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# Governance, ease of living, and citizens' perception: Components for quality-of-life assessment in mid-sized smart cities

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**ABSTRACT**

**BACKGROUND AND OBJECTIVES:** Smart cities are technology-driven urban agglomerations. Sustainability, competitiveness, and quality of life are the three cardinal principles for smart cities. The available studies specific to smart cities are related to smart technologies, innovations, smart infrastructure, etc., and limited studies are conducted from citizens' perspectives. The present study aims to assess the impact of governance, general well-being, also called ease of living of citizens, and citizens' perception of smart cities on their quality of life in mid-sized smart cities of India. The innovation and novelty of present study is that it attempts to fill the research gap in studies on smart cities by adopting the citizen-centric approach rather than infrastructure and technology-centric approach in developing countries.

**METHODS:** Three Indian mid-sized smart cities, Pune, Nagpur, and Indore were identified for the study. For the purpose of this study, a few hypotheses were developed and a structured questionnaire was prepared from the literature review. The data was collected from Pune, Nagpur, and Indore smart cities and it was analyzed by performing factorial analysis and Structural Equation Modelling using appropriate statistical package software.

**FINDINGS:** The findings from the statistical analysis validated the hypotheses. The results of the study indicate a strong positive impact of citizens' perception of smart cities on quality of life (Standardized Estimates = 0.66) while governance (Standardized Estimates = 0.11) and ease of living (SE=0.46) presented low to medium impact relationship with citizens' quality of life.

**CONCLUSION:** The findings of this study concludes that citizens' perception has highest influence on their quality of life. Considering these findings in the context of mid-sized smart cities, this study significantly contributes in existing research on tools and indicators of quality-of-life assessment in urban centers specifically in developing countries. This research article attempts to provide a substantial theoretical and practical contribution to urban studies.

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## INTRODUCTION

A report by the United Nations states that around 55 percent of the world's population lives in urban centers and it is expected to increase up to 66 percent by 2050 (United Nations, 2018). As per the Census of India 2011, the urban population in India is about 31 percent which is projected to increase to about 40 percent by 2030 and to 50 percent by the middle of the 21st century (Sadashivam and Tabassu, 2016). This increase in the urban population in India may be attributed to various reasons such as the natural increase of population in existing urban centers, small settlements growing to urban centers, and migration from rural to urban areas (Das, 2016). This population growth implicit Indian cities to focus on the quality of life of people (De Guimarães *et al*., 2020). Several realities confronting India have resulted in the development of a series of urban policies focusing on various aspects of urbanization (Kumar *et al.,* 2019). Some prominent policies in this series such as Integrated Development of Small and Medium Town (IDSMT-1995), Jawaharlal Nehru National Urban Renewal Mission (JNNURM-2005), and Atal Mission for Rejuvenation and Urban Transformation (AMRUT-2015) focused on the development of physical infrastructure and capacity building in Indian urban centers. The limitations and shortcomings in these policies shift the focus of policymakers from infrastructure-centric to citizen-centric urban policies (Smith and Pathak, 2018; Prasad and Alizadeh, 2020). The citizen-centric approach keeps citizens at the center of public policies and focuses on improving citizens' quality of life. The quality of life is a multifaceted, intricate concept that necessitates numerous approaches from various theoretical perspectives. There are three important theoretical perspectives to measure the quality of life (Diener and Suh, 1997). The first perspective is viewing the quality of life from normative angle such as religion, spirituality and philosophy. The second perspective is defining the quality of life through the satisfactions of priorities which can also be called as material well-being. The third perspective is defining the quality of life from the perception of the individuals which has been built over the period of time from their experiences. This individual perception can also be called as subjective well-being. The subjective as well as material well-being of citizens in urban centers is influenced by factors such as municipal governance, livability, economic prospects, environment, public service quality, satisfaction, and citizen perception (Sharifi, 2019). With the objective of improving citizens' quality of life, the Government of India decided to transform 100 cities into smart cities under Smart Cities Mission.

### *Smart Cities Mission of Government of India*

Smart cities are urban agglomerations that use cutting-edge technologies and Information and Communication Technology (ICT) to plan, develop, and manage urban affairs. In India, the concept of smart cities came into public discourse when the Prime Ministerial candidate of the Bharatiya Janata Party (BJP) Mr. Narendra Modi in the 2014 election manifesto announced his vision to transform 100 Indian cities into smart cities. After a landslide victory in the 2014 general elections, his government announced the Smart Cities Mission (SCM) aiming for the comprehensive development of physical, institutional, social, and economic infrastructure in Indian urban agglomerations. The primary objective of the SCM is "to promote cities that provide core infrastructure, clean and sustainable environment, and give a decent quality of life to their citizens through the application of smart solutions" (MoHUA, 2021). The Ministry of Housing and Urban Affairs of the Government of India has developed an Ease of Living (EoL) Index for the performance evaluation of 100 smart cities under SCM (MoHUA, 2021). The EoL Index aims to measure the ease of living of citizens in smart cities across three parameters- quality of life, economic ability, and sustainability. In 2019, the index has been expanded to include the Municipal Performance parameter to assess the performance of local urban government and their service efficiency. Smart cities have been studied extensively over the past few years. Most of the available studies on smart cities are related to smart technologies, innovations, smart infrastructure, etc., and limited studies are conducted from citizens' perspectives. The present study attempts to fill this research gap by adopting human-centric approach instead of technology-centric approach while studying the smart cities. Multiple studies have proposed many indicators and tools for smart city evaluation (Yadav *et al*., 2019; Sharifi, 2019, 2020). However, limited studies are available that focuses exclusively on quality-of-life assessment indicators in smart cities.

The present study attempts to bridge this research gap by analyzing the components that influence citizens' quality-of-life in smart cities. It is also found that there is a great north-south divide in studies on smart cities across the world. Many researchers have focused their studies on smart cities in developed countries, and very few studies are available on smart cities in developing countries, particularly in India. The present study attempts fill this research gap by contributing in studies on smart urbanization efforts in developing countries and specifically on Smart Cities Mission of Government of India. The present study aims to assess the impact of governance, general well-being, also called ease of living of citizens, and citizens' perception of smart cities on their quality of life in mid-sized smart cities of India. Considering these findings in the context of similar mid-size smart cities in India, this study attempts to propose a conceptual framework for assessment of the citizens' quality of life in mid-sized smart cities. In the present study, the smart governance component includes the parameters such as citizen engagement in city affairs, quality of services provided by the smart cities, and the performance of the municipal administration. The ease of living component in the present study emphasizes the parameters such as citizens' satisfaction with public services, the natural environment, and economic ability in smart cities. The citizens' perception component includes their subjective understanding of smart cities and the associated quality of life. The current study aims at proposing the conceptual framework for the quality-of-life analysis of citizens in mid-sized smart cities of India. The study has been carried out in Nagpur city of Maharashtra state of India during the period of 2022-2023.

*Theoretical background*

Before presenting the hypotheses of the research, it is imperative to study the theoretical background that provides the necessary foundation for the formulation of the hypotheses (Samimi and Moghadam, 2024). This study is based on four components- governance, ease of living, citizen perception, and quality of life. These four components play a crucial role in making a city smart and its citizen smarter. This section in manuscript explains various sub-components of each component- governance, ease of living, and citizen perception focused in present study to assess citizens' quality of life.

