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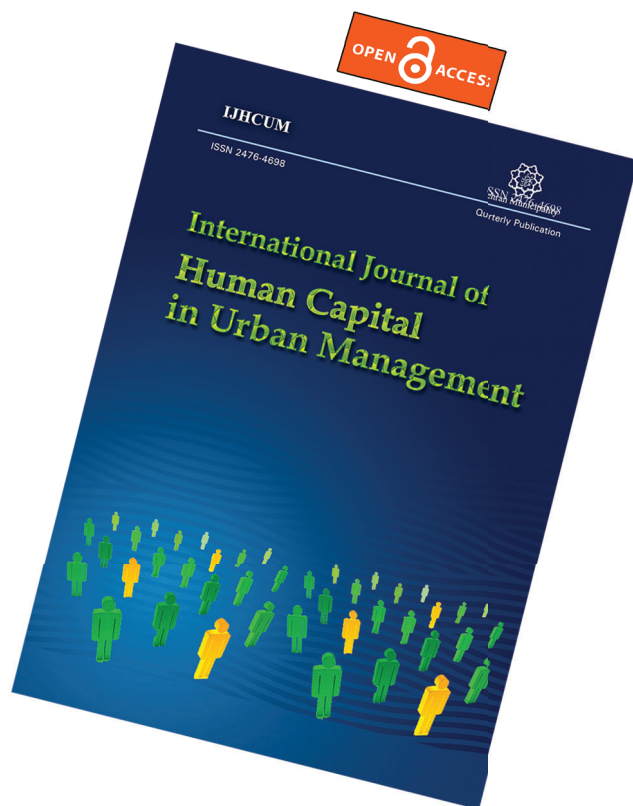
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CONTENTS

Volume 8, Number 4, Autumn 2023

1.	Leadership styles and their associated outcomes: A bibliometric review using VOS viewer	443
	U, Udin (Indonesia)	
2.	Optimization of energy consumption of ozone generator and plasma generator in decolorization and disinfecting of water system in urban residence	457
	M.H. Mosstafavi; A.R. Karbassi; M. Pazoki (IRAN)	
3.	Human capital development in university teaching environment: the role of workplace and innovation culture	469
	T.L.S. Mangahas (Philippines)	
4.	The impact of human capital, institutional quality, and innovation on the regional gross domestic product: panel data approach	485
	H. Izadkhasti (IRAN)	
5.	The mediating effect of climate change on the relationship between energy resources and cost-saving sustainability and energy security in urban context	499
	J.S. Dionysius; H.L. Vasudevan (Malaysia)	
6.	Identifying the antecedents and consequences of phubbing	515
	A. Jamadi; A.R. RajabipoorMeybodi; E. Hosseini; Z.S. Doaei (IRAN)	
7.	Addressing the barriers and difficulties in achieving educational institutions accreditation from public university	529
	E.G Claudio (Philippines)	
8.	Identifying the constituent factors of open governance in public institutions	545
	M. Mirzapour; S. Tootian; G.R. Memarzadeh; G.R. Hashemzadeh Khorasgani (IRAN)	
9.	Human resource management practices and employee engagement	559
	K. Goyal; A. Nigam; N. Goyal (India)	
10.	Prioritizing factors affecting green human resources management, using fuzzy network analysis in the organization	573
	H. Gandomkari; N. Mohamadi; A. Rezghirostami (IRAN)	

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REVIEW PAPER

Leadership styles and their associated outcomes: A bibliometric review using VOSviewer

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ABSTRACT

Leadership plays a crucial role in promoting organizational productivity and sustainability. There are several styles of leadership have been proposed and investigated, as well as their various impacts on different organizations. Therefore, this study aims to analyze the leadership styles in Indonesian settings and their associated outcomes through a bibliometric review. This study employs a qualitative approach. The entire data collecting and screening procedure in the Scopus database provided the foundation for the present study. A total of 84 eligible papers from 2000 to 2023 are explored, and the scientific landscapes are further visualized using the VOSviewer. The results showed evidence that network visualization consists of 5 clusters: red, green, blue, yellow, and purple cluster. The first red cluster includes business strategy, innovation, organizational commitment, and organizational culture. Employee performance, job satisfaction, work environment, and work motivation are represented by the second cluster, which is identified to be green in color. In addition, the third blue cluster covers knowledge management, transactional leadership, and transformational leadership. Creativity and employee engagement are all part of the fourth yellow cluster. Finally, democratic leadership is included in the fifth purple cluster. The findings concluded that leadership styles (i.e., transformational, transactional and democratic leadership) positively contribute to the associated outcomes (i.e., employee performance, job satisfaction, organizational commitment, employee engagement, business strategy, and organizational innovation and creativity). In addition, mainly related to associated outcomes, the transformational leadership style is a more dominant influence than transactional and democratic in Indonesian settings. By demonstrating as role models, transformational leaders establish strong emotional connections with their employees to feel a sense of belonging, leading to increased dedication to go the extra mile.

