for a public meeting can be inefficient and ineffective in engaging citizens. The timing and format of these meetings are often criticized due to the low level of public involvement. Consequently, citizens are increasingly questioning traditional forms of representative democracy and are awaiting innovations in policymaking processes that allow for direct participation (Lironi, 2016). New methods of participation, known as «web-based public participation,» have emerged. Although mobile technology alone cannot overcome traditional barriers to participation (e.g., spatial and temporal barriers, lack of interest, lack of trust), it can make the participation process faster and easier (Thiel, 2017). The basic benefits of traditional public participation can be also achieved by web-based public participation, and the main limitations of Web-based Public Participation (WPP) include potentially limited access to the Internet, which may affect the number and socioeconomics of the participants (Craig *et al.*, 2002; Sarjakoski, 1998; Trevor, 1998). Information and Communication Technology (ICT), particularly social media, is used to increase the number of participants in public debates and give voice to those who typically do not attend in-person debates. Recent positive experiences have shown that the effective use of new media can increase the number of participants in public discussions by tenfold, thereby aiding decision-making. Citizens also participate more actively in the management of their city, playing a central role in the creation and management of public value. This represents a new approach in which bottom-up citizen participation emerges spontaneously without the need for abstract solutions. Instead, new and tangible actions address the everyday problems faced by citizens (Castelnovo *et al.*, 2016). The Internet may have the potential to change the scope of citizen participation and offer new possibilities due to the affordability of the web and its ability to reach a wider audience. This means that the web can reduce the costs of information exchange, facilitate participatory and consultative processes, and ultimately lead to better decision-making at all levels of government (Lironi, 2016). The basic methods used for public participation are structured around “passive,” “active,” and “interactive” forms of engagement. Passive methods are primarily based on one-way communication between planners and the public as one of the stakeholders, without interaction. Active methods involve some interactive elements as they attempt to establish a “dialogue” rather than a “monologue.” Emerging techniques based on ICT are attributed to interactive methods as they aim to enable direct access, reliable feedback, and monitoring engagement regarding the goals, roles, processes, and outcomes of planning (Stauskis, 2014). Each of the aforementioned methods includes numerous capabilities and limitations. According to the research by Stern *et al.* (2009), the fundamental benefits of traditional participation can be better achieved through new participation methods. Using the Jeffries model, which defines three essential characteristics of public participation—”involvement,” “trust,” and “empowerment”(Stern *et al.*, 2009): Involvement in general often refers to an individual’s participation in a given task and is measured as a set of behaviors or activities that such an individual performs (Barki and Hartwick, 1989); It is argued that the quality of public participation can positively affect citizen trust (Halvorsen, 2003); full

public collaboration, throughout the planning and its implementation stages, would entail and reflect the highest level of empowerment (Weil, 2014)—the capabilities of new participation methods are thoroughly discussed. For example, the research highlights that new participation methods enable more citizens to participate in the planning process, regardless of their geographic location. Web-based participation increases public trust through good communication and constant information updates, and it serves as a tool for democratic decision-making. In terms of expanding citizens' abilities, new participation methods allow more people to express their opinions and solutions, gain new skills, and actively control their circumstances. This ultimately increases the level of influence and control people have over the participation process. Furthermore, access to accurate and up-to-date information enhances personal trust, encouraging active participation (Stern *et al.*, 2009). Digital participation technologies have the potential to completely transform professional practices in urban design and development. Enabling constructive participation and co-design activities for the public in the early pre-design stages, when changes are still possible, is essential and more meaningful. The impact of digital participation technologies can be summarized by four general characteristics (Fig. 1) (Weinstock, 2013; Schively, 2007):

- *Crowdsourced Knowledge*: Digital participation tools make it possible to use broader knowledge, as seen in traditional design practices. It also allows for the use of valuable experiences and creativity from non-professionals, particularly local citizen experts.
- *Design Evidence*: New technologies, such as sentiment analysis, provide designers and planners with new evidence during the design process. There is potential for developing projects that confirm public responses and test public attitudes and acceptance in the early stages of the project.
- *Interaction*: In addition to technical advancements, digital participation technologies enable an interactive and communication-centered planning process. Direct exchanges between all stakeholders, particularly planners and users (citizens, residents), will become a key activity in urban design.
- *Agile Design*: Participatory tools and technologies transform the planning process into a parallel and agile workflow, unlike the sequential and linear workflows that have shaped urban design in the past.

Comparative analysis of traditional methods and VR in participatory urban planning

While the limitations of traditional participation methods have become increasingly apparent, the potential of VR as an alternative or complementary approach has garnered significant attention in recent years. Comparative studies between traditional methods and VR-based approaches in participatory urban planning have shed light on the specific advantages that VR can offer. These studies provide empirical evidence for the benefits that VR can bring to the participatory process, many of which align with the theoretical advantages discussed earlier. Several studies have examined this comparison both quantitatively and qualitatively:

– *Engagement Levels*: A study by Smith *et al.*, (2022) found that VR-based participation increased citizen engagement by 45% compared to traditional town hall meetings. Participants reported feeling

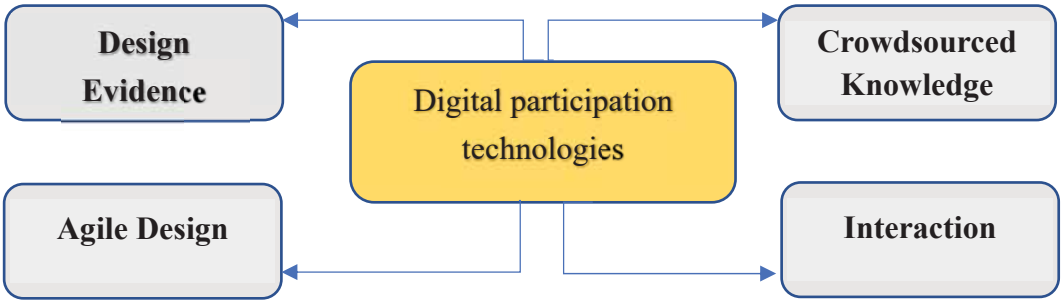


Fig. 1: Features of the impact of digital participation technologies in participatory urban policies

more immersed and invested in the planning process.

– *Comprehension of plans*: Studies conducted a comparative experiment where one group reviewed 2D plans and another used VR. The VR group showed a 30% higher accuracy in understanding spatial relationships and potential impacts of proposed changes (Portman *et al*., 2015).

– *Demographic Reach*: Research by Van Leeuwen *et al*., (2018) indicated that VR-based participation attracted a more diverse age range, an increase in participation from the 18-35 age group compared to traditional methods.

– *Cost-Effectiveness*: While initial setup costs for VR can be high, a long-term analysis showed that VR-based participation could reduce overall costs over the years, primarily due to the reduced need for physical materials and venue rentals.

– *Idea Generation*: A qualitative study by Garcia *et al*., (2015) found that VR sessions produced more unique ideas for urban improvements than traditional brainstorming sessions, likely due to the immersive experience.

– *Time Efficiency*: VR-based planning sessions are shorter on average than traditional meetings, while covering the same amount of material, suggesting improved efficiency.

– Participant Satisfaction: Surveys showed that participants preferred VR-based methods over traditional ones, citing better visualization and a more interactive experience.

These comparative studies highlight the potential advantages of VR in participatory urban planning. However, it's important to note that VR should not entirely replace traditional methods, but rather complement them to create a more comprehensive and inclusive planning process. The integration of VR with existing participatory techniques may offer a balanced approach that leverages the strengths of both traditional and innovative methods.

The emergence of virtual reality in new participation methods and increased stakeholder engagement

As previously mentioned, traditional participation methods such as meetings, conferences, and interviews are no longer sufficient to meet the needs of contemporary society. Additionally, new participation methods are constantly being updated and evolving alongside technological advancements. One of the most significant emerging technologies in facilitating new participation methods is VR. The goal of using VR is to enable users to easily engage in public participation processes without constraints of time or location, utilizing VR and the internet. VR allows for the seamless presentation of interactive proposals for discussion, helping to identify suggestions and evaluate alternatives (Fares *et al*., 2018). A fundamental advantage of VR is its ability to increase stakeholder engagement. One factor that contributed to the increased stakeholder interaction through VR was the onset of the COVID-19 pandemic; due to the risks associated with in-person meetings and activities, face-to-face participation became nearly impossible. As a result, a unique opportunity for virtual labs arose. The term "living labs" is often used to describe a multi-stakeholder platform that brings together different stakeholders to decide on the best strategy for addressing an issue. These labs go beyond merely active participation by citizens and integrate user-centered, participatory design approaches, emerging as a valuable method for implementing effective, sustainable urban solutions at the local scale (Nesti, 2020; Delgado *et al*., 2020). VR helps users understand what designers are creating, enabling them to communicate more effectively with professionals. Furthermore, users can explore their buildings and cities from the comfort of their homes (El Araby, 2002). Today, the success of urban design and planning can be summarized in the ability to convince people and regulatory bodies to accept the functionality of urban guidelines and to persuade urban designers to adopt VR technologies as a powerful and useful tool in urban planning. VR has the potential to enable designers to enhance their imagination by visualizing hidden intentions and thoughts. The use of Geographic Information Systems (GIS) and web-based VR technologies holds significant potential as visualization tools for use in urban planning and design. VR can globalize the design process, allowing many designers to collaborate on a project regardless of their geographic location (El Araby, 2002). As mentioned, the purpose of using VR in the participatory urban design process is to empower participation and enhance stakeholder interaction in the design process, particularly in urban policymaking, with ease and without requiring extensive time. VR technology is also capable of seamlessly presenting interactive proposals for discussion and identifying and evaluating policies

(Fares *et al*., 2018). One of the critical areas where citizens can actively participate in policymaking and decision-making is in the urban design process. Policy formulation involves three potential stages of participation for citizens: informing, engaging, and empowering (Hassan & Hamari, 2020). There are numerous approaches to participatory urban policymaking and decision-making. Public value-based and evidence-based decision-making are two prominent approaches in this field (Savoldelli *et al*., 2014). Acceptance of opinions is influenced by citizens' perceptions of value and transparency in the decision-making process. Positive perceptions of a service's ability to deliver public value, as well as transparency and accountability in decision-making, together with citizen and stakeholder participation, increase citizens' trust in policymakers and public administration (Cosgrave *et al*., 2014; Feeney & Welch, 2012).

Various functions of Virtual Reality in enhancing participatory urban policies

Studies have shown various benefits associated with different forms of VR technology throughout urban design and planning processes. These benefits include increased project understanding, additional opportunities for stakeholder feedback, greater volume, quality, and diversity of public participation, and the ability to provide an almost real immersive environment by adding sensory stimuli to VR (Meenar & Kitson, 2020). Below are some of the different functions of VR in the field of participatory urbanism:

• *Visualization:* One of the most critical features of VR in the urban policymaking process, and in various stages of this process (goal setting, policy formulation, decision-making, implementation, and evaluation), is its ability to aid in visualizing and better understanding issues for decision-making. Visualization generates public interest in proposed plans, while a balance must be maintained between live VR displays and online visits (Stauskis, 2014). Proper visualization becomes essential when it is necessary to make the design aspect of new projects clear not only to government officials, engineers, and managers but also to urban residents (Ceconello & Spallazzo, 2008). Computer-aided visualization can make information comprehensible and usable for a broader range of people, leading to less time spent discussing the physical features of an area and more time spent analyzing the visual consequences of changes (Al-Kodmany, 2020). VR technologies allow citizens to visualize and understand spatial and temporal design processes (Stauskis, 2014). Using VR headsets (Fig. 2), the observer is placed within the design landscape, providing a tool to support decision-making processes in urban planning. The general public is allowed to experience the projected design through immersive visualization (Van Leeuwen *et al*., 2018). Computer visualization can also accurately present complex textual information and facilitate direct visualization of movement and change, multiple views of a dataset, user interaction with maps, and realism through 3D displays (Al-Kodmany, 2020). Visualization tools can be standalone applications, for web-based presentations, WPP that primarily use software libraries (APIs), or modules within programming languages. They can also be classified based on factors such as software type, visualization structure, operating system compatibility, licensing terms, scalability, extendibility, or the date of their latest release (Korkut & Surer, 2023; Caldarola and Rinaldi, 2017).