*Governance*

In its most basic form, public governance is defined as the intersection of administrative rules and regulations, legal positions, and norms that limit, decide, and authorise government functions. The concept of governance in cities relates to the ability of local government to manage its regions to accomplish growth, distribution, and efficient administration of public affairs (Lynn *et al*., 2000; Odendaal, 2003). The components such as citizen engagement, public services, and municipal administration primarily influence public governance (Giffinger and Gudrun, 2010; Díaz-Cayeros *et al*., 2014; Sharifi, 2019, 2020). The traditional model of governance underestimates citizen engagement and service quality while focusing on municipal administration. The modern concept of governance focuses on a system that aims to achieve mutual cooperation between the government and the forces of change (Bolívar and Muñoz, 2019). Citizen participation is an essential and indispensable component of smart governance where collaboration takes place between the public and various spheres of government (Odendaal, 2003; Ju *et al*., 2019). In a study on US cities, (Portney and Berry, 2010) found a direct correlation between citizen participation and city sustainability and vice versa. Their study concludes that the cities which encourage citizen participation in civic matters also tend to frame sustainable civic policies. Similarly, the field of urban governance put significant emphasis on improving public service quality and delivery models in cities (Kelly and Swindell, 2002; Abid Aown *et al*., 2018). The service quality framework depends on five significant dimensions – Tangibles, Reliability, Responsiveness, Assurance, and Empathy (Rolland and Freeman, 2010; Lam *et al*., 2015; Kuo *et al*., 2018). Together, all the above-mentioned dimensions of service quality determine the quality of governance. Another important component of urban governance is municipal administration. Municipalities play a pivotal role in urban governance as they are embedded in the framework of formal laws and rules, checks and balances, separation and division of powers, structures of resources, etc. (March and Olsen, 2010; Wittmayer *et al*., 2017). Municipalities play the roles of promoters, enablers, and partners in advancing the knowledge of urban sustainability

through experimental governance (Kronsell and Mukhtar-Landgren, 2018).

*Ease of living*

Ease of living is a subjective concept. Earlier, it has been established that material well-being, which is grossly calculated in terms of Gross Domestic Product (GDP) is not capable of explaining the broader well-being of a population and region. Since the ultimate goal of smart cities is to improve liveability rather than simply improving the economic output of the general population, developing a robust, holistic measure of well-being becomes essential. The general well-being of the population is influenced by the factors such as the natural environment, economic opportunities, and satisfaction of citizens with the services and facilities provided by the urban administration (Honnakatti, 2020). In fact, various smart city assessment tools being used across the world have given significant emphasis on the public, economy, and environment components (Monfaredzadeh and Berardi, 2015; Sharifi, 2019). Citizen satisfaction assessment is the cornerstone of the citizen-centric approach. According to Stipak (1979), citizen satisfaction influences citizens' usage behavior patterns. Citizens' perceived satisfaction with services is crucial for all the stakeholders, whether policymakers, politicians, or citizens, because of the perception that service quality and citizen satisfaction are interrelated (Gendel-Guterman and Billig, 2021). The Ease of Living Index framework of SCM of the Government of India has three pillars-quality of life, sustainability, and economic ability (MoHUA, 2020). The sustainability pillar includes the natural environment, city resilience, and green spaces within the city limits. The sustainable environment and assured electricity supply are one of the 10 core infrastructural components of SCM. This also includes transition to sustainable energy systems with low CO2 emission technologies and smart grids based on renewable energy sources (Kamyab *et al*., 2020). The present study incorporated sustainability and economic ability along with citizen satisfaction in the ease of living component of the quality of life assessment tool.

*Citizen Perception*

Citizens' perspective of smart cities varies from people to people, city to city, and country to country, depending on the level of development, willingness to change and reform, resources, and aspirations of the city residents. In a study undertaken by (Praharaj and Han, 2019), citizens envisage smart cities as Information and Communication Technology-driven urban agglomerations with active, empowered, and informed residents that follow smart and sustainable behavioral practices. The citizens prefer to call the smart city 'sustainable city' and 'smart community' rather than 'wired city' or 'ubiquitous city.' Citizens' perception of smart cities determines the level of their participation in city affairs and engagement with the municipal administration (Belanche *et al*., 2016; Georgiadis *et al*., 2021).

*Quality of life*

Quality of life is broadly defined as the ability of an individual to survive and prosper in a particular area (MoHUA, 2020). The quality of life of citizens in urban centers is influenced by many factors such as municipal governance, livability, economic prospects, environment, public service quality, satisfaction, and citizen perception (Sharifi, 2019). Quality of life is a fundamental aspect of smart cities (Ismagilova *et al*., 2019). Over the period of time, the global concept of quality of life in urban studies has seen an expansion in its sphere of inclusion. The terms such as governance, urban service quality, economic ability, physical and natural environment, ease of living, citizen satisfaction and perception, etc. have been included and used as indicators for quality of life measurement (Peach and Petach, 2016; Papachristou and Rosas-Casals, 2019; De Guimarães *et al*., 2020). The concept of smart cities is not limited to technical issues but includes the development of urban policies that would contribute to the overall well-being of citizens and ultimately improve their quality of life (Meijer and Bolívar, 2016; Bibri and Krogstie, 2017). The primary objective of the Smart Cities Mission of the Government of India is to improve the quality of life of its citizens by providing participatory governance, core infrastructure, a clean and sustainable environment, and economic opportunities through the application of smart solutions (MoHUA, 2021).

*Literature review and research hypotheses*

A detailed literature review was conducted for the purpose of the present study. The kinds of

literature were focused on that would cover smart city governance, ease of living, citizen perception, quality of life, etc. in smart cities. Multiple studies have been undertaken across the globe on smart cities, particularly on smart technologies and smart innovations for smart cities but very few with a citizen-centric approach. The researcher witnessed a great north-south divide in the studies on smart cities. The researcher reviewed available literature that is pragmatic to the present study and would provide some insights into undertaking the research from citizens' perspectives. There are limited studies focused on smart cities in India. (Smith *et al*., 2019) conducted a preliminary examination of the Smart Cities Mission by examining the quantitative and qualitative attributes of participating cities. (Prasad and Alizadeh, 2020) investigated Smart City Proposals (SCPs) of 20 Indian cities that are selected in the first phase of SCM and attempted to offer a typology of smart city approaches at the policy level. Ayona Datta, in a study on Dholera Smart City, calls smart cities as "new urban utopia of the 21st century" and concludes with the notion that Dholera smart city is being built on the fault lines of utopian imagining where urban centers are developed as business centers which she calls "entrepreneurial urbanization" rather than centers of social justice (Datta, 2015). Praharaj *et al*. (2017) studied the civic engagement component in SCM in India. The study measured civic engagement based on the number of comments and suggestions received by cities on their smart city proposals. Fig. 1 shows the conceptual framework of the present study.