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INTRODUCTION

All researchers and organizational development practitioners have acknowledged and overall agreed that leadership is essential (Denti and Hemlin, 2012) for any organization. Leadership generally plays a crucial role in increasing organizational innovation and creativity (Chaubey *et al.*, 2019), shaping employees' readiness to change (Metwally *et al.*, 2019) and improving employees' positive attitudes and behavior at workplace (Wang and Xu, 2019). Importantly, Bel (2010); Wei and Vasudevan (2022) noted that the different leadership styles adopted tend to have different impacts on employee innovation capability, which in turn affects organizational productivity (Amofa *et al.*, 2016). Numerous studies have been conducted on leadership styles and their impacts for organizations to provide valuable insights. Abdullahi *et al.* (2020) showed that leadership styles (i.e., democratic and transformational leadership) positively predict the organizational citizenship behavior (OCB) of SME employees in Ghana; on the contrary, autocratic leadership has an insignificant effect. Furthermore, Limsila and Ogunlana (2008) acknowledged that leadership styles (i.e., transformational and transactional leadership) have a positive significant relationship with work performance and employees' organisational commitment in construction projects in Thailand, while laissez-faire leadership has a negative significant effect. In several surveys of Indonesian companies in the banking sector, Sabran *et al.* (2022) found leadership styles (i.e., transformational and transactional leadership) that transactional leadership improves employee counterproductive work behavior, while transformational leadership reduces it. In addition, in the education sector, Fadillah *et al.* (2020) showed that both leadership styles (i.e., transformational and transactional) significantly influence teacher innovation capability. Also, Yunarsih *et al.* (2020), in the health sector, acknowledged that leadership styles (i.e., transactional, transformational, democratic, autocratic, bureaucratic and charismatic) increase hospital performance. Furthermore, Pawirosumarto *et al.* (2017), in the health sector, revealed that leadership style not only promotes job satisfaction but also significantly influences employee performance. Udin (2021) further found that leadership styles (i.e., transformational and transactional leadership) significantly enhance innovative work behavior and work engagement of

employees in the stone milling industry. By looking, therefore, at the existing empirical pieces of evidence and because Indonesia is one of the largest countries in the world, which has uniqueness such as a large population (around 273.5 million), more than 1,340 tribes, 718 languages and 6 religions (Databoks, 2023), finding the appropriate leadership style (Chen *et al.*, 2018) in every organization and even the country is very necessary, even though the term 'appropriate leadership' always changes over time (Kjellström *et al.*, 2020). Thus, to fill the gaps, the research questions addressed explicitly in this study are as follows: (1) how is the implementation of leadership styles in Indonesian setting?, and (2) what is the most dominant leadership style applied in Indonesian setting? Therefore, this study provides some potential contributions to organizations, including (1) explaining the implementation of leadership styles in Indonesian setting, and (2) showing the most dominant leadership style applied in Indonesian context.

Literature review

Leadership is defined as an individual's ability to influence and inspire others to achieve organizational goals and effectiveness. Leadership, according to Gurr and Drysdale (2020), is the process of influencing and motivating the behaviors of others towards achievement. Consequently, leadership style refers to an aggregation of skills, traits, and behavior (Van Wart, 2013) or a set of behavior patterns (Molero *et al.*, 2014) of leaders to influence their subordinates for achieving efficiency and organizational goals (Ohemeng *et al.*, 2018). Leadership styles encompass a diverse range of concepts and practices related to how the leaders interact, lead and influence their followers within various organizational contexts. Leadership styles refer to the characteristic approaches and behaviors that leaders adopt when guiding their followers towards achieving common goals. Three major leadership styles, according to Lewin *et al.* in Fiaz *et al.* (2017), have been identified to drive organizations to be more profitable and productive: autocratic, democratic, and laissez-faire styles.

Autocratic leadership style

Autocratic leadership, also known as authoritarian leadership (Briker *et al.*, 2021), is a style of leadership characterized by a leader who has complete control and decision-making authority (Bass and Bass, 2009)

within organization. Autocratic leader holds all the power (Foels *et al.*, 2000) and makes decisions without seeking input (Sauer, 2011) or consensus from others. They also rarely delegate decision-making to others and may not value the ideas of subordinates. Autocratic leaders prioritize obedience (Harms *et al.*, 2018), expecting strict adherence to rules. They may use rewards and punishments as a means of enforcing compliance. Autocratic leaders typically maintain a strict hierarchical structure with clear lines of authority (Khan *et al.*, 2015). Power and information flow from the top to the bottom, and subordinates are expected to follow the established chain of command (Akor, 2014). Also, the communication flow in autocratic leadership is primarily one-way (Iqbal *et al.*, 2015), with instructions coming from the leader to the subordinates. Feedback and input from subordinates are not actively valued. Thus, subordinates have limited autonomy and are expected to follow the leader's directives without question, which in turn, provide little room for individual creativity within the organization. Autocratic leadership can be effective in certain situations, such as in crisis scenarios where quick decisions and clear direction are required. However, autocratic leadership has several drawbacks: (1) autocratic leadership can lead to low employee morale and motivation (De Hoogh *et al.*, 2015). Subordinates may feel disengaged, as their opinions and contributions are not considered important; (2) autocratic leadership often creates a strong dependency on the leader's decision-making abilities. If the leader is absent or unable to make timely decisions, it can slow down the organization and create bottlenecks (Sherf *et al.*, 2019); and (3) autocratic leadership only provides the limited input from subordinates means regarding their new ideas and innovative approaches (Khudhair *et al.*, 2022). This can hinder problem-solving and hinder the organization's ability to adapt to changing circumstances.