• *Simulation:* Simulation and modeling are recognized as an integral part of urban design and planning, enabling the evaluation of proposed designs and the validation of policies. The benefits of this feature include flexible simulations of existing and proposed scenarios, the ability to increase the number of users and functionalities, multi-user environments, and attention to individual preferences. VR is not only useful for simulating future scenarios but also aids in visualizing existing urban areas. Urban planners and designers can use simulations to improve infrastructure upgrades, new transportation options, green spaces, and other changes within the context of new policies (Kamińska *et al*., 2019). Conducting studies in a virtual environment necessitates realistic simulation of the relevant objects to ensure a strong correlation between the virtual environment and real-world conditions (Schrom-Feiertag *et al*., 2020; Li *et al*., 2019). Simulations also support multi-user environments, where multiple users can gather in a room to discuss, design, or collaborate on various activities (Ismail & Sunar, 2009). VR technology assists designers in developing and refining their conceptual designs by enabling them to immerse themselves in their ideas and inspirations, turning abstract concepts into concrete solutions (Liu, 2020; Bishop, 2015).

Fig 2: Use of VR headsets in collective participation processes (Source: Van Leeuwen *et al*., 2018)

Additionally, simulations focus on individuality and increased independence in participation. Simulated models are typically shared among users, allowing everyone to view the same cohesive model, or models can be adapted based on individual needs and preferences (Scerri & Attard, 2023). Simulation is regarded as an essential tool for public participation in presenting, evaluating, and implementing urban policies. In a study by Stauskis, simulation was a prominent paradigm within virtual reality technology. The study combined 3D modeling and virtual space simulation with community participation techniques to confirm the initial design of a public park in Vilnius, providing a tool for analysis and accessible outcomes (Fig. 3) (Stauskis, 2014).

• *Engaging individuals:* Another key feature of VR technology is actively engaging users. Video games, in addition to assisting with policy implementation, project visualization, and design simulations, are appealing and enjoyable due to their graphical and interactive scenarios, leading to active user engagement. For example, the SimCity video game series, which began in 1989, is one of the first virtual city-building programs that inadvertently engages users in the design and planning process. In addition to its entertainment aspects, it also has educational value, and it has been used in several urban design processes worldwide (Stauskis, 2014). The combination of VR and ArcGIS data can enhance access to feedback across all ages, particularly younger generations, reduce the time residents need to become familiar with a project, increase transparency, and improve efficiency (Meenar & Kitson, 2020).

• *Immersiveness:* Immersive virtual reality is a relatively unknown but potentially significant tool for increasing participation and gaining attention in academic and practical fields over the past decade. Immersive systems allow users to immerse themselves in a computer-generated world with a head-mounted display that tracks their position and orientation. These systems may also be enhanced by audio, tactile, and sensory interfaces (Boertien, 2021; Wu *et al*., 2020). A key component of VR is the level of immersion, which engages users' minds and bodies through visuals, sound, and even touch. Creating a near-real immersive environment by adding sensory stimuli to VR is one of its most important features (Meenar & Kitson, 2020). Combining additional sensory stimuli with VR may create a near-real immersive environment and enhance meaningful public participation (Jiang *et al*., 2018). Unfortunately, while olfactory perception is one of the most fundamental and impactful forms of environmental perception, there is limited understanding of the role or benefits of olfactory cues in the multi-dimensional experience of participatory planning (Won *et al*., 2023; Kitson *et al*., 2019). Another critical feature of VR technology is its linkability with other technologies and devices. Combining VR and GIS data can improve accessibility, reduce the time required for residents to familiarize themselves with a project, enhance

Fig. 3: Virtual urban simulation methodology for public participation in Vilnius Park (Source: Stauskis, 2014)

transparency, and promote more efficient use of the tools (Meenar & Kitson, 2020).

• *Data collection:* VR environments provide a platform for conducting immersive surveys and collecting real-time feedback, preferences, needs, and experiences from citizens virtually and online. This feedback can include preferences related to aesthetics, functionality, accessibility, and other key considerations in urban design (Agudelo-Vélez *et al.*, 2021). Collecting feedback through VR offers a dynamic and immersive approach to gathering stakeholder perspectives in the design, planning, and policymaking process (Stauskis, 2014). Designers can use VR to test products, interfaces, and spaces by placing users in virtual prototypes. By tracking eye movements, gestures, and responses, designers can gather valuable data on how users interact with their designs (Kim *et al.*, 2020; Sagnier *et al.*, 2020).

• *Decision-making and problem-solving*: VR technology enables individuals to practice decision-making in complex, dynamic scenarios, gain valuable insights, and enhance their problem-solving skills in a controlled and supportive environment. Various studies show that digital technologies can positively impact learning problem-solving skills (Ehab *et al.*, 2023; Araiza-Alba *et al.*, 2021). VR can be a useful tool in participatory spatial planning, enhancing understanding, providing critical feedback, improving participation in planning events, and enabling people to experience a place without physically traveling there (Meenar & Kitson, 2020). In some cases, gaps between decision-makers and citizens, as well as the lack of stimulating policies, reduce the effectiveness of integrating citizens into decision-making processes (Fares *et al.*, 2018). Methods, techniques, and tools based on VR facilitate participatory decision-making, improve stakeholder communication and engagement, support scenario analysis and simulations, reduce uncertainty in decision-making, and ultimately simplify urban planning and design processes (Boos *et al.*, 2023). One VR tool that facilitates decision-making and problem-solving is

the Virtual Urban Living Labs (VULL) platform. This platform allows local participants to provide input in the decision-making process (Scerri & Attard, 2023).

• *Evaluation of designs, policies, and feedback:* VR can be used to simulate urban designs and policies before implementation. This helps government authorities and stakeholders assess the potential impacts of these plans and policies on the city and its residents, making necessary adjustments before implementation (Scrivner *et al*., 2019). After the simulation, modeling, and visualization of various urban design and planning scenarios, the evaluation phase follows. During this phase, citizens can also participate. In some urban development projects, citizen participation is more prominent in the scenario evaluation phase, as VR tools and techniques allow users to visualize and experience different scenarios (Kamińska *et al*., 2019). Some simulation systems allow users to modify urban development models, such as changing houses, trees, and other design elements. The ability to modify is a useful feature for local community residents (Stauskis, 2014). For example, Wizard is a VR tool that enables participants to make decisions supported by simulations and interactions, allowing more informed decisions to be made during the advanced design evaluation stage. It allows citizens to explore the site and identify proposals as part of the decision-making and design evaluation process (Fares *et al*., 2018).

• *Target group education*: In the education domain, traditional approaches often have limitations in addressing the diverse needs and learning styles of target groups. However, education using VR methods and techniques can reduce time and financial costs, simplify communication, and overcome spatial limitations (Checa *et al*., 2020; Getso & Bakon, 2017). It has been repeatedly proven that VR, by providing a more engaging environment that stimulates different points of perception, has significant potential for positive educational outcomes. VR allows experiential learning and enables learners to develop practical skills and decision-making abilities in a dynamic and immersive environment (Kamińska *et al*., 2019). VR offers new ways for users to access information and encourages them to explore specific events. One of the most appealing aspects of VR in education is that it can be used for simulations, allowing users to practice procedures without risk (Getso & Bakon, 2017). VR and Augmented Reality (AR) applications in educational and learning activities through 3D visualizations help provide a deeper understanding of the subject (Kuna *et al*., 2023). VR-based simulations offered a secure space to conduct exercises that would otherwise be risky and costly in real life (Pallavicini *et al*., 2016; Lele, 2013). Numerous surveys and reports indicate that most users remember what they experienced in VR and conclude that VR provides a more memorable environment than other methods. VR environments allow professionals to engage in learning activities that are difficult to conduct in regular laboratory sessions (Kamińska *et al*., 2019). VR enhances users' skills for analyzing issues, exploring new terms, and acquiring knowledge (Kuna *et al*., 2023). In addition, It can present complex data in an accessible way to students which is both easy to learn and fun (Gandhi & Patel, 2018). A comprehensive overview of the diverse functions of VR in enhancing participatory urban policies is provided in the following table (Table 1).

Challenges and limitations of VR in participatory urban policy-making

Technological limitations

Despite the transformative potential of VR in various domains, it faces several technological limitations. These limitations include expensive infrastructure, numerous hardware and software requirements, a lack of realism, unequal access across social strata, and the need for infrastructure to facilitate comprehensive education in VR technologies. High-cost infrastructure impedes the widespread application of VR in citizen participation projects (Pimentel *et al*., 2022). The high price of technological innovations, combined with hardware and software prerequisites that allow individuals to immerse themselves in virtual environments, imposes a significant financial burden, limiting the widespread adoption and engagement in VR-based participatory processes (Kaddoura & Al Husseiny, 2023; Fernández & Alonso, 2015). Another key challenge is the lack of visual realism and dynamic interactivity, as current VR graphic production and visualization technologies are limited. Thus, maximizing the appearance of reality in VR environments remains a persistent challenge. Realistic VR environments require powerful computing hardware for rendering (Kamińska *et al*., 2019; Stanney *et al*., 2020). Furthermore, unequal access among elderly and disabled individuals is

Table 1: Various functions of VR in enhancing participatory urban policies

	Function	Key Stages in the Urban Planning Process	Benefits and capabilities
1	**Visualization**	Setting goals or objectives Developing and approving policies Decision-making Implementation Evaluation	Enhanced conceptualization and comprehension Enabling a broader range of people to understand and utilize information Examining visual consequences Conceptualizing and comprehending spatial and temporal design dynamics Communicating intricate textual data
2	**Simulation**	Evaluation of proposed designs Policy viability analysis	Dynamic modeling of current and potential situations Increasing the number of users and features Multi-user environments Emphasis on individuality and greater autonomy in participation
3	**Engaging Individuals**	Policy implementation Evaluation	Involving users actively in the design and planning phases Making feedback accessible to all generations, particularly younger individuals
4	**immersiveness**	Evaluation	Stimulating users' senses with visuals, audio, and haptics Developing an immersive, almost lifelike experience Accelerating residents' understanding of a project
5	**Data collection**	Evaluation and Feedback	Collecting real-time citizen feedback, preferences, needs, and experiences through comprehensive online surveys Gathering stakeholder perspectives to inform urban design, planning, and policy development
6	**Decision-Making and Problem-Solving**	Decision-making Data analysis	Enhances problem-solving abilities Encourages collaborative decision-making and improves stakeholder communication Makes urban planning and design more efficient
7	**Evaluation of Designs, Policies, and Feedback**	Evaluation	Conducting simulations of urban plans and policies before implementation Analyzing the potential consequences of plans and policies for the city and its residents
8	**Target Group Education**	-	Facilitating experiential learning Enhancing learners' practical skills and decision-making through dynamic and comprehensive experiences Inspiring users to discover specific events

another significant limitation in enhancing citizen participation in urban policy-making through VR. The complexities associated with VR technologies create substantial barriers for many individuals, particularly those with physical disabilities or age-related impairments (Kaddoura & Al Husseiny, 2023). Additionally, the lack of educational programs for community members due to insufficient expertise in VR technologies is a barrier, hindering the dissemination of knowledge and skills necessary for effective engagement (Rogers *et al*., 2014).