*Governance and quality of life*

The citizens' quality of life in smart cities is influenced by various components of smart governance including municipal administration, citizen engagement, service quality, etc. (De Guimarães *et al*., 2020). Smart city governance is seen to be capable of addressing a variety of urban issues while also promoting long-term growth and improved quality of life in urban areas (Lee *et al*., 2013). A city is considered smart when it achieves economic and sustainable growth through investments in human and social capital as well as participatory governance that improves the quality of life (Caragliu *et al*., 2011). The more the citizens use the urban services, the better the service quality, and the better the service quality, the greater the life's quality (Zenker and Rütter, 2014; Georgiadis *et al*., 2021). The individual studies analyze the impact of various elements of governance on citizens' quality of life. The present study comprehensively analyzes the impact of all the above elements of governance and hypothesizes that the governance of mid-sized smart cities positively influences the citizens' quality of life.

*H1: Governance has a positive impact on the quality of life of citizens in mid-sized smart cities of India.*

*Ease of living and quality of life*

The ease of living means the general well-being of an individual as well as society. General well-being includes life satisfaction with physical as well as mental health, employment, education, natural environment, liberty, safety and security, religious freedom, etc. (Honnakatti, 2020). Multiple studies have observed that ease of living positively influences the quality of life (Shoshani *et al*., 2016; Stefansson *et al*., 2018). In the field of medical sciences, the evaluation of ease of living and general well-being is actually an assessment of the quality of life (Vitman Schorr and Khalaila, 2018; Hanna and Strober, 2020; Alyami *et al*., 2021; Nielsen *et al*., 2022). The well-being of students is the primary concern of teachers as it directly influences the students' quality of life (Cegarra-Navarro *et al*., 2014). While all these studies are pertaining to various aspects of quality of life, the present study attempt to understand the relationship between ease of living and citizens' quality of life in the context of mid-sized smart cities in India. The study hypothesizes that ease of living positively influences the citizens' quality of life in mid-sized smart cities of India.

*H2: The ease of living has a positive impact on citizens' quality of life in mid-sized smart cities of India.*

*Citizen Perception and quality of life*

Quality of life is both objective and subjective (Rasaizadi and Askari, 2020). The researchers suggest the citizen perspective studies for subjective analysis of quality of life (Macke *et al*., 2018; Santos, 2023). The citizens' overall quality of life is a potential mediator between urban green spaces and citizens' perception of the environment, social inclusion, and urban management (Giannico *et al*., 2021). The

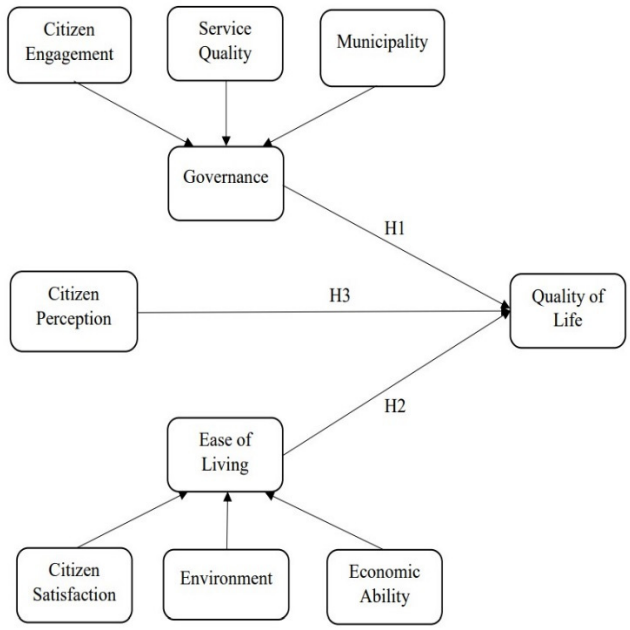


Fig. 1: Conceptual Framework

frequent review of citizens' perception of smart cities makes the community smart, creative, informed, and concerned and thereby improving liveability and life quality (Evans, 2009). The objective of the current study is to comprehend how individuals' perceptions of their respective smart cities affect the general quality of life. The study hypothesizes that the citizens' perceptions positively impact the citizens' quality of life in mid-sized smart cities.

*H3: The citizens' perception has a positive impact on citizens' quality of life in mid-sized smart cities of India*.

## STUDY AREA OF RESEARCH

Pune Smart City, Smart City Nagpur, and Indore Smart City are study areas of the present research. Fig. 2 shows location map of India in the world and Fig. 3 shows the location map of three study smart cities in India. As per the Census of India 2011, Pune and Nagpur are two major cities in the Maharashtra state of India while Indore is the largest city in the Madhya Pradesh state of India in terms of population. Pune is the ninth-largest city in India in terms of population, having a population of 3.12 million approximately and it had grown with a decadal population growth rate of 7.8 percent during the period of 2005-2014 (Pune Municipal Corporation, 2021). Nagpur city is the 13th largest city in India and the third-largest city in Maharashtra state in terms of population. According to the Census of 2011, the population of Nagpur city is 2.4 million and is growing with a decadal population growth rate of 19.21 percent (Banerjee, 2011). Indore city is the 14th largest city in India in terms of population. As per the 2011 Census report, the approximate population of Indore city is two million (Indore Municipal Corporation, 2023). These cities are cultural, educational, economic, and industrial centers of India. Pune and Indore cities were selected in the first round, while Nagpur city was selected in the third round of SCM. Pune, Nagpur, and Indore smart cities are selected for the study as they share common grounds in multiple parameters such as historical and cultural backgrounds, the area under municipal corporation, population, demography, level of urbanization, economy, employment, education, health, municipal performance, quality of life, etc. As per the Smart Cities Mission dashboard, smart cities Pune, Nagpur, and Indore are performing better in terms of municipal performances, projects completed, and projects under progress compared to other similar mid-sized smart cities in India. The focus of the