Democratic leadership style

Democratic leadership, also known as participative leadership (Amanchukwu *et al.*, 2015), is a style of leadership that involves active participation and decision-making involvement of subordinates. Democratic leader encourages collaboration, seeks input from others, and takes their opinions and suggestions into account (Miloloza, 2018) before making decisions. Democratic leaders foster open and transparent communication within the organization.

They encourage subordinates to express their opinions, concerns, and suggestions. They actively listen to their feedback (Fiaz *et al.*, 2017) and create an environment where everyone feels comfortable contributing to discussions. Democratic leadership promotes collaboration and teamwork (Jiang, 2014; Liggett, 2020). The leader facilitates and encourages cooperation among team members (Tajpour and Razavi, 2023), allowing them to work together to achieve common goals (Hilton *et al.*, 2021; Moneva and Pedrano, 2019). This approach can enhance creativity, problem-solving, and overall team performance. Also, democratic leaders empower their team members by giving them a certain degree of autonomy and responsibility (Choi, 2007). They trust their abilities and provide opportunities for growth and development, which in turn, lead to increased job satisfaction (Dyczkowska and Dyczkowski, 2018; Munir and Iqbal, 2018) and motivation among team members. Democratic leadership has some benefits for organization, including: (1) democratic leadership can foster a positive work environment that encourages individuals to contribute their best efforts (Caillier, 2020). When team members feel that their opinions are valued, and their voices are heard, they tend to be more engaged and motivated; (2) By involving team members in the decision-making process (Kotamena *et al.*, 2020), democratic leaders tap into the diverse perspectives, ideas, and experiences of their team. This can lead to more creative and innovative solutions to problems. While democratic leadership has many advantages, it may not be suitable in all situations. In certain time-sensitive or crisis scenarios, a more directive leadership approach may be required for quick decision-making. Additionally, in some cases, the input from team members may not be feasible or appropriate, such as when dealing with highly technical matters or when specific expertise is needed. Therefore, leaders should be adaptable and consider the situation's needs when determining the most effective leadership style to employ (Haryanto *et al.*, 2022).

Laissez-faire leadership style

Laissez-faire leadership, also known as hands-off leadership (Dasborough and Scandura, 2022), is a style of leadership where the leader provides minimal guidance (Barnett, 2017), involvement, or direction to their subordinates. Laissez-faire leader

delegates authority and decision-making power to the subordinates and allows them to work independently (Breevaart and Zacher, 2019; Kehinde and Banjo, 2014) with little interference. Laissez-faire leaders fully trust their subordinates (Northouse, 2013; Puni *et al.*, 2014) to take responsibility for their work and make decisions without constant supervision. The subordinates under laissez-faire leadership have a high level of autonomy and independence in their work (Iqbal *et al.*, 2021). They are expected to be self-directed, motivated, and capable of managing their own tasks and responsibilities (Antonakis *et al.*, 2004). Laissez-faire leaders provide minimal rules. They may offer support when requested (Igbaekemen, 2014), but they do not enforce specific processes to monitor progress. Advantages of laissez-faire leadership include: (1) laissez-faire leadership allows team members to think freely and explore new ideas. This can stimulate creativity within the team; (2) laissez-faire leadership provides individuals with opportunities to develop their skills (Yang, 2015). It encourages them to take on challenges from their experiences. However, laissez-faire leadership has some disadvantages include: (1) the absence of clear direction from the leader can lead to ambiguity regarding roles and expectations (Skogstad *et al.*, 2007; Skogstad *et al.*, 2015); (2) with minimal involvement from the leader, coordination among subordinates may suffer (Heyliger and

Heyliger, 2014; Neuman and Baron, 2005). This can result in duplication of efforts or a lack of alignment with overall goals (Glambek *et al.*, 2018; Skogstad *et al.*, 2014). Thus, laissez-faire leadership can be effective in certain situations where subordinates are highly skilled, self-motivated, and capable of working independently. However, laissez-faire leadership may not be suitable in situations where clear direction or close supervision is necessary to achieve organizational objectives effectively. Avolio and Bass (1991) further proposed the Full Range model of Leadership (FRL) to briefly explain the leadership styles for organizational competitiveness. The FRL includes three different leadership styles: transformational, transactional, and laissez-faire leadership style.

Based on the FRL, as shown in Fig. 1, transformational leadership style has four components (i.e., individual consideration, intellectual stimulation, inspirational motivation, and idealized influence), transactional leadership has three components (i.e., passive management by exception, active management by exception, and contingent reward), and laissez-faire leadership style (Avolio and Bass, 1991). Laissez-faire is a hands-off leadership style in which employees are free to make all decisions. Although laissez-faire leadership leads to low organizational commitment (Silva and Mendis, 2017) and productivity, leaders with this type are able to work with self-motivated