Physical, psychological, ethical, and social limitations

Integrating citizens into urban policy-making processes through VR presents a range of subtle limitations in physical, psychological, ethical, and social dimensions. These limitations range from inherent risks to physical and mental health to time constraints that cause discomfort and nausea during prolonged use (Kaimara *et al*., 2022). Moreover, cultural and language barriers, combined with gender and socio-economic inequalities, exacerbate the complexities of ensuring fair participation in VR-based urban governance projects. Numerous recent studies have shown that prolonged use of VR can lead to issues such as addiction or over-reliance on virtual interactions, reducing face-to-face meetings and gatherings. Complete dependence on this technology can result in physical and psychological problems (Kaddoura & Al Husseiny, 2023). One significant issue related to VR use is cybersickness or motion sickness caused by VR. Cybersickness is a phenomenon where users

experience symptoms similar to motion sickness (e.g., nausea, dizziness, light-headedness) as a result of using VR devices (Kim *et al*., 2019; Baniasadi *et al*., 2018). VR headsets can also be heavy, causing physical strain on users, leading to headaches and pain, particularly around the neck and shoulders (Kaplan *et al*., 2021; Hirzle *et al*., 2022). The impact of using VR tools may cause discomfort or nausea in users within just 10 to 15 minutes, so it is advisable to use them in moderation (Pimentel *et al*., 2022; Stanberry, 2001). Furthermore, the widespread use of ICT raises concerns about the potential for exacerbating social and economic inequalities, as it may exclude "unskilled and illiterate local community segments." In VR, several real-world inequalities are significantly magnified (Kaddoura & Al Husseiny, 2023).

Privacy and legal limitations

The integration of VR technology into urban policy-making processes presents multifaceted challenges due to concerns about network security, privacy, data collection and storage practices, and the absence of legal restrictions (Bolton, 2021). VR technology faces a major issue in data collection and storage, often referred to as data confidentiality. With the vast amount of data being collected, analyzed, classified, and eventually commodified, privacy becomes a foundational concern. For businesses, the value of data lies not in its physical presence but in the connections, it can create with databases and analytical tools (Kaddoura & Al Husseiny, 2023). VR technology must address data privacy issues comprehensively. As concerns about platform security grow, attacks on VR headsets can confuse users by altering or placing images in their field of view (Gumbo *et al*., 2022; Kulal *et al*., 2022). Additionally, in the emerging landscape of virtual spaces, there is a glaring lack of comprehensive legal regulations at both national and international levels. Thus, the establishment of legal provisions for this environment is crucial and may attract attention from national and international educational communities. Since the internet is a decentralized environment, computer security tends to be low (Kaddoura & Al Husseiny, 2023).

Successful examples of VR usage in participatory urban policy-making

Melbourne's growth vision project

In 2014, the Victorian government launched the "Melbourne" project to outline a vision for the city's growth by 2050. The draft strategy statement identified the "northern district of the city" as an excellent area for urban regeneration that could accommodate significant growth. This project allowed citizens to explore future city development plans through immersive VR experiences. The initiative aimed to involve the public in urban policy decision-making by offering a realistic simulation of proposed developments, infrastructure projects, and public spaces. The primary goal of Melbourne's VR project was to engage citizens in the urban planning process by providing them with immersive and interactive experiences. Through VR technology, the project sought to enhance public awareness, understanding, and participation in decisions about the city's future development. The project was developed in collaboration with urban designers, architects, developers, and technology experts. The team used advanced 3D modeling, simulation, and VR technologies to create realistic virtual environments showcasing proposed urban developments, infrastructure projects, and public spaces.

The Melbourne VR project allows users to explore various aspects of the city's future, such as new buildings, transport networks, parks, and amenities. Users can navigate virtual environments, interact with objects, and experience different scenarios to understand potential changes to the urban landscape. Overall, the Melbourne VR project demonstrates the potential of VR to transform urban planning and policy-making by enhancing public participation, collaboration, and decision-making. Through innovative approaches like this, cities can become more inclusive, sustainable, and resilient in the face of future challenges (Jamei *et al*., 2017).

Urban planning in Stockholm

Stockholm, Sweden, has used VR to involve citizens in planning and designing urban spaces and addressing some of the city's urban challenges. VR workshops and simulations enabled stakeholders to provide feedback on proposed designs and fostered greater community participation and collaboration in urban policy-making. For instance, recent challenges that have drawn the attention of planners in Stockholm include rising sea levels (the Baltic Sea is expected to rise by up to 3 meters by 2030, threatening the city's coastline), population

growth, and balancing sustainability goals. Planners need to create new neighborhoods that are resilient to climate change, have low carbon emissions, align with national and international sustainability goals, and are safe and accessible to all citizens. Therefore, they have considered VR/AR as a potential solution. Their project, titled *''Augmented Urbans''*, aims to develop a prototype of VR/AR technology to support integrated planning processes that consider both people and nature. The project focuses on two key elements:

- *Engaging citizens in planning processes:* VR/AR can be a way to engage younger people, who are usually more difficult to involve in planning.
- *Visualizing ecosystem services:* VR/AR can help visualize the flow of benefits nature provides, such as clean air and water management.

While VR and AR have significant potential to enhance urban planning, it's important to note their limitations. These technologies should complement, rather than replace, traditional face-to-face interactions and public dialogue, and ethical and privacy considerations must be addressed when using VR and AR to collect data and share personal information. With these considerations in mind, VR and AR are powerful tools that can help cities create more participatory, transparent, and sustainable planning processes. As Stockholm and other leading cities have shown, these technologies have the potential to transform how plans are designed for a livable and resilient future (Mellegard, 2020).

Extended Reality (XR) in Helsinki

The city of Helsinki, Finland, established an XR center to explore the use of extended reality technologies, including virtual reality, in urban planning and governance. Through collaboration with technology companies, research institutions, and community groups, the XR Embassy develops innovative VR applications to engage citizens, analyze policies, and design urban spaces. These initiatives enhance public awareness and foster co-creation in Helsinki's urban development processes. One of the center's recent projects, SkillBill, seeks to raise awareness and education among academics, industry leaders, policymakers, and civil society about the urgent need to reduce carbon emissions through the widespread deployment of Renewable Energy Sources (RES) to achieve a sustainable urban future. SkillBill is a three-year project funded by the European Union under the Horizon Europe program. Its main objective is to promote education across different sectors to meet the evolving skill requirements in renewable energy. The project aims to involve citizens and stakeholders from all educational backgrounds, professional positions, and genders. Focusing on social, scientific, and technological approaches to tackling energy challenges, SkillBill seeks to contribute to the development of a low-carbon energy system. Metropolia University of Applied Sciences and its subsidiary, the XR Center Helsinki, are key participants. In Work Package 4, four universities are collaborating on an international master's degree program. Additionally, the XR center has developed four VR training modules, which will be used in various courses throughout the program (Helsinkixrcenter, 2022).

Collaborative redesign of a public park

The municipality of The Hague, in collaboration with The Hague University of Applied Sciences, participated in a collaborative design activity to gather evidence of the effectiveness of VR technology in participatory urban planning processes. In this project, 3D rendering and VR technology were integrated into the collaborative redesign of a public park in a neighborhood of approximately 13,500 people. The municipality defined four levels of participation, including consultation, proposal submission, co-creation, and joint decision-making. The goal of the district manager and neighborhood manager was to foster a sense of ownership among residents and involve them in a collective activity regarding the development of the park in their neighborhood. Initially, the municipality issued a call for residents to attend an informational session with experts. More than 70 residents participated in the event. Experts explained the project's technical and budgetary possibilities and limitations. Residents then presented their ideas for the park, resulting in over 60 written proposals. A working group of 25 neighborhood residents was formed. This working group collaborated with municipal experts to create three designs for the park. Members of the working group produced several preliminary drafts of park designs. These drafts were then refined by an urban landscape architect to create more detailed preliminary designs. Finally, using VR technology,

Table 2: Case studies of the use of VR technology in participatory urban planning

Case Study	Objective & Scope	Technology Used	Citizen Engagement Method	Policy Outcomes	Lessons Learned
Melbourne's Growth Vision Project	Urban growth and regeneration by 2050	VR	Immersive simulations, interactive experiences	Enhanced awareness; influenced policy discussions	VR can effectively visualize large-scale urban transformations. Collaboration with experts is key.
Urban Planning in Stockholm	Climate resilience and sustainable development	VR/AR	Workshops, simulations, targeting youth engagement	Improved dialogue on sustainability and urban resilience	Combining VR/AR with traditional methods ensures inclusivity and addresses privacy concerns.
Extended Reality (XR) in Helsinki	Renewable energy education and urban planning	XR	Training modules, public and professional involvement	Advanced public and stakeholder awareness on sustainability	XR is effective in integrating education with urban planning; collaboration enhances outcomes.
Collaborative Redesign of a Public Park (The Hague)	Neighborhood park redesign through collaborative efforts	VR	Workshops, voting mechanisms with local residents	Achieved community consensus and fostered ownership	VR enhances localized collaborative design and decision-making processes.
Neighborhood Parks Project in Jordan	Assess user preferences in neighborhood parks	VR	Immersive visualization, questionnaires	Improved design based on user feedback	VR is effective in gathering precise feedback; accessible technologies are essential.
Pedestrian Path Multi-Sensory Simulation	Evaluate pedestrian pathways using multi-sensory feedback	Multi-sensory VR	Guided simulations, participant observation	Increased feedback and engagement levels	Multi-sensory VR provides richer data and enhances user recall and feedback.
Houston and Bowery Street Wall History	Preservation of urban art history using immersive experiences	AR	Virtual historical tours for the public	Increased cultural engagement and awareness	AR effectively preserves and communicates cultural heritage.

working group members could visualize their preliminary designs in a semi-realistic environment and cast their final votes (Van Leeuwen *et al*., 2018).

Neighborhood park user preferences project in Jordan

In 2024, Al Shawabkeh and Arar conducted a project in Jordan, West Asia, to examine citizens' preferences in neighborhood parks. VR technology was used in this project to demonstrate that it has fewer limitations compared to traditional participation methods. In this project, local participants, based on their prior understanding of the current conditions, experienced the park design through VR and were then asked to complete a questionnaire. This questionnaire included 22 questions divided into two sections: one focused on safety and legibility and the other on accessibility factors. Through the use of VR headsets and other tools, participants were able to visualize and understand the type of interventions needed to resolve the issues in their neighborhood park (Al Shawabkeh & Arar, 2024).

Pedestrian path and multi-sensory VR simulation

In another study conducted by Meenar and Kitson in 2020, multi-sensory VR technology (comprising multiple dimensions) was tested and evaluated. After creating a basic VR simulation, the project team added different transportation modes, vegetation, and more to a pedestrian pathway. In this simulation, some physical or sensory design flaws were intentionally retained to record participants' reactions. In later stages, auditory and olfactory

stimuli were added. Group experiments were predetermined, and participants had no control over the exploration path or speed. A 7-minute simulation of the pedestrian area under study was recorded. This simulation explained the proposed design features and walked participants through the path. In this project, compared to 2D projects, participants shared more opinions, asked more questions, exhibited higher memory recall, and provided more dynamic and active positive/negative responses to the designed scenarios (Meenar & Kitson, 2020).

Display the artistic history of the famous Houston and Bowery Street Wall

One potential use of VR technology is "place-making in urban spaces," with AR playing a prominent role. In 1982, American artist Alan Haring painted a mural on the wall at Houston and Bowery Streets. Unfortunately, the original mural was destroyed. However, in 2008, the wall was reconstructed. In 2012, AR technology was incorporated into the project to create a virtual history of the site. Users can take a virtual tour of the wall's history and view each section as it originally appeared. This project serves as a public engagement tool, transferring the historical memories of urban art through AR solutions (Sanaeipoor & Emami, 2020). Table 2 provides a summary of virtual reality-related projects.