Fig. 2: Location map of India

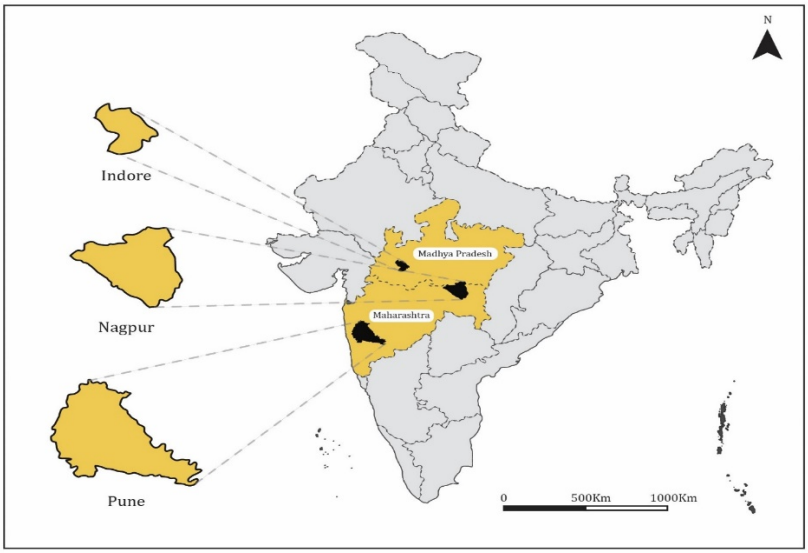


Fig. 3: Location Map of three study smart cities

present study is mid-sized smart cities. Ramachandra and Aithal (2013) have classified the Indian cities into large cities (population > 5 million), mid-sized cities (population 0.5-5 million) and small cities (population < 0.5 million). Large cities in India, such as Delhi, Mumbai, Bengaluru, Kolkata, Chennai, etc., have reached the saturation level in terms of urban sprawl growth, population, employment generation capacity, etc. that they cannot sustain more burden of urbanization. Therefore, policymakers are focusing on mid-sized cities as centers of regional development and limiting the influx of migrating population to large cities. The mid-size cities play a pivotal role in the balanced regional development of any country and are likely to witness drastic urban growth as compared to large cities in the coming decades (Chettry and Surawar, 2021; Chettry, 2023). To meet the demands of rapidly rising urbanization, the Government of India has decided to transform or set up 100 urban agglomerations into smart cities. According to the 2011 Census, India has around 84 mid-sized cities, out of which 56 cities are selected for prospective smart cities under the Smart Cities Mission of the Government of India.

## MATERIALS AND METHODS

The study utilizes the hypotheses based on related literature and background studies. Two mid-sized Indian smart cities were selected for this study. A structured questionnaire was prepared and validated by using factor analysis. The data was collected from a total of 402 respondents from Pune, Nagpur and Indore smart cities. To test the hypotheses, the researcher performed Structural Equation Modeling on the collected data. Finally, the conclusion was drawn based on the results obtained. Fig. 4 illustrates the flow chart of research methodology that was followed in the present research.

*Questionnaire*

A brief literature review was carried out to frame the questionnaire. The survey questionnaire for this study contains 52 items, including items for demographic information (Table 1). The questionnaire was prepared using a five-point Likert Scale technique ranging from 1 (Strongly disagree/Very bad/ strongly dissatisfied) to 5 (Strongly agree/Very good/ strongly satisfied). The items in the questionnaire pertaining to the identified four components for this study. The items of the Governance component are related to various aspects of smart city governance such as citizen engagement, service quality, and municipal performance in smart cities. The items of the Ease of Living component are related to citizen satisfaction, environment, and economic ability. The items of citizens' perception component are related to the ease, feeling, and attitude of citizens while using the services offered by their smart cities, including IT-enabled services. The quality-of-life component includes the items related to various aspects of good quality of life such as personal achievements, self-actualization, self-reliance, aspirations of citizens and community, social and physical well-being, etc.

*Data collection*

The data from 402 respondents (61.2 percent male, 38.6 percent female, and 0.2 percent other) were collected from the cities of Pune, Nagpur, and Indore such that 139 respondents were from Pune, 136 respondents were from Nagpur, and 127 respondents were from Indore. The data was collected by visiting the cities of Pune, Nagpur, and Indore smart cities from October 2020 to April 2021. Apart from the field survey, the questionnaire was distributed online to a few respondents from all three cities. The respondents were selected by using random sampling techniques. The focus was to incorporate citizens from all walks of life in the survey on smart cities. The questionnaire collected the demographic information of all the respondents. The respondents from all age groups participated in the survey. While collecting the data for this study, the researcher took the utmost care to include the respondents from diverse educational qualifications and varied professions to avoid any bias in the results. Out of 402 respondents, 2.7 percent had educational qualification secondary, 15.7 percent had higher secondary, 5.5 percent were diploma holders, 40.3 percent were graduates, and 35.8 percent were postgraduates with ages ranging below 18 years 4.73 percent, 18 to 30 years 50.25 percent, 31 to 40 years 12.94 percent, 41 to 50 years 10.68 percent, 51 to 60 years 8.46 percent and above 60 years 12.94 percent. The entire demographic scenario is shown in Table 2. The participants in our survey belonged to diverse professions and occupations such as Architectures (8), Chartered Accountant (5), Doctors (40), Engineers (77), Entrepreneurs (28), Government employees (17), Lawyers (8), Media personnel (12), Professor (13), Teachers (31), Scientists (5), Students (99), Workers/Labors (7), Housewives (14) and 38 participants belonged to some other profession/ occupation. Throughout our study, we met certain stakeholders in smart cities such as bureaucrats, and local political leadership involved in planning, implementing, and executing policies to discuss the outline of our study and collect information related to smart cities to maintain the generality which otherwise might get lost in conclusion (Podsakoff *et al.*, 2003).

*Validation Method*

The researcher performed the Confirmatory Factor Analysis (CFA) on collected data to validate the items in the questionnaire. CFA is used to determine the underlying relationship between the relatively large set of variables in this study. The factorial analysis is a multivariate approach to studying the interdependence of variables in which all the variables are evaluated concurrently, each related to the other, to study their interrelationship and minimize data (Hair *et al.*, 2019). Earlier research suggests that each of the values of loading factors should be greater than

Table 1: Constructs, measurements, and indicators

| Construct | Indicator | Measurement | Sources |
|---|---|---|---|
| Citizen Engagement | CE1 | Citizens of smart cities are socially engaged with different IT-enabled Services. | Cegarra-Navarro *et al*. (2014); Chatterjee and Kar (2018) |
| | CE2 | The government uses e-governance mode to deliver different services to the citizens. | |
| | CE3 | Citizens are well connected with the civil authorities via different e-governance services. | |
| | CE4 | Community participation of citizens is well established using different modes of services | |
| | CE5 | The government provides different sorts of information to the citizens using digital media | |
| | CE6 | Citizens' usage of digital IT-enabled services in every sphere of life enhances their lifestyle. | |
| | CE7 | Citizens are well-advised and trained to use IT-enabled services. | |
| Service Quality | SQ1 | The system is reliable and it maintains its performance as per the requirements. | Zeithaml *et al*. (1990); Chatterjee and Kar (2018) |
| | SQ2 | The information is continuously updated with the latest information in place. | |
| | SQ3 | The services are efficient and user-friendly to the citizens of the smart city. | |
| | SQ4 | The systems are well maintained providing quality services to the citizens. | |
| | SQ5 | The functionalities are adequately designed to meet the needs of the citizens with full satisfaction. | |
| Municipality | MUN1 | The smart city administration gives prompt service to citizens. | Gorla *et al*. (2010); Albino et al. (2015); Sofyani *et al*. (2020) |
| | MUN2 | The smart city administration is always responsive to citizens' requests. | |
| | MUN3 | The transparency of government information and actions is an instrument for the empowerment of citizens | |
| | MUN4 | Availability of performance achievement report | |
| Environment | ENV1 | Smart cities create and maintain attractive natural conditions for residents. | Gupta and Hall (2017); MoHUA (2021) |
| | ENV2 | Smart cities ensure environmental protection and sustainable resource management. | |
| | ENV3 | Physical infrastructure built under Smart Cities Mission helps in reducing pollution. | |
| | ENV4 | Citizens find a green, clean, healthy Environment necessary for improving the ease of living in smart cities. | |
| Economic Ability | ECO1 | A smart city environment facilitates entrepreneurship with an innovative spirit. | Gupta and Hall (2017); MoHUA (2021) |
| | ECO2 | Smart cities provide more employment opportunities & improve employability. | |
| Citizen Satisfaction | CS1 | Satisfaction with public health care infrastructure in your city? | Macke *et al*. (2018) |
| | CS2 | Satisfaction with the quality & quantity of Municipality water supply services in your city? | |
| | CS3 | Satisfaction with cleanliness, sanitation, and hygiene in your city? | |
| | CS4 | Satisfaction with a solid waste management system in your city? | |
| | CS5 | Satisfaction with the state of 24*7 assured electricity supply in your city? | |
| | CS6 | Satisfaction with public education infrastructure in your city? | |
| | CS7 | Satisfaction with the public transportation system in your city? | |
| | CS8 | Satisfaction with the condition of gardens, green gyms, playgrounds, recreational centers, etc. | |
| | CS9 | Satisfaction with affordable housing and slum rehabilitation in your city | |
| | CS10 | Satisfaction with the state of law and order in your smart city? | |
| | CS11 | Satisfaction with the level of pollution and quality of air in your smart city? | |
| | CS12 | Satisfaction with the progress of the Smart City Project in your city? | |
| Citizens' Perception | CP1 | How would you rate the community involvement efforts by your municipality? | Chatterjee and Kar (2018); MoHUA (2020) |
| | CP2 | How would you rate the city's resilience to disasters? | |
| | CP3 | How would you rate the government's efforts to address air/noise pollution? | |
| | CP4 | The citizens have a positive attitude to use the services provided under Smart City Project. | |
| | CP5 | The smart city project would have a positive impact on the quality of life of citizens in your city. | |