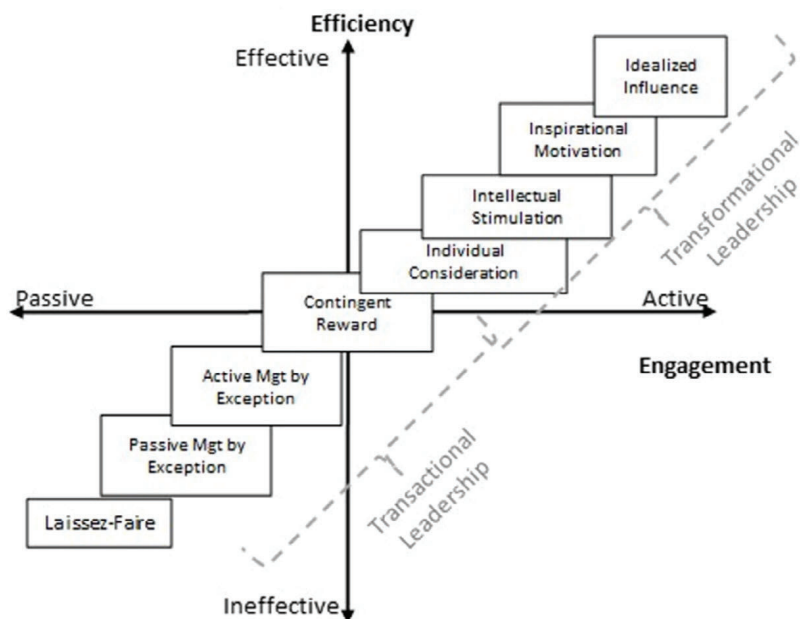


Fig. 1: The Full Range model of Leadership (FRL)

and highly-skilled employees (Zareen *et al.*, 2015). However, transformational leaders refer to leaders who are proactive in influencing and raising employees' awareness to pursue collective interests and larger organizational goals (Antonakis *et al.*, 2003; Udin, 2023). Transformational leaders seek to pay attention to and satisfy the high-level needs of employees and involve them in achieving organizational goals (Hoch *et al.*, 2018; Udin *et al.*, 2023). On the other hand, transactional leadership is built on a clear promise of recognition, structure of rewards, advancement and punishments for various levels of agreed performance between leaders and employees (Antonakis *et al.*, 2003). Transactional leadership values rewards (for high performance) and sanctions (for unsatisfactory performance) to deal with employees in attaining organizational goals (Jensen *et al.*, 2019).

Transactional leadership style

Transactional leadership is a leadership style that focuses on the exchange of rewards and punishments (Abu Nasra and Arar, 2020; Bass and Avolio, 1990) between leaders and subordinates. Transactional leaders set clear expectations, establish performance goals, and use contingent rewards and punishments (Afsar *et al.*, 2017) to motivate their subordinates (Klein, 2023). Transactional leaders set specific goals and offer rewards (i.e., *contingent rewards*), such as recognition or bonuses, in exchange for meeting those goals. The contingent reward approach offers and establishes a transactional dynamic where subordinates work to achieve the desired outcomes in exchange for the promised rewards, both tangible and intangible (Dai *et al.*, 2013). Failure to meet promised expectations, conversely, may result in punishments. Furthermore, transactional leaders do indeed utilize *management by exception* approach (Bass *et al.*, 2003; Gemeda and Lee, 2020) to focus on significant deviations from the desired outcomes of day-to-day activities. They set specific goals and intervene for improvement, as well as allow their subordinates to exercise their problem-solving abilities while ensuring alignment with predetermined expectations. They maintain the status quo (Qalati *et al.*, 2022) and provide feedback, as well as establish a clear hierarchy within the organization (Kark *et al.*, 2018). They provide clear guidelines and set clear expectations that enable subordinates to understand what is required of them (Abdelwahed *et al.*, 2023). In addition, transactional leaders tend

to limit independent thinking and creativity among subordinates. According to Riaz and Haider (2010), transactional leadership is more effective in certain situations where tasks are well-defined and clear direction. Transactional leaders further establish clear guidelines and procedures for achieving certain goals and maintaining greater productivity within the organization (Lan *et al.*, 2019). However, it may not be as effective in situations that require a long-term vision.

Transformational leadership style

Future organizations, which are likely to face complex and rapid changes, transformational leadership becomes even more challenging. Transformational leadership is a style of leadership that focuses on entrusting, aligning and inspiring subordinates (Bass and Avolio, 1990) to achieve exceptional performance for the greater good of organization as a whole. Therefore, transformational leaders challenge their subordinates to go beyond their self-interests and work towards a collective vision (Denhardt and Campbell, 2006; Dumdum *et al.*, 2013). They encourage and empower subordinates to develop their skills and capabilities, as well as foster a sense of ownership to the organization's objectives. According to Bass and Avolio (1990), Bass and Riggio (2006), the key elements of transformational leadership include: (1) *idealized influence*, i.e., leaders serve as role models and admiration as well as earn the trust of their subordinates (Astuty and Udin, 2020; Hosna *et al.*, 2021; Sengphet *et al.*, 2019). They demonstrate high ethical standards and exhibit consistency between their words and actions. By exemplifying the values and behaviors they expect from their subordinates, transformational leaders influence their followers to adopt similar principles (Le and Le, 2021); (2) *inspirational motivation*, i.e., leaders provide a compelling vision that inspires their subordinates. They communicate their vision in a way that generates enthusiasm, excitement, and a sense of purpose among their team members. By effectively articulating the organization's goals and values, transformational leaders rally their subordinates around a common cause (Boamah and Tremblay, 2019); (3) *individualized consideration*, i.e., leaders demonstrate genuine concern for the aspirations and development of their subordinates. They recognize and appreciate individual strengths