CONCLUSION

VR has emerged as a transformative tool in participatory urban policy-making, offering significant potential for enhancing citizen engagement, improving transparency, and facilitating collaborative decision-making. By immersing users in simulated virtual environments, VR provides an engaging experience of urban designs, projects, and policies, allowing citizens to actively participate in the planning process. This technology holds the promise of encouraging participation, particularly among those who may be reluctant to engage in traditional methods, such as public meetings or surveys, by presenting information in a more comprehensible and interactive manner. However, while the advantages of VR are substantial, it is crucial to address the challenges and limitations associated with its implementation. High costs of equipment and technical knowledge requirements can restrict access for certain groups, especially in low-income communities. Older individuals and those less familiar with technology may struggle to utilize VR effectively, which could exacerbate existing digital divides. Furthermore, the potential for bias, manipulation of perceptions, and concerns over data privacy must be carefully managed to ensure the responsible use of VR in participatory processes. To maximize the potential of VR in urban policy-making and to overcome current challenges, several avenues for future work should be explored. Research on accessibility and inclusivity is vital to ensure that VR technologies cater to diverse demographic groups, particularly marginalized communities. Developing hybrid engagement models that combine VR with traditional participatory methods can further broaden citizen involvement. Empirical evaluations of VR's impact on decision-making will provide insights into how it influences stakeholder engagement and the quality of discussions in urban planning. Specific Future Research Opportunities:

- *Longitudinal Studies:* Conduct studies to assess the long-term effects of VR engagement on public policy decisions and community satisfaction.
- *Quantitative Assessments:* Perform comparative analyses of VR-based methods against traditional participatory approaches to measure engagement levels and policy outcomes.
- *Cross-Case Comparisons:* Analyze various case studies to identify best practices and key factors for successful VR implementation in different contexts.
- *Demographic Impacts:* Investigate how different demographic groups interact with VR technologies to ensure inclusive engagement in policy-making.
- *Ethical Considerations:* Explore the ethical implications of VR use in urban planning, focusing on data privacy and potential biases.
- *Technology Integration:* Study the synergistic effects of combining VR with other emerging technologies to enhance participatory processes.

Establishing a clear ethical framework for the use of VR in participatory processes is essential, addressing concerns related to data privacy, security, and biases in VR representations. Continued advancements in VR technology, such as improved graphics and interactivity, will enhance the realism and effectiveness of participatory simulations. Moreover, fostering cross-disciplinary collaborations can lead to innovative approaches that leverage VR for storytelling and community engagement. Public education and training programs are crucial

for demystifying VR technology and empowering individuals to engage actively in urban policy discussions. Real-world applications through pilot projects can offer valuable insights, helping refine methods for broader implementation. Finally, establishing continuous feedback mechanisms from participants will enable iterative improvements in VR applications, ensuring that these technologies remain relevant and effective in addressing the needs of communities. In conclusion, our research demonstrates that virtual reality is a powerful tool with the potential to revolutionize participatory policy-making processes. By addressing current challenges and using this technology responsibly, VR can serve as a valuable instrument for enhancing citizen engagement, transparency, and collaborative decision-making in urban policy-making. As we continue to develop and refine these technologies, we move closer to creating more sustainable, inclusive cities that are truly responsive to the needs of their citizens.

AUTHOR CONTRIBUTIONS

Shakibamanesh led the research project, coordinated the contributions of all authors, and was responsible for the overall direction, planning, and supervision of the study. A. Shakibamanesh also reviewed and edited the manuscript. M. Ghorbanian performed the literature review, contributed to the development of the methodology, and analyzed and interpreted the data. M. Ghorbanian also contributed to manuscript preparation and revision. S. Izadi was involved in the study of various case studies, collected data from different sources, and assisted in analyzing and interpreting the data. S. Izadi also contributed to the review of articles for the paper. A. Riahi developed the background section, assisted with analyzing different articles for the review, and contributed to manuscript editing and formatting. P. Zeif Aldini contributed to the analysis of various case studies, helped compile the data, and was involved in the preparation and editing of the manuscript.

ACKNOWLEDGMENT

This paper is extracted from a research project entitled *"Utilizing the Operational Capabilities of Virtual Reality Modeling in the Implementation of Urban Policies & Plans,"* funded by the Tehran Urban Research & Planning Center (TURPC) under the auspices of Tehran Municipality in 2024. Gratefully acknowledge the support provided by TURPC and Tehran Municipality, which enabled the successful completion of this research.

CONFLICT OF INTEREST

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

OPEN ACCESS

PUBLISHER NOTE

ABBREVIATIONS

AR	Augmented Reality
GIS	Geographic Information System
ICT	Information and Communication Technology
MR	Mixed Reality
RES	Renewable Energy Sources

TURPC	Tehran Urban Research & Planning Center
VR	Virtual Reality
WPP	Web-Based Public Participation
EX	Extended Reality

REFERENCES

Agudelo-Vélez, A.; Sarmiento-Ordosgoitia, I.; Córdoba-Maquilón, J. (2021). Virtual reality as a new tool for transport data collection. Arch. Transp., 60(4): 23–38 **(16 pages).**

Al Shawabkeh, R.; Arar, M. (2024). The role of virtual reality in improving neighborhood park design: A comparative study of virtual reality and traditional approaches. Int. J. Geoheritage Parks: 75–97 **(23 pages)**.

Al-Kodmany, K. (2020). Tall buildings and the city: Improving the understanding of placemaking, imageability, and tourism. Springer Nature: 83–119 **(37 pages)**.

Al-Kodmany, K. (2002). Visualization tools and methods in community planning: from freehand sketches to virtual reality, J. Plan. Lit., 17(2): 189–211 (**23 pages**).

Arabiun, A.; Tajpour, M.; Zahedi, M. R. (2024). The effect of digital leadership on the performance of businesses: the mediating role of organizational entrepreneurship. International Journal of Human Capital in Urban Management., 9(1): 17–28 (**12 pages**).

Araiza-Alba, P.; Keane, T.; Chen, W. S.; Kaufman, J. (2021). Immersive virtual reality as a tool to learn problem-solving skills. Comput. Educ., 164: 1–33 (**34 pages**).

Bakhanova, E.; Garcia, J. A.; Raffe, W. L.; Voinov, A. (2020). Targeting social learning and engagement: What serious games and gamification can offer to participatory modeling. Environ. Modell. Software., 134: 1–15 (**15 pages**).

Barki, H.; Hartwick, J. (1989). Rethinking the concept of user involvement. MIS Quarterly: 53–63 **(11 pages)**.

Baniasadi, T.; Niakan Kalhori, S. R.; Ayyoubzadeh, S. M.; Zakerabasali, S.; Pourmohamadkhan, M. (2018). Study of challenges to utilize mobile-based health care monitoring systems: a descriptive literature review. J. Telemed. Telecare., 24(10): 661–668 (**8 pages**).

Basu, A. (2019). A brief chronology of Virtual Reality. Preprint submitted to ArXiv, November 22: 1–18 **(18 pages)**.

Batty, M. (2013). Big data, smart cities, and city planning. Dialogues in Human Geography., 3(3): 274–279 **(6 pages)**.

Boertien, R. (2021). Immersive Virtual Reality, a participatory-enhancing tool for collaborative spatial planning and design (Doctoral dissertation): 1–73 **(73 pages)**.

Boos, Bolton, T.; Dargahi, T.; Belguith, S.; Al-Rakhami, M. S.; Sodhro, A. H. (2021). On the security and privacy challenges of virtual assistants. Sensors., 21(7): 1–19 **(19 pages)**.

Brilakis, I.; Fischer, H.; Pan, Y.; Borrmann, A.; Mayer, H.-G.; Rhein, F.; Vos, C.; Pettinato, E.; Wagner, S. (2019). Built environment digital twinning: Report of the international workshop on built environment digital twinning. Technical University of Munich, Germany: 1–40 **(40 pages)**.

Burdea, G.; Coiffet, P. (1994). Virtual Reality Technology. John Wiley & Sons: 1–23 **(23 pages)**.

Caldarola, E. G.; Rinaldi, A. M. (2017). Big data visualization tools: a survey. Research Gate: 1–10 **(10 pages)**.

Castelnovo, W.; Misuraca, G.; Savoldelli, A. (2016). Smart cities governance: The need for a holistic approach to assessing urban participatory policy making. Social Sci. Comput. Rev., 34(6): 724–739 **(16 pages)**.

Ceconello, M.; Spallazzo, D. (2008, October). Virtual reality for enhanced urban design. In Proceedings of 5th INTUITION, International Conference Virtual Reality in Industry and Society: From Research to Application. 6-8 Ottobre 2008. Torino: 1–8 **(8 pages)**.

Checa, D.; Bustillo, A. (2020). A review of immersive virtual reality serious games to enhance learning and training. Multimedia Tools and Applications., 79(9): 5501–5527 **(27 pages)**.

Clarke, E. (2021). Virtual reality simulation—the future of orthopedic training? A systematic review and narrative analysis. Advances in Simulation., 6: 1–10 **(10 pages).**

Connor, D. M. (1988). A new ladder of citizen participation. Nat'l Civic Rev., 77: 248–257 **(10 pages).**

Cosgrave, E.; Tryfonas, T.; Crick, T. (2014). The smart city from a public value perspective: 1–10 **(10 pages).**

Cruz-Neira, C.; Sandin, D. J.; DeFanti, T. A. (1993). Surround-screen projection-based virtual reality: The design and implementation of the CAVE. In Proceedings of the 20th Annual Conference on Computer Graphics and Interactive Techniques: 135–142 **(8 pages)**.

Delgado, J. M. D.; Oyedele, L.; Demian, P.; Beach, T. (2020). A research agenda for augmented and virtual reality in architecture, engineering, and construction. Advanced Engineering Informatics., 45: 1–21 **(21 pages).**

Dembski, F.; Wössner, U.; Letzgus, M.; Ruddat, M.; Yamu, C. (2020). Urban digital twins for smart cities and citizens: The case study of Herrenberg, Germany. Sustainability., 12(6): 1–17 **(18 pages).**

Deterding, S.; Sicart, M.; Nacke, L.; O'Hara, K.; Dixon, D. (2011). Gamification: Using game-design elements in non-gaming contexts. In CHI'11 Extended Abstracts on Human Factors in Computing Systems., 2425–2428 **(4 pages)**.

Dyer, M.; Corsini, F.; Certomà, C. (2017). Making urban design a public participatory goal: toward evidence-based urbanism. Proceedings of the Institution of Civil Engineers-Urban Design and Planning, 170(4):173–186 **(13 pages)**.

Ehab, A.; Heath, T.; Burnett, G. (2023, July). Virtual Reality and the Interactive Design of Elevated Public Spaces: Cognitive Experience vs VR Experience. In International Conference on Human-Computer Interaction., 176–184 **(9 pages)**.

El Araby, M. (2002, February). Possibilities and constraints of using virtual reality in urban design. In Proceedings of the 7Th International CORP Symposium, Vienna, Austria., 457–463 **(7 pages)**.

Falanga, R. (2020). Participatory design: participatory urban management. In Sustainable Cities and Communities (pp. 449-457). Cham: Springer International Publishing., 449–457 **(8 pages)**.

Fares, F.; Taha, D. S.; Sayad, Z. T. E. (2018). Achieving public participation in inaccessible areas using virtual reality a case study of Beit Hanoun–Gaza–Palestine. Alexandria Engineering Journal., 57(3): 1821–1828 **(8 pages)**.

Feeney, M. K.; Welch, E. W. (2012). Electronic participation technologies and perceived outcomes for local government managers. Public Management Review., 14(6): 815–833 **(18 pages)**.

Fernández, R. P.; Alonso, V. (2015). Virtual Reality in a shipbuilding environment. Advances in Engineering Software., 81: 30–40 **(11 pages)**.