Continued Table 1: Constructs, measurements, and indicators

| Construct | Indicator | Measurement | Sources |
|---|---|---|---|
| Quality of Life | QoL1 | Would enhance the quality of life through the use of green energy and ensure a pollution-free environment. | Harrison *et al.* (2012); Chatterjee and Kar (2018) |
| | QoL2 | Would enable personal achievement, self-actualization, and success of achievement. | |
| | QoL3 | Would improve the perceived ability to do things by citizens themselves enhancing self-reliance. | |
| | QoL4 | Would improve the quality of social activities, more participation in community work, better social security as well as good relationships with others in society. | |
| | QoL5 | Would improve perceived physical well-being, safety, security, healthy lifestyle, good avenues, etc. | |
| | QoL6 | The valorization of joint work between government and citizens, with the aid of technology, allows prioritizing actions that directly impact the quality of life of citizens. | |

Table 2: Demographic information of participants/respondents

| City (%) | Gender (%) | Educational Qualification (%) | Age Groups (%) |
|---|---|---|---|
| Pune: 34.58 | Female: 38.6 | Secondary: 2.7 | Below 18 Years: 4.73 |
| Nagpur: 33.83 | Male: 61.2 | Higher Secondary: 15.7 | 18-30 Years: 50.25 |
| Indore: 31.60 | Other: 0.2 | Diploma: 5.5 | 31-40 Years: 12.94 |
| | | UG: 40.3 | 41-50 Years: 10.68 |
| | | PG: 35.8 | 51-60 Years: 8.46 |
| | | | Above 60 Years: 12.94 |

0.5, and that of cross-loading factors to be smaller than 0.5 (Žlender and Gemin, 2020). The items having a factor loading value less than 0.5 can be omitted (Goretzko *et al.*, 2023). Factor Analysis was performed using Statistical Package of Social Sciences (SPSS) v23 software. Along with factor loadings, the Construct Reliability (CR) should be greater than 0.7 to confirm that indicator components used in this study are reliable (Hair *et al.*, 2019). The CR is computed with the help of Eq. 1.

$$CR = \frac{(\Sigma \text{ Standardized Factor Loading})^2}{(\Sigma \text{ Standardized Factor Loading})^2 + (\Sigma e_i)} \quad (1)$$

Where $e_i$ is the error. The reliability of measurements in the construct can be confirmed from the value of Cronbach's Alpha (α) which should be greater than 0.7 for the construct to be reliable (Kelarestaghi *et al.*, 2019). The values of Cronbach alpha are calculated using Eq. 2.

$$\alpha = \frac{N * \overline{C}}{\overline{v} + (N-1) * \overline{C}} \quad (2)$$

Where,

N = number of measurements

$\overline{C}$ = mean covariance between measurements.

$\overline{v}$ = mean measurements variance.

*Method for Hypothesis testing*

Structural Equation Modelling (SEM) is a comprehensive statistical tool for testing the hypotheses and understanding the correlations/ covariance among a set of variables (Suhr, 2006; Kock, 2023). Multicollinearity is one of the significant factors that can affect the SEM results. Multicollinearity refers to a situation where the measured variables are highly related to each other and are eligible for omission. The Pearson correlation test was performed to confirm whether there exists an issue of multicollinearity. Ideally, the Pearson correlation coefficient higher than r = 0.85 is a concern for SEM (Weston and Gore, 2006). After confirming that there did not exist an issue of multicollinearity, the SEM was performed using AMOS v23 software. The Pearson Correlation Coefficient is computed using Eq. 3.

$$r = \frac{\sum (x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum (x_i - \bar{x})^2 \sum (y_i - \bar{y})^2}} \quad (3)$$

Where,

$r$ = Pearson correlation coefficient

$x_i$ = values of x variable in sample (here e.g. variables of Governance)

$\bar{x}$ = mean of the values of x variable

$y_i$ = values of y variable in sample (here e.g. variables of Ease of Living)

$\bar{y}$ = mean of the values of y variable

The SEM helps understand the overall acceptability of the model and the significance of various paths in the given model through various fit indices results (Li *et al*., 2020; Kock, 2023;). The fit indices such as chi-square values and Root Mean Square Error of Approximation (RMSEA) are discrepancy functions adjusted for our sample size. The chi-square value describes the difference between observed covariance and the expected covariance matrix. The smaller chi-square value indicates little difference between observed and expected covariance matrices. The value of RMSEA ranges from 0 to 1, with the smaller the value, the better the model fit. The fit indices such as Goodness of Fit Index (GFI), Adjusted Goodness of Fit Index (AGFI), Comparative Fit Index (CFI), Normed Fit Index (NFI), and Tucker Lewis Index (TLI) compare the observed model with the null model. The values of GFI, AGFI, CFI, NFI, TLI, etc., range from 0 to 1, with values greater than 0.9 indicating better model fit.