and weaknesses and provide mentorship to help their subordinates grow. They establish a personalized connection with each subordinates, fostering a supportive and empowering environment (Hilton *et al.*, 2023); (4) *intellectual stimulation*, i.e., leaders encourage creativity, innovation (Alzoraiki *et al.*, 2018), and critical thinking among their subordinates. They challenge the status quo, encourage problem-solving, and invite subordinates to question assumptions and explore new possibilities (García-Morales *et al.*, 2012). By fostering an intellectually stimulating environment, transformational leaders inspire followers to think outside the box and approach challenges from different perspectives. Transformational leadership has several positive effects on organizations, groups and individuals. Transformational leaders lead to increased motivation, satisfaction, and commitment among employees (Eliyana *et al.*, 2019; Rita *et al.*, 2018), resulting in higher levels of performance and productivity (Hoch *et al.*, 2018). Transformational leaders also foster a sense of empowerment and personal growth, enabling employees to reach their full potential. According to Bass (2000), over the past century, the study of leadership style has advanced, especially in developing countries and by considering different cultural influences (Hofstede, 2011; House *et al.*, 2004). Therefore, the impact of leadership style on organizational outcomes is challenging and requires more dynamic leadership to ensure organizational success today and in the future (Mgbere, 2009). In addition, the effective leadership style is able to inspire, generate admiration, and empower employees to commit and take high risks to achieve better performance in the organization (Ohemeng *et al.*, 2018; Wright *et al.*, 2012). Thus, to fill the gaps, the research questions addressed explicitly in this study are as follows: (1) how is the implementation of leadership styles in Indonesian setting?, and (2) what is the most dominant leadership style applied in Indonesian setting? The current study has been carried out in Indonesia in 2023.

METHODOLOGY

This study employs a qualitative approach to explore the leadership styles in Indonesian settings and their associated outcomes. The entire data collecting and screening procedure in the Scopus database provided the foundation for the present study. In the analysis, several steps, as shown in Fig. 2, have been

taken by entering the keywords, including:

1. 1st step: title-abs-key (leadership and styles and in and indonesia), and the result shows 219 documents.
2. 2nd step: title-abs-key (leadership and styles and in and indonesia) and (exclude (pubyear, 1998) or exclude (pubyear, 1980) or exclude (pubyear, 1978), and the result shows 216 documents.
3. 3rd step: title-abs-key (leadership and styles and in and indonesia) and (exclude (pubyear, 1998) or exclude (pubyear, 1980) or exclude (pubyear, 1978) and (limit-to (doctype, "ar") or limit-to (doctype, "cp") and (limit-to (exactkeyword, "leadership style") or limit-to (exactkeyword, "indonesia")), and the result shows 84 documents.

In summary, a total of 84 eligible papers from 2000 to 2023 are explored utilizing the Scopus database. The scientific landscapes of this study are further visualized using the VOSviewer. The VOSviewer software is selected to facilitate data visualization. Also, this software is free and available for bibliometric mapping, which is very useful for displaying large scientific maps in an easy-to-understand way (Van Eck and Waltman, 2010), with a high-quality of visual representation (Sinkovics, 2016). Several potential contributions of bibliometric analysis using VOSviewer include: (1) identifying key research areas within their domain via publication patterns and co-citation networks, to inform strategic decision-making and research prioritization, (2) mapping collaboration networks among researchers or institutions by analyzing co-authorship networks to identify potential collaborators, and (3) assessing research impact, such as citation counts, to evaluate the influential publications, authors, or institutions.

RESULTS AND DISCUSSION

Detailed explanations of the results of the bibliometric review using VOSviewer are performed in the following visualization.

Over the period of 20 years, 84 publications in all were published, as shown in Fig. 3, indicating that no paper publications between 2000 and 2010. With only one document, the number of publishing began in 2011. A further increase of four papers in publications was seen in 2015, and this growth continues until 2020. Furthermore, in 2020 and 2021, respectively, there was the highest number of publications.