Fraser, M.; Bjornsson, H. (2004). Real-time digital modeling in design education and practice. Urban Design International., 9: 187–196 **(9 pages)**.

Gandhi, R. D.; Patel, D. S. (2018). Virtual reality–opportunities and challenges. Virtual Reality., 5(01): 2714–2724 **(11 pages)**.

García, M.; Eizaguirre, S.; & Pradel, M. (2015). Social innovation and creativity in cities: A socially inclusive governance approach in two peripheral spaces of Barcelona. City, Culture and Society, 6(4), 93-100 **(8 pages)**.

Getso, M. M. A.; Bakon, K. A. (2017). Virtual reality in education: the future of learning. International Journal of Information System and Engineering., 5(2): 30–39 **(10 pages)**.

Greenhalgh, T.; Robert, G.; Macfarlane, F.; Bate, P.; Kyriakidou, O. (2004).

Diffusion of innovations in service organizations: systematic review and recommendations. The Milbank Quarterly., 82(4): 581–629 **(49 pages)**.

Halvorsen, K. E. (2003). Assessing the effects of public participation. Public Administration Review., 63(5): 535–543 **(9 pages)**.

Harris, T.; Weiner, D. (1998). Empowerment, marginalization, and" community-integrated" GIS. CaGIS., 25(2): 67–76 **(10 pages)**.

Hassan, L.; Hamari, J. (2020). Gameful civic engagement: A review of the literature on gamification of e-participation. Government Information Quarterly., 37(3): 1–21 **(22 pages)**.

Healey, P. (2020). Collaborative planning: Shaping places in fragmented societies. Bloomsbury Publishing., 1–362 **(363 pages).**

Hidayah, N.; Meidiana, C.; Firdausiyah, N.; Ghosh, R. K.; Amalia, R. (2024). STATUS OF THE RURAL COMMUNITY ON THE LADDER OF PUBLIC PARTICIPATION. THE CASE OF WASTE MANAGEMENT PROGRAM IN MOJOSARI VILLAGE, BOJONEGORO. Journal of Environmental Engineering and Sustainable Technology., 11(01): 14–23 **(10 pages).**

Hirzle, T. (2023). Digital Eye Strain in Virtual Reality Head-Mounted Displays: Properties, Causes, Solutions, and Perspective (Doctoral dissertation, Universität Ulm)., 1–248 **(248 pages)**.

Ismail, A. W.; Sunar, M. S. (2009). Collaborative augmented reality: multi-user interaction in urban simulation., 382–391 **(10 pages)**.

Jamei, E.; Mortimer, M.; Seyedmahmoudian, M.; Horan, B.; Stojcevski, A. (2017). Investigating the role of virtual reality in planning for sustainable smart cities. Sustainability., 9(11): 1–16 **(16 pages)**.

Jiang, L.; Masullo, M.; Maffei, L.; Meng, F.; Vorländer, M. (2018). How do shared-street design and traffic restriction improve urban soundscape and human experience?An online survey with virtual reality. Building and Environment., 143: 318–328 **(11 pages)**.

Johansen, A. G.; Pedersen, C. B. (2019). Gamified participation: Challenging the current participation methods in urban development with Minecraft. Institute of Architecture & Design, Aalborg University., 1–102 **(102 pages).**

Kaddoura, S.; Al Husseiny, F. (2023). The rising trend of Metaverse in education: Challenges, opportunities, and ethical considerations: PeerJ Comput. Sci., 9: 1–33 **(33 pages).**

Kaimara, P.; Oikonomou, A.; Deliyannis, I. (2022). Could virtual reality applications pose real risks to children and adolescents? A systematic review of ethical issues and concerns. Virtual Reality., 26(2): 697–735 **(38 pages)**.

Kamińska, D.; Sapiński, T.; Wiak, S.; Tikk, T.; Haamer, R. E.; Avots, E.; Anbarjafari, G. (2019). Virtual reality and its applications in education: Survey. Information., 10(10): 1–20 **(20 pages).**

Kaplan, A. D.; Cruit, J.; Endsley, M.; Beers, S. M.; Sawyer, B. D.; Hancock, P. A. (2021). The effects of virtual reality, augmented reality, and mixed reality as training enhancement methods: A meta-analysis. Human factors., 63(4): 706–726 **(11 pages)**.

Kim, J.; Kim, S. (2019). Finding the optimal D/H ratio for an enclosed urban square: Testing an urban design principle using immersive virtual reality simulation techniques. Int. J. Environ. Res. Public Health., 16(5): 1–19 **(19 pages).**

Kim, Y. M.; Rhiu, I.; Yun, M. H. (2020). A systematic review of a virtual reality system from the perspective of user experience, Int. J. Hum.-Comput. Interact., 36(10): 893–910 **(18 pages)**.

Kitson, J.; Leiva, M.; Christman, Z.; Dalton, P. (2019). Evaluating urban odor with field olfactometry in Camden, NJ. Int. J. Urban Sci., 3(3): 1–12 **(12 pages).**

Korkut, E. H.; Surer, E. (2023). Visualization in virtual reality: a systematic review. Virtual Reality., 27(2): 1447–1480 **(34 pages)**.

Kulal, S.; Li, Z.; Tian, X. (2022). Security and privacy in virtual reality: A literature review. Issues in Information Systems., 23(2): 185–192 **(8 pages)**.

Kuna, P.; Haková, A.; Borza, Ľ. (2023). Creation of virtual reality for education purposes. Sustainability., 15(9): 1–19 **(20 pages).**

Lanier, J. (2017). Dawn of the New Everything: Encounters with Reality and Virtual Reality. Henry Holt and Co., 1–350 **(351 pages)**.

Lele, A. (2013). Virtual reality and its military utility. J. Ambient Intell. Hum. Comput., 4: 17–26 **(10 pages)**.

Li, H.; Zhang, J.; Xia, L.; Song, W.; Bode, N. W. (2019). Comparing the route-choice behavior of pedestrians around obstacles in a virtual experiment and a field study. Transp. Res. Part C Emerging Technol., 107: 120–136 **(17 pages).**

Lippman, A. (1980). Movie-maps: An application of the optical videodisc to computer graphics Proc. ACM Comput. Graphics Comput. Syst., 32–42 **(11 pages).**

Lironi, E. (2016). Potential and Challenges of E-participation in the European Union., 1–76 **(77 pages).**

Liu, X. (2020). Three-dimensional visualized urban landscape planning and design based on virtual reality technology. IEEE Access., 8: 149510–149521 **(12 pages).**

Meenar, M.; Kitson, J. (2020). Using multi-sensory and multi-dimensional immersive virtual reality in participatory planning. Int. J. Urban Sci., 4(3), 34: 1–19 **(19 pages).**

Mueller, J.; Lu, H.; Chirkin, A.; Klein, B.; Schmitt, G. (2018). Citizen Design Science: A strategy for crowd-creative urban design. Cities., 72: 181–188 **(8 pages).**

Nesti, G. (2020). Partnerships for innovation: The case of the urban living lab in Turin. In C. Van Montfort, & A. Michels (Eds.), Partnerships for livable cities., 317–334 **(28 pages).**

Nochta, T.; Wan, L.; Schooling, J. M.; Parlikad, A. K. (2021). A socio-technical perspective on urban analytics: The case of city-scale digital twins. J. Urban Technol., 28(1-2): 263–287 **(24 pages).**

Oksman,V.; Väätänen, A.; Ylikauppila, M. (2014). Future Illustrative and Participative Urban Planning Developing Concepts for Co-creation. Proceedings of the Sixth International Conference on Creative Content Technologies., 22–29 **(8 pages).**

Pallavicini, F.; Argenton, L.; Toniazzi, N.; Aceti, L.; Mantovani, F. (2016). Virtual reality applications for stress management training in the military. Aerosp. Med. Hum. Perform., 87(12): 1021–1030 **(10 pages).**

Pimentel, D.; Kalyanaraman, S. (2022). The effects of embodying wildlife in virtual reality on conservation behaviors. Sci. Rep., 12(1): 1–18 **(19 pages).**

Portman, M. E., Natapov, A., & Fisher-Gewirtzman, D. (2015). To go where no man has gone before: Virtual reality in architecture, landscape architecture and environmental planning. Computers, Environment and Urban Systems., 54: 376-384 **(9 pages).**

Rheingold, H. (1991). Virtual Reality. Summit Books: 1–415 **(416 pages).**

Rogers, S. L.; Broadbent, R.; Brown, J.; Fraser, A.; Speelman, C. P. (2022). Realistic motion avatars are the future for social interaction in virtual reality. Front. Virtual Reality., 2: 1–12 **(12 pages).**

Saeed, Z. O.; Mancini, F.; Glusac, T.; Izadpanahi, P. (2022). Future city, digital twinning, and the urban realm: A systematic literature review. Buildings., 12(5): 1–24 **(24 pages).**

Sagnier, C.; Loup-Escande, E.; Valléry, G. (2020). Effects of gender and prior experience in immersive user experience with virtual reality. In Advances in Usability and User Experience: Proceedings of the AHFE 2019 International Conferences on Usability & User Experience, and Human Factors and Assistive Technology, July 24-28, 2019, Washington DC, USA 10 (pp. 305-314). Springer International Publishing: 305–314 **(9 pages).**

Sarjakoski, T. (1998). Networked GIS for public participation—emphasis on utilizing image data. Computers, Environment, and Urban Systems., 22(4): 381–392 **(12 pages).**

Savoldelli, A.; Codagnone, C.; Misuraca, G. (2014). Understanding the e-government paradox: Learning from literature and practice on barriers to adoption. Government Information Quarterly., 31: S63–S71 **(9 pages).**

Scerri, K.; Attard, M. (2023). People as planners: Stakeholder

participation in the street experimentation process using a virtual urban living lab. J. Urban Mobility., 4: 1–8 **(8 pages).**

Schively, C. (2007). A quantitative analysis of consensus building in local environmental review. JPER., 27(1): 82–98 **(18 pages).**

Schrom-Feiertag, H.; Stubenschrott, M.; Regal, G., Matyus, T.; Seer, S. (2020, May). An interactive and responsive virtual reality environment for participatory urban planning. In Proceedings of the 11th Annual Symposium on Simulation for Architecture and Urban Design., 1–7 **(7 pages).**

Schrotter, G.; Hürzeler, C. (2020). The digital twin of the city of Zurich for urban planning. PFG Journal of Photogrammetry, Remote Sensing and Geoinformation Science., 88(1): 99–112 **(14 pages).**

Scrivner, O.; Madewell, J.; Buckley, C.; Perez, N. (2019). Best practices in the use of augmented and virtual reality technologies for SLA: Design, implementation, and feedback. Teaching language and teaching literature in virtual environments., 55–72 **(18 pages).**

Shahat, E.; Hyun, C. T.; Yeom, C. (2021). City digital twin potentials: A review and research agenda. Sustainability., 13(6): 1–20 **(20 pages).**

Shakeri, M. (2017). The use of digital games in participatory planning practices (Master's thesis, The University of Manchester)., 1–209 **(209 pages).**

Sherman, W. R.; Craig, A. B. (2003). Understanding Virtual Reality: Interface, Application, and Design. Morgan Kaufmann., 1–903 **(903 pages).**

Smith, L.; Lyons, F.; Bridges, B.; & Casey, R. (2022, December). WithFeelVR: the spatial and textural affordances of VR as a mapping strategy for an accessible digital musical instrument. In Proceedings of the International Computer Music Conference 2022: Standing Wave, 124–131 **(8 pages).**

Springs, D. (2024). Elements of Smart Leadership Approaches for Smart City Development. Business Ethics and Leadership., 8(2): 35–48 **(14 pages).**