## RESULTS AND DISCUSSION

A Principal Component Analysis (PCA) was performed on 45 variables. The Kaiser-Meyer-Olkin (KMO) measure confirmed the sample adequacy for the analysis, KMO = 0.950 which is "superb" according to (Field, 2009) and Bartlett's Test of Sphericity, $X^2$ (1275) = 13946.067, $p < 0.001$, indicating that correlation between the measurements was sufficiently significant for PCA. Table 3 shows the factor loadings above 0.5 (Kock, 2023). Table 3 shows that Cronbach's Alpha values (α) are 0.858, 0.951, 0.839, and 0.903 for GOV, EOL, CP, and QL respectively, which are well above 0.7. It appears from table 4 that Pearson Correlation Coefficients with reference to all the components lie in the range of 0.60 and 0.83. The path analysis for our research framework is shown in Fig. 5. It illustrates the results obtained by performing SEM. The results obtained from SEM indicate that the research model is within the acceptable range of

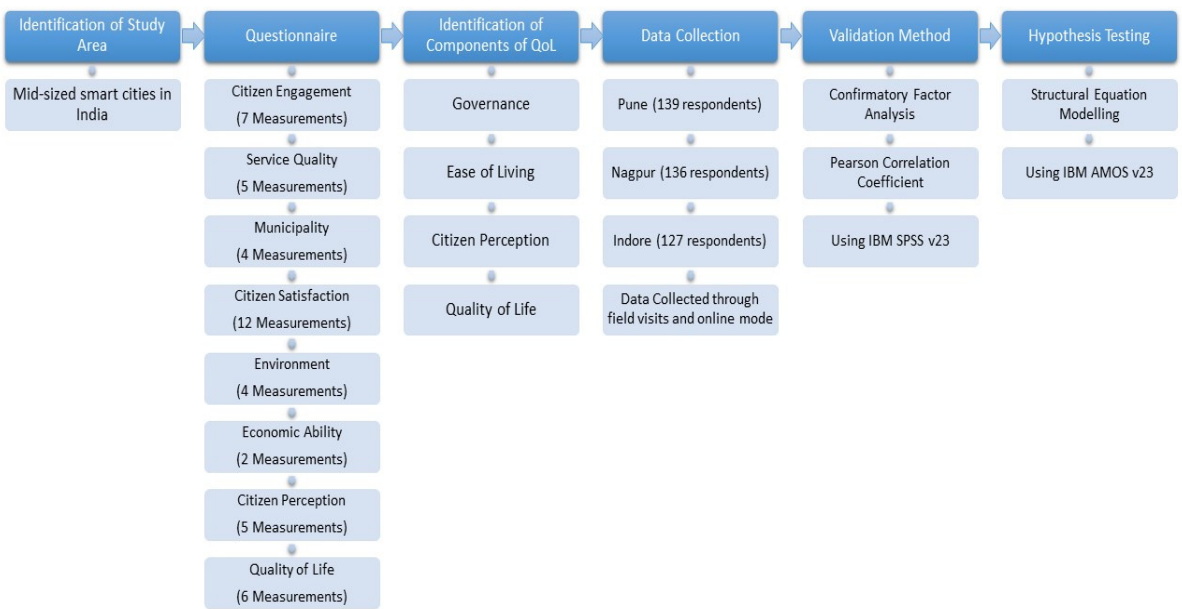


Fig. 4: Flow chart of research methodology

Table 3: Confirmatory factorial analysis

| Constructs | Factor Loadings | Communality | Mean | Standard Deviation | AVE | Cronbach's Alpha | KMO | CR |
|---|---|---|---|---|---|---|---|---|
| Governance (GOV) | | | | | | | | |
| CE1 | 0.757 | 0.637 | 3.54 | 1.116 | 0.571 | 0.858 | 0.875 | 0.942 |
| CE2 | 0.801 | 0.686 | 3.51 | 1.076 | | | | |
| CE3 | 0.753 | 0.622 | 3.68 | 1.087 | | | | |
| CE4 | 0.217 | 0.144 | 3.93 | 1.042 | | | | |
| CE5 | 0.708 | 0.581 | 3.54 | 1.057 | | | | |
| CE6 | 0.743 | 0.714 | 3.89 | 1.083 | | | | |
| CE7 | 0.686 | 0.681 | 3.68 | 1.118 | | | | |
| SQ1 | 0.749 | 0.685 | 4.02 | 0.880 | | | | |
| SQ2 | 0.809 | 0.741 | 3.95 | 0.890 | | | | |
| SQ3 | 0.797 | 0.700 | 4.00 | 0.866 | | | | |
| SQ4 | 0.821 | 0.724 | 3.98 | 0.853 | | | | |
| SQ5 | 0.799 | 0.682 | 4.06 | 0.921 | | | | |
| MUN1 | 0.687 | 0.533 | 2.77 | 1.188 | | | | |
| MUN2 | 0.791 | 0.646 | 3.26 | 1.009 | | | | |
| MUN3 | 0.683 | 0.620 | 3.03 | 1.027 | | | | |
| MUN4 | 0.757 | 0.642 | 3.47 | 0.966 | | | | |
| Ease of Living (EoL) | | | | | | | | |
| CS1 | 0.696 | 0.660 | 3.06 | 1.022 | 0.509 | 0.957 | 0.960 | 0.951 |
| CS2 | 0.657 | 0.551 | 3.37 | 0.980 | | | | |
| CS3 | 0.712 | 0.677 | 3.69 | 1.102 | | | | |
| CS4 | 0.716 | 0.597 | 3.80 | 1.019 | | | | |
| CS5 | 0.626 | 0.441 | 3.98 | 0.958 | | | | |
| CS6 | 0.662 | 0.592 | 3.04 | 1.043 | | | | |
| CS7 | 0.723 | 0.664 | 3.88 | 1.010 | | | | |
| CS8 | 0.722 | 0.642 | 3.72 | 1.108 | | | | |
| CS9 | 0.835 | 0.734 | 3.56 | 1.074 | | | | |
| CS10 | 0.780 | 0.669 | 3.68 | 1.053 | | | | |
| CS11 | 0.789 | 0.656 | 3.57 | 1.143 | | | | |
| CS12 | 0.768 | 0.658 | 3.80 | 1.014 | | | | |
| ENV1 | 0.650 | 0.564 | 3.19 | 1.034 | | | | |
| ENV2 | 0.526 | 0.466 | 4.03 | 0.977 | | | | |
| ENV3 | 0.640 | 0.490 | 3.64 | 1.054 | | | | |
| ENV4 | 0.682 | 0.639 | 3.76 | 1.016 | | | | |
| ECO1 | 0.807 | 0.721 | 3.13 | 1.091 | | | | |
| ECO2 | 0.772 | 0.599 | 3.39 | 1.009 | | | | |
| Citizen Perception (CP) | | | | | | | | |
| CP1 | 0.766 | 0.587 | 3.67 | 0.970 | 0.610 | 0.839 | 0.842 | 0.717 |
| CP2 | 0.794 | 0.631 | 3.77 | 0.982 | | | | |
| CP3 | 0.825 | 0.681 | 3.74 | 0.964 | | | | |
| CP4 | 0.805 | 0.647 | 3.60 | 0.966 | | | | |
| CP5 | 0.709 | 0.503 | 3.60 | 0.999 | | | | |
| Quality of Life (QoL) | | | | | | | | |
| QoL1 | 0.817 | 0.667 | 3.67 | 1.027 | 0.674 | 0.903 | 0.894 | 0.721 |
| QoL2 | 0.840 | 0.706 | 3.55 | 0.970 | | | | |
| QoL3 | 0.850 | 0.722 | 3.54 | 1.068 | | | | |
| QoL4 | 0.795 | 0.633 | 3.53 | 1.092 | | | | |
| QoL5 | 0.791 | 0.626 | 3.55 | 1.054 | | | | |
| QoL6 | 0.831 | 0.691 | 3.54 | 1.073 | | | | |

fit indices. From Fig. 5, it appears that all the path coefficients of interaction between GOV and QoL, EoL and QoL, and CP and QoL are significant at the confidence level of 99 percent. The researchers used the values of various fit indices obtained after performing the SEM to evaluate the quality of conceptual framework. Most of these fit indices are derived from chi-square values: i) Chi-square value