Table 1 lists the top ten authors with at least

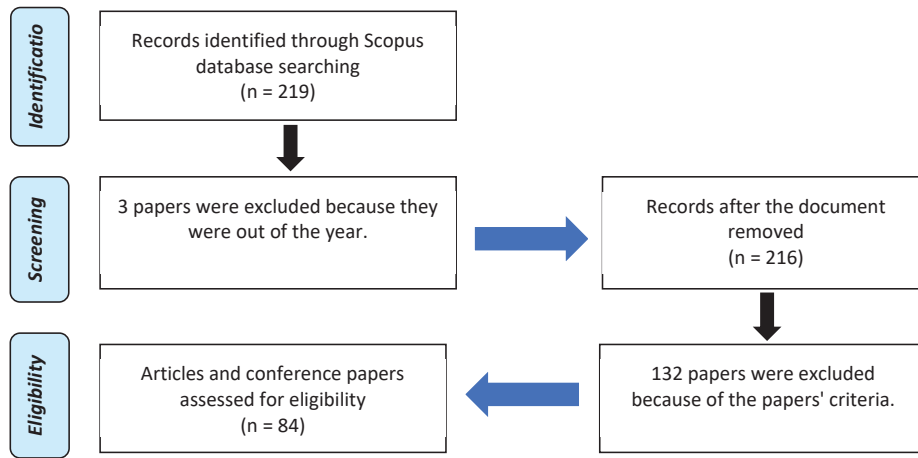


Fig. 2: Flow chart for bibliometric review

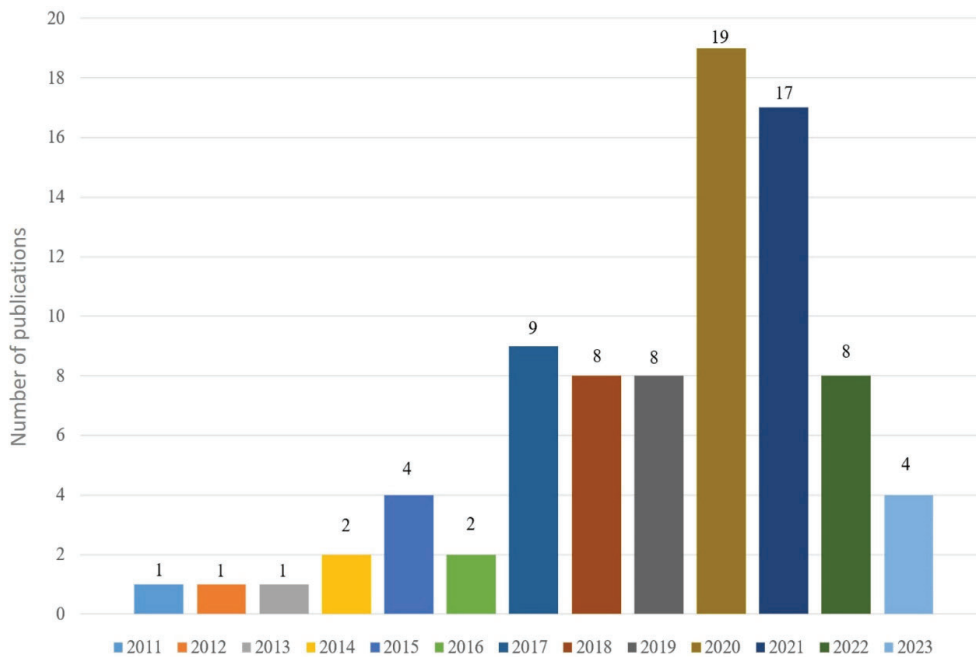


Fig. 3: Trend of publications

two publications on leadership styles research, representing the most productive and influential authors. Ekowati, Purwanto, and Udin, respectively, each of them contributed with 4 publications, followed by Fakhri, Irawanto, Pawirosumarto, and Supriyanto with 3 publications. In addition, Arifin, Arli, and Bernarto, respectively, devote 3 publications.

Table 2 and Figs. 4, 5 and 6 show evidence that

network visualization consists of 5 clusters: red, green, blue, yellow, and purple cluster. The first red cluster includes business strategy, innovation, organizational commitment, and organizational culture. Employee performance, job satisfaction, work environment, and work motivation are represented by the second cluster, which is identified to be green in color. In addition, the third blue cluster covers knowledge management,

Table 1: Most productive and influential authors

No.	Authors	Amount of paper
1	Ekowati	4
2	Purwanto	4
3	Udin	4
4	Fakhri	3
5	Irawanto	3
6	Pawirosumarto	3
7	Supriyanto	3
8	Arifin	2
9	Arli	2
10	Bernarto	2

Table 2: Cluster of constructs

Cluster	Color	Items	Constructs
Cluster 1	Red	4 items	Business strategy Innovation Organizational commitment Organizational culture Employee performance
Cluster 2	Green	4 items	Job satisfaction Work environment Work motivation Knowledge management
Cluster 3	Blue	3 items	Transactional leadership Transformational leadership
Cluster 4	Yellow	2 items	Creativity Employee engagement
Cluster 5	Purple	1 items	Democratic leadership

transactional leadership, and transformational leadership. Creativity and employee engagement are all part of the fourth yellow cluster. Finally, democratic leadership is included in the fifth purple cluster.

The appeal of transformational, transactional and democratic leadership styles and their impacts

Transformational leadership focuses on inspiring and motivating employees to achieve their full potential and surpass their own expectations (Antonakis and House, 2014; Avolio and Bass, 1991). Transformational leaders influence job satisfaction, organizational commitment, and employee performance by inspiring and empowering them to create a positive work environment and foster

a shared sense of vision. By demonstrating as role models, transformational leaders establish strong emotional connections with their employees to feel a sense of belonging, leading to increased dedication to go the extra mile. Effective transformational leaders in Indonesian settings should place a strong emphasis on interpersonal relationships and respect for authority. By building strong relationships, trust, and respect for employees, transformational leaders could inspire them to generate positive organizational outcomes. Transactional leadership, in contrast to transformational leadership, focuses more on maintaining the status quo and achieving predetermined goals through reward systems and punishments (Antonakis and House, 2014). Therefore,