Stanberry, B. (2001). Legal ethical and risk issues in telemedicine. Comput. Methods Programs Biomed., 64(3): 225–233 **(9 pages).**

Stanney, K.; Fidopiastis, C.; Foster, L. (2020). Virtual reality is sexist: but it does not have to be. Front. Rob. AI., 7: 1–19 **(19 pages).**

Stauskis, G. (2014). Development of methods and practices of virtual reality as a tool for participatory urban planning: a case study of Vilnius City as an example for improving environmental, social and energy sustainability. Energy Sustainability Soc., 4: 1–13 **(14 pages).**

Stern, E.; Amir, I. (2006). "Benefits of public participation as evaluated by the participating citizens''. In Annual Conference of Israel Planning Association, Hertzelia (in Hebrew)., 1067–1085 **(19 pages).**

Stern, E.; Gudes, O.; Svoray, T. (2009). Web-based and traditional public participation in comprehensive planning: a comparative study. Environment and Planning B: Planning and Design., 36(6): 1067–1085 **(19 pages).**

Sutherland, I. E. (1965). The Ultimate Display. Proceedings of the IFIP Congress., 506–508 **(3 pages).**

Thiel, S. K. (2017). Let's play Urban Planner: the use of game elements in public participation platforms. plaNext–next-generation planning., 4: 58–75 **(18 pages).**

U. C.; Reichenbacher, T.; Kiefer, P.; Sailer, C. (2023). An augmented reality study for public participation in urban planning. J. Locat. Based Serv., 17(1): 48–77 **(30 pages).**

Van Dessel, A. (2019). The Use of Virtual Reality in Urban Planning: Review paper on the (dis)advantages and a new perspective for future research., 3–8 **(6 pages).**

Van Leeuwen, J. P.; Hermans, K.; Jylhä, A.; Quanjer, A. J.; Nijman, H. (2018, November). Effectiveness of virtual reality in participatory urban planning: A case study. In Proceedings of the 4th Media Architecture Biennale Conference., 128–136 **(9 pages).**

Wang, Y.; Lin, Y. S. (2023). Public participation in urban design with augmented reality technology based on indicator evaluation—Front. Virtual Reality., 4: 1–18 **(18 pages).**

Weil, M. (2014). Community practice: Conceptual models. Routledge: 1–31 **(31 pages).**

Weinstock, M. (2013). E-Participation–New opportunities for citizen participation in urban planning projects. Citizen Participation in Project Development (German), Immobilien Manager Verlag, Köln., 1–18 **(18 pages).**

Weiner, D.; Harris, T. M.; Craig, W. J. (2002). Community participation and geographic information systems. In Community participation and geographical information systems., 3–16 **(14 pages).**

Whyte, J.; Nikolić, D. (2018). Virtual Reality and the Built Environmen., 14–25 **(12 pages).**

Wohlgenannt, I.; Simons, A.; Stieglitz, S. (2020). Virtual reality. (BISE)., 62: 455–461 **(7 pages).**

Won, M.; Ungu, D. A. K.; Matovu, H.; Treagust, D. F.; Tsai, C. C.; Park, J.; Tasker, R. (2023). Diverse approaches to learning with immersive Virtual Reality identified from a systematic review. Comput. Educ., 195: 1–24 **(24 pages).**

Wu, B.; Yu, X.; Gu, X. (2020). Effectiveness of immersive virtual reality using head-mounted displays on learning performance: A meta-analysis. J. Educ. Technol. Syst., 51(6): 1991–2005 **(15 pages).**

Xiang, R. (2024). Enhancing Democratic Governance: The Crucial Role of Broad Public Participation in Government Public Consultations. International Journal of Education and Humanities., 13(3): 254–256 **(3 pages).**

Xu, S. (2021). Three-Dimensional Visualization Algorithm Simulation of Construction Management Based on GIS and VR Technology. J. Complexity., 2021(1) : 1–13 **(13 pages).**

Yamu, C.; Poplin, A.; Devisch, O.; De Roo, G. (2017). The virtual and the real in planning and urban design: perspectives, practices and applications. Routledge, Taylor & Francis Group., 1–279 **(280 pages).**

HOW TO CITE THIS ARTICLE

Shakibamanesh, A.; Ghorbanian, M.; Izadi, S. ; Riahi, A. ; Zeifodini, P., (2025). Utilizing virtual reality in the participatory urban policy-making process: A step toward facilitating effective citizen engagement.Int. J. Hum. Capital Urban Manage., 10(2): 371-390.

DOI: 10.22034/IJHCUM.2025.02.12

URL: https://www.ijhcum.net/article_718747.html

PUBLICATION ETHICS

The ethical policy of IJHCUM is based on the Committee on Publication Ethics (COPE) guidelines and complies with International Committee of IJHCUM Editorial Board codes of conduct. Readers, authors, reviewers and editors should follow these ethical policies once working with IJHCUM. The ethical policy of IJHCUM is liable to determine which of the typical research papers or articles submitted to the journal should be published in the concerned issue. For information on this matter in publishing and ethical guidelines please visit http://publicationethics.org

Duties and Responsibilities of Publishers

1. IJHCUM is committing to ensure that editorial decisions on manuscript submissions are the final.
2. IJHCUM is promising to ensure that the decision on manuscript submissions is only made based on professional judgment and will not be affected by any commercial interests.
3. IJHCUM is committing to maintain the integrity of academic and research records.
4. IJHCUM is monitoring the ethics by Editor-in-Chief, Associate Editors, Editorial Board Members, Reviewers, Authors, and Readers.
5. IJHCUM is always checking the plagiarism and fraudulent data issues involving in the submitted manuscript.
6. IJHCUM is always willing to publish corrections, clarifications and retractions involving its publications as and when needed.

Duties and Responsibilities of Editors

1. The Editors of the journal should have the full authority to reject/accept a manuscript.
2. The Editors of the journal should maintain the confidentiality of submitted manuscripts under review or until they are published.
3. The Editor-in-Chief should take a decision on submitted manuscripts, whether to be published or not with other editors and reviewers
4. The Editors of the journal should preserve the anonymity of reviewers.
5. The Editors of the journal should disclose and try to avoid any conflict of interest.
6. The Editors of the journal should maintain academic integrity and strive to meet the needs of readers and authors.
7. The Editors of the journal should be willing to investigate plagiarism and fraudulent data issues and willing to publish corrections, clarifications, retractions, and apologies when needed.
8. The Editors of the journal should have the limit themselves only to the intellectual content.
9. The Editors of the journal must not disclose any information about submitted manuscripts to anyone other than the corresponding author, reviewers, potential reviewers, other editorial advisers, and the publisher, as appropriate.
10. Unpublished materials disclosed in a submitted paper will not be used by the editor or the members of the editorial board for their own research purposes without the author's explicit written consent.

Duties and Responsibilities of Reviewers

1. The Reviewers of the journal should assist the Editors in taking the decision for publishing the submitted manuscripts.
2. The Reviewers should maintain the confidentiality of manuscripts, which they are invited to review.
3. The Reviewers should provide comments in time that will help editors to make decision on the submitted manuscript to be published or not.
4. The Reviewers are bound to treat the manuscript received for peer reviewing as confidential, and must not use the information obtained through peer review for personal advantage.
5. The Reviewers comments against each invited manuscript should be technical, professional and objective.
6. The Reviewers should not review the manuscripts in which they have found conflicts of interest with any of the authors, companies, or institutions.
7. The Reviewers should disclose and try to avoid any conflict of interest.

Duties and Responsibilities of Authors

1. Manuscripts must be submitted only in English and should be written according to sound grammar and proper terminology.
2. Manuscripts must be submitted with the understanding that they have not been published elsewhere (except in the form of an abstract or as part of a published lecture, review, or thesis) and are not currently under consideration by another journal published by or any other publisher.
3. The submitting (corresponding) author is responsible for ensuring that the manuscript article's publication has been approved by all the other coauthors.
4. In order to sustain the peer review system, authors have an obligation to participate in peer review process to evaluate manuscripts from others.
5. It is also the authors' responsibility to ensure that the manuscripts emanating from a particular institution are submitted with the approval of the necessary institution.
6. It is a condition for submission of a manuscript that the authors permit editing of the paper for readability.
7. Authors are requested to clearly identify who provided financial support for the conduct of research and/or preparation of the manuscript and briefly describe the role of the funder/sponsor in any part of the work.
8. A copy right release and conflict of interest disclosure form must be signed by the corresponding author in case of multiple authorships, prior to the acceptation of the

manuscript, by all authors, for publication to be legally responsible towards the Journal ethics and privacy policy.

9. Under open access license, authors retain ownership of the copyright for their content, but allow anyone to download, reuse, reprint, modify, distribute, and/ or copy the content as long as the original authors and source are cited properly.
10. All authors have agreed to allow the corresponding author to serve as the primary correspondent with the editorial office, to review the edited manuscript and proof.
11. When author(s) discovers a significant error or inaccuracy in his/her own published work, it is the author's obligation to promptly notify the journal editor or publisher to retract or correct the manuscript.
12. All authors must know that that the submitted manuscripts under review or published with IJHCUM are subject to screening using Plagiarism Prevention Software. Plagiarism is a serious violation of publication ethics.

Violation of Publication Ethics

1. **Plagiarism:** Plagiarism is intentionally using someone else's ideas or other original material as if they are one's own. Copying even one sentence from someone else's manuscript, or even one of your own that has previously been published, without proper citation is considered by IJHCUMJournal as plagiarism. All manuscripts under review or published with IJHCUM are subject to screening using plagiarism prevention software. Thus, plagiarism is a serious violation of publication ethics. The development of CrossCheck is a service that helps editors to verify the originality of papers. CrossCheck is powered by the Ithenticate software from iParadigms, known in the academic community as providers of Turnitin. For a searchable list of all journals in the CrossCheck database, please visit: www.ithenticate.com/search
2. **Data Fabrication and Falsification:** Data fabrication and falsification means the researcher did not really carry out the study, but made up data or results and had recorded or reported the fabricated information. Data falsification means the researcher did the experiment, but manipulated, changed, or omitted data or results from the research findings.
3. **Simultaneous Submission:** Simultaneous submission occurs when a manuscript (or substantial sections from a manuscript) is submitted to a journal when it is already under consideration by another journal.
4. **Duplicate Publication:** Duplicate publication occurs when two or more papers, without full cross referencing, share essentially the same hypotheses, data, discussion points, and conclusions.
5. **Redundant Publications:** Redundant publications involve the inappropriate division of study outcomes into several articles, most often consequent to the desire to plump academic vitae.
6. **Improper Author Contribution or Attribution:** All listed authors must have made a significant scientific contribution to the research in the manuscript and approved all its claims. Don't forget to list everyone who made a significant scientific contribution, including students and laboratory technicians.
7. **Citation Manipulation:** Citation Manipulation is including excessive citations, in the submitted manuscript, that do not contribute to the scholarly content of the article and have been included solely for the purpose of increasing citations to a given author's work, or to articles published in a particular journal. This leads to misrepresenting the importance of the specific work and journal in which it appears and is thus a form of scientific misconduct.

Handling Cases of Misconduct

Once IJHCUM confirms a violation against IJHCUM's publication ethics, IJHCUM addresses ethical concerns diligently following an issue-specific standard practice as summarized below.