Table 4: Pearson correlation coefficient

| Components | Governance | Ease of Living | Citizen perception | Quality of Life |
|---|---|---|---|---|
| Governance | 1 | | | |
| Ease of Living | 0.81 | 1 | | |
| Citizen perception | 0.77 | 0.60 | 1 | |
| Quality of Life | 0.76 | 0.72 | 0.83 | 1 |

Table 5: Hypothesis tests

| Components | | Research Model | |
|---|---|---|---|
| | | Unstandardized Estimates (UE) | Standardized Estimates (SE) |
| H1 | Governance (GOV) → Quality of life (QoL) | 0.18 | 0.11 |
| H2 | Ease of Living (EoL) → Quality of life (QoL) | 0.53 | 0.46 |
| H3 | Citizens' Perception (CP) → Quality of life (QoL) | 0.74 | 0.66 |

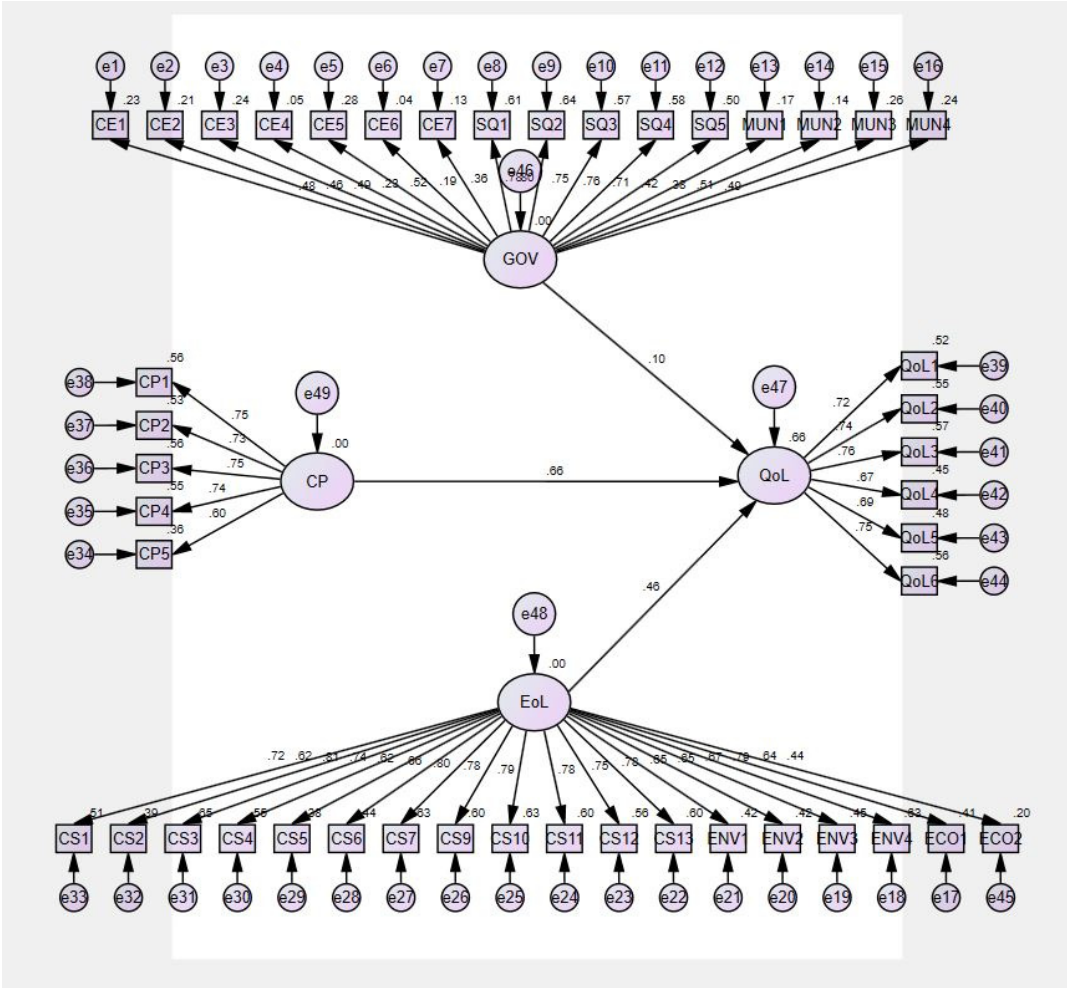


Fig.5: Path analysis of conceptual framework

divided by the degree of freedom (CMIN/DF) with a value of 4.09; ii) CFI = 0.735; iii) NFI = 0.683; iv) GFI = 0.782; v) AGFI = 0.767; vi) RMSEA = 0.081. The values of fit indices interpret that the conceptual model can be enhanced, with the inclusion or exclusion of certain items employing statistical standards. It should be emphasized that the ideal fit indices do not necessarily illustrate the strength of path relationships among the variables in research frameworks (Chatterjee and Kar, 2018). Table 5 shows the values of Unstandardized Estimates (UE) and Standardized Estimates (SE) of hypothesis tests which indicate the impact of various components in smart cities on citizens' quality of life residing in smart cities. It is observed that all the values of unstandardized estimates and standardized estimates are positive and statistically significant. The relation between components CE → QoL (H1), and EoL → QoL (H2) shows positive and medium impact relationships as standardized estimates are smaller than 0.5 while CP → QoL (H3) shows positive and high impact relationships as standardized estimates are greater than 0.5 (Suhr, 2006).