Fig. 4: Network visualization of keywords cluster

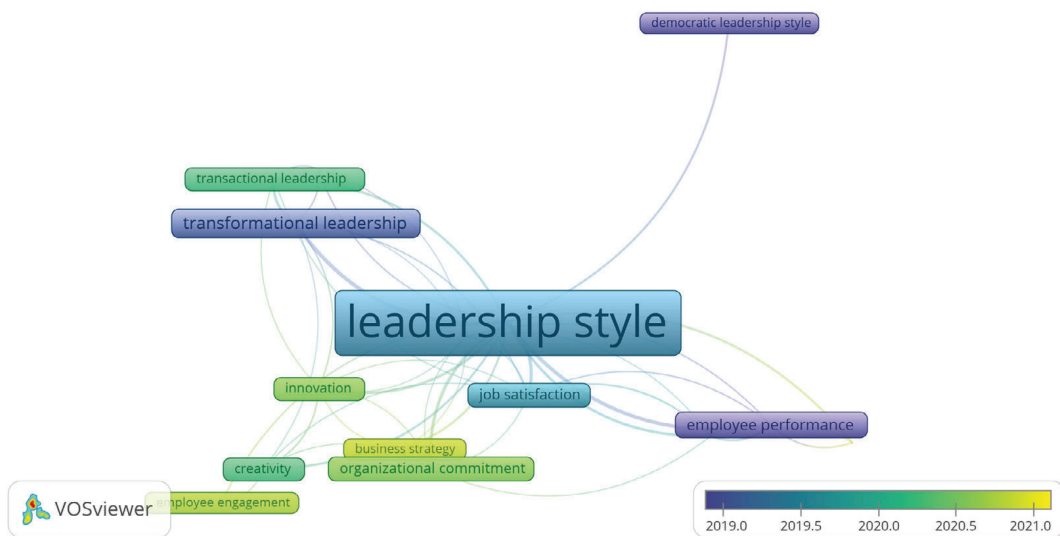


Fig. 5: Overlay visualization

transactional leaders typically establish clear expectations for their employees. Also, transactional leaders place emphasis on task accomplishment and performance targets (Aboramadan and Kundi, 2020). By providing specific targets and outlining the desired outcomes, transactional leaders create a framework that guides employees' efforts to increase their

creativity and innovative performance. Transactional leaders in Indonesia should clearly communicate performance expectations, targets and goals to their employees. By providing clear and specific instructions, it may help employees to understand what is expected of them and what rewards they can achieve through their performance criteria. Also, there is a strong



Fig. 6: Density visualization

respect for hierarchy and authority in Indonesian culture. Therefore, transactional leaders need to assert their authority while maintaining a supportive attitude in order to manage their employees effectively. Democratic leadership, also known as participative leadership, commits to involving employees in decision-making processes (Woods, 2021) and actively seeking their input and feedback. By engaging employees in strategic discussions, democratic leaders tap into this knowledge and expertise, enabling the development of more accurate and effective business strategies. Employees also develop a deeper understanding of the strategic objectives and are more likely to be committed to their successful implementation (Tajpour *et al.*, 2023). In addition, democratic leaders encourage open and transparent communication channels to facilitate the exchange of ideas and diverse perspectives. When employees feel comfortable expressing their opinions, they are more likely to be productive and proactive in the success of the organization (Hilton *et al.*, 2021; Sutiyaatno, 2022; Udin, 2023).

CONCLUSION

This research concluded that leadership styles (i.e., transformational, transactional and democratic leadership) positively contribute to the associated

outcomes (i.e., employee performance, job satisfaction, organizational commitment, employee engagement, business strategy, and organizational innovation and creativity). In addition, mainly related to associated outcomes, transformational leadership style is a more dominant influence than transactional and democratic in Indonesian settings. Therefore, transformational leadership becomes one of the most effective leadership styles for creating high-performing and successful organizations. Transformational leaders engage and empower employees by involving them in the decision-making process and valuing them to promote higher employee satisfaction, commitment, loyalty, and performance. The findings of this study can potentially be generalized to similar countries or contexts with specific considerations: (1) cultural similarities, for instance, the countries in Southeast Asia such as Malaysia, Thailand, or the Philippines that have historical and cultural ties with Indonesia, (2) similarities in economic development, income levels, and education. This study only uses the Scopus database as the primary source being analyzed regarding the leadership styles research in Indonesian settings. This, of course, leads to the study limitation that needs to be reported. Thus, it is possible for future research to expand the secondary sources, such as

Web of Science (WoS) and Google Scholar databases.

AUTHOR CONTRIBUTIONS

U. Udin has performed the writing of the original draft, investigation, methodology, and supervision.

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CONFLICT OF INTEREST

The author declared no conflict of interest concerning this research work. Also, the author has checked all the ethical affairs comprising duplicates, misconduct, data making, informed consent, and plagiarism.

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ABBREVIATIONS

FRL	Full Range model of Leadership
WOS	Web of Science

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ORIGINAL RESEARCH PAPER

Optimization of energy consumption of ozone generator and plasma generator in decolorization and disinfecting of water system in urban residence

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Plasma

ABSTRACT

BACKGROUND AND OBJECTIVES: The water field futurology is mostly focused on the water shortage and resulting political-security crises. However, the emphasis of this study is on the water pollution crisis. This study utilizes water decolorization and microbial decontamination as novel and low-risk methods in water and water resources sanitization with the preservation of the municipal environment approach. Modern oxidation methods for pre-treatment or aid-treatment have well-attained their place in the water and wastewater treatment process to reduce microbial and chemical contamination of water. Applying light, plasma, ozone, and Ultraviolet light is one of the modern and eco-friendly methods for water treatment and disinfection with growing usage.