1. The first action of the journal Editor is to inform the Editorial Office of IJHCUM by supplying copies of the relevant material and a draft letter to the corresponding author asking for an explanation in a nonjudgmental manner.
2. If the author's explanation is unacceptable and it seems that serious unethical conduct has taken place, the matter is referred to the Publication Committee via Editorial Office. After deliberation, the Committee will decide whether the case is sufficiently serious to warrant a ban on future submissions.
3. If the infraction is less severe, the Editor, upon the advice of the Publication Committee, sends the author a letter of reprimand and reminds the author of IJHCUM publication policies; if the manuscript has been published, the Editor may request the author to publish an apology in the journal to correct the record.
4. Notification will be sent to corresponding author and any work by the author responsible for the violation or any work these persons coauthored that is under review by IJHCUM journal will be rejected immediately.
5. The authors are prohibited from serving on IJHCUM editorial board and serving as a reviewer for IJHCUMJournal. IJHCUM reserves the right to take more actions.
6. In extreme cases, notifications will be sent to the affiliations of the authors and the authors are prohibited from submitting their work to IJHCUM for 5 years.
7. In serious cases of fraud that result in retraction of the article, a retraction notice will be published in the journal and will be linked to the article in the online version. The online version will also be marked "retracted" with the retraction date.

GUIDE FOR AUTHORS

International Journal of Human Capital in Urban Management (IJHCUM) is a double blind peer reviewed electronic and print quarterly publication concerned with allaspects of environmental science and management. IJHCUM publishes original research papers, review papers, case reports and short communications, letters to editor and authors' response about letters to editor across the broad field of human capital in urban management and the related fields of urban management. The publication appears at regular intervals time quarterly. The Journal database is fully openaccess and full text of published articles are available for everyone who can get access to the Journal website free of cost. The authors never pay any charges for submission, article processing and publication.

Guide for Authors: More details on guide for authors refer: http://ijhcum.net/journal/authors.note

GENERAL

1. Authors should submit their contributions electronically through the IJHCUM website submission system to the Editorial Office.

2. Manuscripts must be submitted only in English and should be written according to sound grammar and proper terminology. Manuscripts should be typed in Times New Roman of 11 pt. font and in MS-Word format in one column with 2.5 cm margin at each side. Manuscript submission must be applied once in order to obtain only one submission ID number. More than one submission for a single manuscript can lose the chance of the manuscript consideration. Manuscript must be accompanied by a covering letter including title and author(s) name.

3. There are no strict formatting requirements but all manuscripts must contain the essential elements needed to convey your manuscript, for example Abstract, Keywords, Introduction, Materials and Methods, Results, Conclusions, Artwork and Tables with Captions. Please ensure the figures and the tables included in the single file are placed next to the relevant text in the manuscript, rather than at the bottom or the top of the file. There are no strict requirements on reference formatting at submission. References can be in any style or format as long as the style is consistent.

BEFORE YOU BEGIN

1. Peer-Review Process: In order to sustain the peer review system, authors have an obligation to participate in peer review process to evaluate manuscripts from others. When appropriate, authors are obliged to provide retractions and/or corrections of errors to the editors and the Publisher. All papers submitted to IJHCUM journal will be peer reviewed for at least one round. IJHCUM journal adopts a double-blinded review policy: authors are blind to reviewers, but reviewers are not blind to authors. After receiving reviewers' comments, the editorial team member makes a decision. Because reviewers sometimes do not agree with each other, the final decision sent to the author may not exactly reflect recommendations by any of the reviewers. The decision after each round of peer review may include (a) Accept without any further changes, (b) Accept with minor revision, (c) Major changes are necessary for resubmission and (d) Decline without encouraging resubmission.

2. Post-Publication Evaluation: In addition to rapid Peer Review Process, the IJHCUM Journal has Post-Publication Evaluation by the scientific community. Post-Publication Evaluation is concentrated to ensure that the quality of published research, review and case report meets certain standards and the conclusions that are presented are justified. The post-publication evaluation includes online comments and citations on published papers. Authors may respond to the comments of the scientific community and may revise their manuscript. The Post-Publication Evaluation is described in such a way; it is allowing authors to publish quickly about Environmental science, management, engineering and technology concepts.

3. Publication Ethics: The ethical policy of IJHCUM is based on the Committee on Publication Ethics (COPE) guidelines and complies with International Committee of IJHCUM Editorial Board codes of conduct. Readers, authors, reviewers and editors should follow these ethical policies once working with IJHCUM. The ethical policy of IJHCUM is liable to determine which of the typical research papers or articles submitted to the journal should be published in the concerned issue. The ethical policy insisted the Editor-in-Chief, may confer with other editors or reviewers in making the decision. Visit at: http://publicationethics.org

4. Conflict of Interest: Authors are requested to evident whether impending conflicts do or do not exist. A copyright transfer agreement is signed by the corresponding author, upon the acceptance of the manuscript, on behalf of all authors, for publication to be legally responsible towards the journal ethics and privacy policy. Authors will be notified as soon as possible of decisions concerning the suitability of their manuscripts for publication in the journal. The submitted materials may be considered for inclusion but cannot be returned and Editors of the journal reserve the right to accept or reject any article in any stage, if necessary. Conflict of Interest Disclosure form can be found at: http://ijhcum.net/data/ijhcum/news/Conflict of Interest.doc

5. Submission Declaration and Verification: While submitting a manuscript to IJHCUM, all contributing author(s) must verify that the manuscript represents authentic and valid work and that neither this manuscript nor one with significantly similar content under their authorship has been published or is being considered for publication elsewhere including electronically in the same form, in English or in other language, without the written consent the copy right holder.

6. Authorship: All contributing authors should qualify for authorship and corresponding author should sign the authorship form while submitting the manuscript. It can be found at:
http://ijhcum.net/data/ijhcum/news/Authroship form.docx

7. Changes to Authorship: After the manuscript is submitted or accepted for publication, the corresponding author is required to send a request to add or remove an author or to rearrange the author names of the submitted/accepted manuscript by sending the change of authorship form to editorial office. No authorship change is allowed after publication of manuscript. More details may be found at:
http://ijhcum.net/data/ijhcum/news/change of authorship form.docx

8. Retained Author Rights: As an author, author or authors' employer or institution retains certain rights. For more information on author rights, found at:
http://ijhcum.net/data/ijhcum/news/retained_authors_right.docx

9. Copy Right: Journals should make clear the type of copyright under which authors' work will be published. For open access articles the publisher uses an exclusive licensing agreement in which authors retain copyright in their manuscript. More details may be found at: http://ijhcum.net/data/ijhcum/news/copyright form.doc

10. User license Agreement: IJHCUM provides access to archived material through IJHCUM archives. Manuscripts are the parts of an open archive are made freely available from IJHCUM website after certain period, which begins from the final publication date of the manuscript. All articles published open access will be immediately and permanently free for everyone to read and download. Permitted reuse is defined by Creative Commons user license called ***Creative Commons Attribution***. Visit at: **(**Creative Commons Attribution 4.0 International (CC BY 4.0)**)**

11. Plagiarism Prevention and Violation of Publication Ethics: All manuscripts under review or published with IJHCUM are subject to screening using Plagiarism Prevention Software. Plagiarism is a serious violation of publication ethics. Other violations include duplicate publication, data fabrication and falsification, and improper credit of author contribution. Thus, the Plagiarism or Fraudulent or knowingly inaccurate statements constitute unethical behavior are unacceptable and submitting the same manuscript to more than one journal concurrently constitutes unethical publishing behavior and is unacceptable. The development of CrossCheck is a service that helps editors to verify the originality of papers. CrossCheck is powered by the Ithenticate software from iParadigms, known in the academic community as providers of Turnitin. For more details visit at: www.ithenticate.com/search

12. Handling Cases of Misconduct: Once IJHCUM confirms a violation against IJHCUM's publication ethics, the following actions will be taken.

a. The work is rejected / retracted immediately. Notification will be sent to corresponding authors. In extreme cases, notifications will be sent to the affiliations of the authors.
b. The authors are prohibited from submitting their work to IJHCUM for 5 years.
c. Any work by the authors responsible for the violation or any work these persons coauthored that is under review by any IJHCUM journal will be rejected immediately.
d. The authors are prohibited from serving on IJHCUM editorial board. IJHCUM reserves the right to take more actions.

MANUSCRIPT PREPARATION

1. Title Page: The title page should include: the name(s) of the author(s), a concise and informative title, the affiliation(s) and address (es) of the author(s), and e-mail address, telephone and fax numbers of the corresponding author.

2. Manuscript Title: Title of up to 17 words should not contain the name of locations, countries or cities of the research as well as abbreviations. The title should be oriented to Environmental issues while not being obscure or meaningless.

3. Abstract: An abstract of 150 to 250 words that sketches the purpose of the study; basic procedures; main findings its novelty; discussions and the principal conclusions, should not contain any undefined abbreviations or references.

4. Keywords: Provide 5 to 7 keywords which can be used for indexing purposes. Keywords should not repeat the words of the manuscript title or contain abbreviations and shall be written in alphabetical order as separated by semicolon.

5. Introduction: The Introduction should state the purpose of the investigation and identify clearly the gap of knowledge that will be filled in the Literature review study. Date and location of the research carried out throughout the study must be mentioned at the end of this section.

6. Materials and methods: The Materials and Methods section should provide enough information to permit repetition of the experimental work. It should include clear descriptions and explanations of sampling procedures, experimental design, and essential sample characteristics and descriptive statistics, hypothesis tested, exact references to literature describing the tests used in the manuscript, number of data involved in statistical tests, etc.

7. Results and Discussion: The Results section should describe the outcome of the study. Data should be presented as concisely as possible - if appropriate in the form of tables or figures, although very large tables should be avoided. The Discussion should be an interpretation of the results and their significance with reference to work by other authors. Please note that the policy of the Journal with respect to units and symbols is that of SI symbols.

8. Tables: Do not submit tables and graphs as photograph. Place explanatory matters in footnotes, not in the heading. Do not use internal horizontal and vertical rules. Tables should be called out in the text and should have a clear and rational structure and consecutive numerical order. All tables should be numbered 1, 2, 3, etc. Give enough information in subtitles so that each table is understandable without reference to the text. Footnotes to tables should be indicated by superscript lower-case letters (or asterisks for significance values and other statistical data) and included beneath the table body.

9. Figures: Figures/ illustrations should be in high quality art work, within 200-300 dpi and separately provided in Excel format. Ensure that figures are clear, labeled, and of a size that can be reproduced legibly in the journal. Each figure should have a concise caption describing accurately what the figure depicts. Figure captions begin with the term Fig. Figures should be with the captions placed below in limited numbers. No punctuation is to be placed at the end of the caption.

10. Conclusion: This section should highlight the major, firm discoveries, and state what the added value of the main finding is, without literature references.

11. Acknowledgements: Acknowledgments of people, grants, funds, etc. should be placed in a separate section before the reference list. The names of funding organizations should be written in full. Financial support affiliation of the study, if exists, must be mentioned in this section. Thereby, the Grant number of financial support must be included.

12. References: All the references should be cited throughout the manuscript text as well as in the Reference section organized in accordance with Harvard system. Groups of references should be listed first alphabetically, then chronologically. The number of references extracted from each journal should not exceed 3 to 5 citations, which is the average acceptable amount. The number of references should not be less than 30 for original paper, less than 100 for review paper. It is substantially recommended to the authors to refer to more recent references rather than old and out of date ones. Volume, issue and pages of the whole references must be specified according to the IJHCUM format.

Citing and listing of Web references: As a minimum, the full URL should be given. Any further information, if known (Author names, dates, reference to a source publication, etc.), should also be given.

Text: All citations in the text should refer to: 1. Single author: the author's name (without initials, unless there is ambiguity) and the year of publication; 2. Two authors: both authors' names and the year of publication; and 3. Three or more authors: first author's name followed by "et al." and the year of publication. Citations may be made directly (or parenthetically). Groups of references should be listed first alphabetically, then chronologically. Examples: "as demonstrated (Allan, 1996a, 1996b, 1999; Allan and Jones, 1995). Kramer *et al.,* (2000) have recently shown …".

List: References should be arranged first alphabetically and then further sorted chronologically if necessary. More than one reference from the same Author(s) in the same year must be identified by the letters "a", "b", "c", etc., placed after the year of publication.