*Discussion*

This study has aimed on ascertaining the impact of governance, ease of living, and citizens' perception on the citizens' quality of life in mid-sized smart cities in India. Results of CFA show that the loading factor of measurements in all the constructs is greater than 0.5, and that of cross-loading factors is smaller than 0.5. Therefore, the results respond affirmatively to the convergent validity and discriminant validity of the components. Both convergent and discriminant validity are subcategories of component validity, and both together confirm the component validity (Brown and Chin, 2004; Chatterjee and Kar, 2018). After confirming the component validity, the SEM was performed on the research model using AMOS Graphics version 23 software (Zhu *et al*., 2022). One of the important issues that can influence the SEM results is multicollinearity. The Pearson correlation test was used to determine whether there exists a problem of multicollinearity. All the correlation coefficients in the Pearson correlation test are found to be in the range of 0.60 and 0.83 which infers that there does not exist an issue of multicollinearity, and the data is fit to feed to SEM. The results of fit indices obtained from the SEM indicate that the conceptual model is valid but can be improved further by incorporating other factors that can influence the quality of life. The Standardized and Unstandardized estimates obtained by performing SEM and shown in Table 5 validate all the hypotheses and reiterate the results so obtained. The outcome of the conceptual framework present important findings regarding the impact of governance, ease of living, and citizen perception on the citizens' quality of life in smart cities. The results show that governance has a low but positive impact on citizens' quality of life in smart cities (SE=0.11) since good governance promotes citizen engagement, and makes service quality, and municipal administration efficient, effective, and reliable resulting in improving the quality of life of citizens in smart cities. These findings corroborate with the findings of Vázquez *et al*., (2018) which found that smart governance component is least associated with citizens' quality of life as compared to components like economy and people. The findings also corroborate with the findings of Capdevila and Zarlenga (2015) which highlights that smart citizens and not smart governance of smart cities should be the focus to improve living standards of the citizens. The findings of the study contribute an additional dimension to findings of Bovaird and Löffler (2003) which emphasizes on the role of awards, incentives, and rankings to public governance bodies for their performance in improving the citizens' quality-of-life. The ease of living component which include citizen satisfaction with smart city services, environment and economic ability presented a medium positive relation with citizens' quality of life in smart cities (SE=0.46). The findings corroborate with the study conducted by Macke *et al*. (2018) which states that overall well-being which encompasses the satisfaction with municipal services and natural environment along with socio-structural relation and community integration determine citizens' quality of life in smart cities. The study conducted by Diener and Suh (1997) imply that economic well-being, subjective well-being and social indices together ensures better quality of life for citizens in society. This study aligns with the findings of present study. The citizens' perception component has a highly positive impact on the quality of life of citizens living in smart cities (SE=0.66). The findings support the study conducted by Giannico *et al*. (2021) which states that citizen perception of objective greenness

in the neighborhood has positive influence on their quality of life. The findings are novel and contribute additional dimensions to the findings of Weziak-Białowolska (2016) which states that citizens are tend to satisfy with their quality of life when they "feel" safe and secure with their place of living as oppose to other parameters such as municipal services, public administration, natural environment etc. which otherwise influence their material well-being. It confirms that citizens' quality of life is influenced by their subjective understanding of experiences in smart cities.

## CONCLUSION

This research article attempts to provide a substantial theoretical and practical contribution to urban studies. The hypotheses test reveals that citizens' quality of life in Indian mid-sized smart cities is positively influenced by the components such as city governance, ease of living, and citizens' perception of smart cities. Among the three components focused on in the present study, the citizens' perception component has the highest influence relationship over the citizens' QOL in mid-sized smart cities. This finding highlights the contribution of citizens' perception of smart cities in improving their QOL. The study reveals that the citizens' subjective understanding of smart cities is influenced by various factors such as their city's resilience to pollution and disaster management, efforts of the municipality in involving the citizens in city affairs, and the ease of using the services and facilities in smart cities. The positive perception of the above factors has a positive influence on their QOL. The crucial advantage of citizen perspective component in quality of life assessment is that it based on the experiences of the individuals. When significant population have positive experience with the smart cities, it reflects on their overall quality of life. The ease of living component in the present study shows a medium positive impact on citizens' quality of life in mid-sized smart cities. This finding highlights the importance of citizen satisfaction, the natural environment, and the economic ability of citizens to fulfill their aspirations, etc. in enhancing their QOL. The study reveals that cities that focus on the factors such as sustainable resource management, pollution-free natural green, and a clean environment, ensure employability and entrepreneurship with an innovative spirit to ensure a significant QOL for their citizens. The governance component in the present study which includes citizen engagement, quality of services provided by the smart city, and the role of the Municipal Corporation shows little positive impact on the quality of life of citizens in smart cities. The findings reveal that the factors such as service quality, the performance of local urban government and administration as well as citizen engagement in city affairs do not significantly influence the citizens' living standards. But the findings can be summarized as citizens are consumers of services and engaging citizens in urban affairs would ensure constant feedback from the users on the services, thereby improving the service quality. The proactive response of the municipality to the feedback from the citizens and timely redressed of the grievances expedite good and smart governance. Thus, from the study, it can be concluded that the QOL is more a psychological construct than a social one. Smart cities are perceived differently by different people. Some pursue smart cities as tall high rising buildings while some pursue smart cities as technologically driven urban agglomerations. Similarly, the quality of life is perceived differently by different people. The citizens of smart cities strongly believe that smart city projects in their respective cities enhance their quality of life. Considering these findings in the context of mid-sized smart cities, this study significantly contributes in existing studies on tools and indicators of quality-of-life assessment in urban centers specifically in developing countries. This research article provides a substantial theoretical and practical contribution to urban studies. By applying this conceptual framework to mid-sized smart cities, policymakers and administrators can frame and implement the policies for enhancing the citizens' quality of life through citizens' perspectives. As the study is conducted from the citizens' perspective, its managerial contribution is focused on the targeting strategic drivers that can assist policymakers in the formulation of public policies and initiatives of the municipal executive that involve the populace from the perspective of the components of smart governance, ease of living, and citizens' perception to improve the QoL.

*Limitations and future scope*

The study is limited to three components-governance, ease of living and citizen perception, which influences the quality of life. The quality of life is a multifaceted, intricate concept that necessitates numerous approaches from various theoretical perspectives. Future studies are suggested to investigate more components that influence citizens' quality of life in smart cities. While we tried to incorporate the respondents-participants in the survey from all walks of life, various educational qualifications, professions, and occupations, as the genders and different socio-cultural backgrounds, it is necessary to admit that our study is not a true representative of the whole population residing in smart cities which is spread across all 100 smart cities in India. All the respondents-participants in the survey belong to Pune, Nagpur, and Indore cities, representing mid-size smart cities in India. The results of this study therefore cannot be applied to both large and small cities in India. The results of this study cannot be applied to all 100 prospective smart cities in India, which are located in the country's northern, eastern, western, southern, and central regions and have different cultures, belief systems, and political environments, etc. These are some limitations to our research that future researchers need to address. It is also crucial to study the governments of smart cities in terms of various policies and programs to improve citizen participation, quality of services, overall satisfaction of citizens, and their quality of life in smart cities. A comprehensive study on all the smart cities in India and separate studies on other smart cities in India and various aspects related to those smart cities can also be conducted.

## AUTHOR CONTRIBUTIONS

M. Vikrant Dhenge performed the conceptualization, literature review, data collection, analysis and interpretation of the data, prepared the manuscript text, and manuscript edition. G.N. Nimbarte performed the literature review, compiled the data and manuscript preparation.

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## CONFLICT OF INTEREST

The authors declare no potential conflict of interest regarding the publication of this work. 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

| | |
|---|---|
| *AVE* | Average Variance Extracted |
| *CR* | Composite Reliability |
| *CE* | Citizen Engagement |
| *CS* | Citizen Satisfaction |
| *CP* | Citizens' Perception |
| *ECO* | Economic A |
| *EoL* | Ease of Living |
| *ENV* | Environment |
| *GOV* | Governance |

| | |
|---|---|
| *KMO* | Kaiser-Meyer-Olkin |
| *MUN* | Municipality |
| *p-value* | Probability value |
| *QoL* | Quality of Life |
| *r* | Pearson correlation coefficient |
| *r-value* | Pearson correlation coefficient |
| *RMSE* | Root Mean Square Error |
| *SCM* | Smart Cities Mission |
| *SE* | Standardize Estimates |
| *SQ* | Service Quality |
| *UE* | Unstandardized Estimates |

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