Journal article: Nouri J.; Lorestani B.; Yousefi N.; Khorasani N.; Hassani A. H.; Seif, F.; Cheraghi M., (2011). Phytoremediation potential of native plants grown in the vicinity of Ahangaran lead-zinc mine. Environ. Earth Sci., 62(3): 639-644.

Book: Davis, M. L., (2005). Introduction to Environmental Engineering, 3rd. Ed. McGraw Hill Inc.

Book chapter: Mettam, G. R.; Adams, L. B., (1999). How to prepare an electronic version of your article, in: Jones, B. S., Smith, R. Z. (Eds.), Introduction to the electronic age. E-Publishing Inc., New York.

Conference paper: Brown, J., (2005). Evaluating surveys of transparent governance. In UNDESA, 6th. Global forum on reinventing government: towards participatory and transparent governance. Seoul, Republic of Korea 24-27 May. United Nations: New York.

Dissertation: Trent, J. W., (1975). Experimental acute renal failure. Ph.D. Dissertation, University of California. USA.

Online document: Cartwright, J., (2007). Big stars have weather too. IOP Publishing Physics Web.
http://physicsworld.com/cws/article/news/2007/jun/26/big-stars-have-weather-too

AFTER ACCEPTANCE

1. Online Proof Correction: Corresponding authors will receive an e-mail with a link to our online proofing system, allowing annotation and correction of proofs online. Use this proof only for checking the typesetting, editing, completeness and correctness of the text, tables and figures. Significant changes to the article as accepted for publication will only be considered at this stage with permission from the Editor-in-Chief. It is important to ensure that all corrections are sent back to us in one communication. Please check carefully before replying, as inclusion of any subsequent corrections cannot be guaranteed. Proofreading is solely the corresponding author responsibility.

2. Offprints: The offprints can be downloading from the IJHCUM website once the final corrected manuscripts are disseminated.

AUTHORS INQUIRIES

Authors can track their submitted article through IJHCUM website on author's login section at: http://ijhcum.net/contacts?_action=login

International Journal of Human Capital in Urban Management (IJHCUM)

Copyright Transfer Agreement

1. Parties of the agreement

Author (s):

Manuscript Title:

Manuscript ID:

(Herewith referred to as the "materials"),

Journal Title: International Journal of Human Capital in Urban Management (IJHCUM)

2. Subject of the agreement

A) Copyright
1- The Author and each co-authors shall transfer and sell to the Publisher for the length of the copyright starting from the moment the present agreement comes into force the exclusive rights to the materials, including the rights to translate, reproduce, transfer, distribute or otherwise use the materials or parts (fragments) contained therein, for publication in scientific, academic, technical or professional journals or other periodicals and in derivative works thereof, worldwide, in English, in print or in electronic editions of such journals, periodicals and derivative works in all media or formats now existing or that may exist in future, as well as the right to license (or give permission to) third parties to use the materials for publication in such journals, periodicals and derivative works worldwide. The transfer under this agreement includes the right to adapt the presentation of the materials for use in conjunction with computer systems and programs, reproduction or publication in machine-readable format and incorporation into retrieval systems.
2- Reproduction, placement, transfer or any other distribution or use of the materials, or any parts of the materials contained therein, in any way permitted under this Agreement, shall be accompanied by reference to the Journal and mentioning of the Publisher, namely: the title of the article, the name of the Author (Co-authors), the name of the Journal, volume/number, copyright of the publisher.

B) Reserved Rights
The Author (Co-authors) or the employer of the Author (Co-authors) of the materials shall retain all proprietary rights (with the exception of the rights transferred to the Publisher under the present Agreement).

C) Author Guarantee
The Author (Co-authors) guarantees that the materials are an original work, submitted only to IJHCUM, and have not been published previously.
In case the materials were written jointly with co-authors, the Author guarantees that he/she has informed them of the terms of this Agreement and obtained their signatures or written permission to singe on their behalf.
The Author guarantees as well that:
The materials do not contain libelous statements.
The materials do not infringe on other persons' rights (including without limitation copyrights, patent rights and the trademark right).
The materials do not contain facts or instructions that can cause damage or injury to third parties and their publication does not cause the disclosure of any secret or confidential information

---

Author (Corresponding Author):

Correspondence Address:

Phone:

Fax:

Email:

Corresponding Author Name: Signature Date

On Behalf of the Publisher:

Human Resource Development,
Navab High Way, Tehran 1346914117
Iran

Phone: (+9821) 6403 8606

Fax: (+9821) 6403 8226

Email: *editor@ijhcum.net*
ijhcum@gmail.com

Website: www.ijhcum.net

Accepted for publication ☑ Signature Date

PLEASE NOTE: The accepted manuscript cannot be processed for publication until the publisher has received this signed form. The form MUSTbe signed by the Corresponding Author and then scanned and sent through the system or email. If the manuscript is not published in the Journal, this release will not take effect.

The sole responsibility for the whole content (s) of the article remains only with the corresponding author. However, Editor would reserve the right to adjust the style to certain standards of uniformity before publication.

CONFLICT OF INTEREST DISCLOSURE FORM

Conflict of Interest is defined as a set of conditions in which professional judgment concerning a primary interest, such as the validity of research, may be influenced by a secondary interest, such as financial gain. A Conflict of Interest Disclosure is an agreement or notification from the authors that they have not been paid for the work, or if they have, stating the source of their payment. The purpose of Conflict of Interest Disclosure form is to provide readers of authors' manuscript with information about authors' interests that could influence how the authors receive the work. The corresponding author (on behalf of all co-authors) should submit a conflict of interest disclosure form and is responsible for the accuracy and completeness of the submitted manuscript. Conflict of Interest Disclosure form can be signed by the corresponding author on behalf of all co-authors and stating that the submitted manuscript is the authors' original work, has not received prior publication and is not under consideration for publication elsewhere, permission has been received to use any material in the manuscript much as tables, figures etc. or no permissions have necessary to publish the authors' work.

1. Name of the corresponding author

2. Affiliation including e-mail and phone number

3. Manuscript Title

4. Do the authors or authors' institution at any time receive payment or services from a third party (government, commercial, private foundation, etc.) for any aspect of the submitted manuscript (including but not limited to grants, data monitoring board, study design, manuscript preparation, statistical analysis, etc.)?

   Are there any relevant conflicts of interest? Yes / No

5. Do the authors have any patents, whether planned, pending or issued, broadly relevant to the work?

   Are there any relevant conflicts of interest? Yes / No

6. Are there other relationships or activities that readers could perceive to have influenced, or that give the appearance of potentially influencing, what the authors' information in the submitted manuscript?

   Are there any relevant conflicts of interest? Yes / No

7. Are there any aspect of the work covered in this manuscript that has involved either experimental animals or human patients has been conducted with the ethical approval of all relevant bodies or not.

   Are there any relevant conflicts of interest? Yes / No

Corresponding Author Signature | Print Name | Date

AUTHORSHIP FORM

By completing and signing the following statements, the corresponding author acknowledges and accepts the responsibility on behalf of all contributing authors, if any, concerning Authorship Responsibility.

Manuscript title:

Corresponding author:

Affiliation:

Email:

Phone No:

By signing and filling this form, the corresponding author certifies that each author has met all criteria below (A, B, C, and D) and indicates each author general and specific contributions by listing his or her name next to the relevant section.

A. I certify that

- The manuscript is authentic and valid and that neither this manuscript nor one with considerably similar content under my authorship has been published or is being considered for publication elsewhere, except as described in an attachment, nor copies of closely related manuscripts are provided.
- I will provide the data or will contribute fully in providing and obtaining the data on which the manuscript is based for examination by the editors or their assignees, if requested.
- Every author has agreed to allow the corresponding author to serve as the primary correspondent with the editorial office, to review the edited manuscript and proof.

B. Each author has given final approval of the submitted manuscript.

C. Each author has participated sufficiently in the work to take public responsibility for the whole content.

D. Each author qualifies for authorship by listing his or her name on the appropriate line of the categories of contributions listed below. List appropriate author next to each section – each author must be listed in at least 1 field. More than 1 author can be listed in each field.

- conception and design
- acquisition of data
- analysis and interpretation of data
- drafting of the manuscript
- critical revision of the manuscript for important intellectual content
- statistical analysis
- obtaining funding
- administrative, technical, or material support
- supervision
- no additional contributions
- other (specify)

Corresponding Author Signature **Print Name** **Date**

FINAL CHECKLIST

International Journal of Human Capital in Urban Management (IJHCUM)

Prior to acceptance of the manuscript, the corresponding author is responsible to adjust the whole manuscript according to the following items and then the marked final checklist should be attached along with the covering letter:

- ☐ A covering letter herewith, **not previously published and submitted elsewhere, fully or partially,** must be signed and accompanied by the corresponding author in the time of manuscript submission.
- ☐ All authors have read the **Ethics in publishing, Plagiarism prevention and violation of Publication Ethics and Handling cases of misconduct**.
- ☐ The Manuscript has been **read and approved by all listed authors**.
- ☐ The title page contains the **Title, Author (s) Name, Degree (s), Addresses, Tel., Fax and Email** of author (s) separated from the manuscript body.
- ☐ Not only the corresponding author, but also the whole contributors of the manuscript are advised to be registered at the journal website in order to keep their names in the manuscript biosketches.
- ☐ The abstract words content is not less than **150** and more than **250 words**, which brings upper scores for both; the publication as well as author (s).
- ☐ Key words count should be 5 to 7 words.
- ☐ It is suggested to the authors to define some proper main subjects related to their manuscript topic.
- ☐ Figures / illustrations are **in high quality art work**, with at least 200 dpi to 300 dpi. All graphs preferred to be provided in excel format.
- ☐ All Figures and Tables are cited throughout the text.
- ☐ The references are cited based on the authors surname and year of publication (Harvard System) throughout the text body. Moreover, the list of the references is carefully arranged alphabetically at the end of manuscript.
- ☐ The number of references in the review paper preferred to be not contain less than 100; for original research paper or case report not less than 30 and for short communication 20 references are required.
- ☐ The majority of manuscript references must not be extracted from a single journal. The acceptable average can be indicated at most 4 to 6 references from each journal.
- ☐ A **copy right release and conflict of interest disclosure form** must be signed by the corresponding author in case of multiple authorships, prior to the acceptation of the manuscript, by all authors, for publication to be legally responsible towards the Journal ethics and privacy policy.
- ☐ The manuscript is in structured format with; **Abstract; Key words; Introduction; Materials and Methods; Results and Discussion; Acknowledgements and References.**
- ☐ The author(s) are appealed to provide the source(s) of financial support along with the grand number for the study in the acknowledgements section.
- ☐ Hereby, I accept liability for the scientific integrity of the manuscript contents.

Name:

Corresponding Author Signature:

Date:

SUBSCRIPTION FORM

Subscription form

International Journal of Human Capital in Urban Management

Int. J. Hum. Capital Urban Manage.

Please enter my annual subscription to the International Journal of Human Capital in Urban Management, including 4 quarterly issues for the year .... Vol. ..... Nos.....

	Domestic	Foreign
Institutional	IRR. 1,000,000	USD 100
Individual	IRR. 800 , 000	USD 80
Student	IRR. 600,000	USD 60
Single copy	IRR. 3 00,000	USD 30

Name: Tel.: Email:

Mailing Address:

** Please allow 3 to 5 weeks for delivery*

Please send this filled in order form along with the Bank receipt payment to:

International Journal of Human Capital in Urban Management (IJHCUM),

No. 32, Akbari St. Pol-e-Roomi, Tehran 1964635611 Iran

International Journal of Human Capital in Urban Management
(IJHCUM)

CONTENTS

Volume 10, Number 2, Spring 2025
(Serial # 38)