METHODS: In this research, various types of ozone and plasma generators, with the approach of energy consumption reduction, were manufactured for simultaneous decolorization and disinfecting of the water. All these devices consist of three main sections; frequency-increasing circuits, voltage-increasing transformers, and a reactor based on electrical discharge in gas. The simulation was performed using Orcad and PSPICE and Comsol softwares. After designing and simulation, a pilot of each of these three sections was made.

FINDINGS: Both plasma and ozone reactors, which act as light tubes with a purple color spectrum were made and optimized for water treatment in the form of tubular tubes and flat cell for volume and surface radiation. Microbial testing of 8 water samples in terms of coliform in laboratory was confirmed by the Iran Environmental Organization mpn/100ml.

CONCLUSION: After computer simulation, all three basic sections of an ozone generator device with a power consumption equal to a 30-watt lightbulb were made and optimized. By 5-minute injection of the ozone generated by this device into the water containing methylene blue as the color contamination index and Escherichia coli as the microbial contamination index, 99% of microbial decontamination was achieved, along with decolorization.

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INTRODUCTION

Although the more than three-quarters of Earth is covered by water (Shi, 2022) and 97% of the water on this planet accumulates in oceans and seas, humans provide their drinking and sanitary water from the 1% of water flowing in the rivers or stored in freshwater lakes and underground resources (Greenberg and Schneider, 2019). In the last decade, in addition to the water shortage crisis, due to the increase in population and the change in the consumption pattern, the crisis of clean water shortage also stands out (Moghadam and Samimi, 2022). On the other hand, in addition to preventing environmental pollution and emerging hygienic hazards, modern communities treat wastewater to provide a permanent and assured water resource for industry, agriculture, and other usages (Obaideen et al., 2022; Karbassi and Pazoki, 2015). The specific contaminants causing water contamination contain a wide range of pathogen microorganisms and chemical substances due to the leakage of municipal and hospital swages and industrial wastewater into the water resources (Mukhopadhyay et al., 2022; Saini and Deepak, 2021). Eliminating contaminants that cause diseases and eliminating contaminants that make the aroma, color, and taste of water undesirable for human consumers are the two prominent reasons for water treatment. In the treatment of municipal water and wastewater, most of the fecal coliforms, a subgroup of coliforms, are investigated. *E. coli* bacteria, as the microbial contamination index in water and foodstuff, belongs to this subgroup (Bonetta et al., 2022). On the other hand, colors are among the first pollutants diagnosed in the water. Another source of water contamination is the leakage of wastewater and surficial and stray waters containing color and novel industrial color solvents (Arif et al., 2021). The interference and entering the hexagonal aromatic ring present in perfumes (Arctander, 2019) or in Fragrance (Sell, 2019), petrochemical products (Samimi and Shahriari Moghadam, 2018), pesticides (Speight, 2016; Mensah et al., 2021), medicines, such as antibiotics (Pollak, 2011), and drugs (Myers, 2007) into the water resources shows the necessity of the applying appropriate eco-friendly methods to eliminate these contaminants in water and wastewater. Although biological treatment is known as the best and most affordable method for treatment, it cannot treat the contamination of water-soluble

colors containing aromatic structures correctly (Ramos et al., 2021). For more than a century, chemical oxidants were initially used as disinfectants in water treatment and then used for decreasing the mineral and organic contaminants (Von Gunten, 2018). For instance, ozone, as a potent oxidant, can eliminate the minor and resistant contaminants in an aquatic environment (Nashmi et al., 2020). Other oxidants can be used for this purpose, as well. However, adding slight amounts of chemical compounds, such as H_2O_2 , TiO_2 , and peroxymonosulfate salt (Moreno-Andres et al., 2020) as the chemical catalysts with ozone lead to Advanced Oxidation Process (AOP) for accelerating and increasing the disinfecting (Rodríguez-Chueca et al., 2015) or decreasing the applied ozone dose (Rivas-Zaballos et al., 2022). One of the most robust synergies in the impact of ozone on water contamination is adding Ultra Violet (UV) light radiation to the ozonation process (Lu et al., 2022). In recent years, using chemical oxidation and advanced oxidation based on producing of highly active and reactive compounds as a pre-treatment or aid-treatment method have been proposed (Pavithra and Jaikumar, 2019). However, the presence of ozone in most AOP methods (Capodaglio, 2020), its significant effect on water pollutants, and its short half-life have made it especially prominent (Venkatesh et al., 2014). Ozone has shown brilliant performance in eliminating viruses, bacteria, flavor, chloramines and combined chlorine, and most organic substances (Von Sonntag and Von Gunten, 2012). As an oxidant, ozone is directly effective in eliminating water contaminants. Moreover, ozone indirectly accelerates the formation of hydroxyl radicals as a principal component of advanced oxidation (Gao et al., 2019). It is proven that ozone-based AOPs are effective in the detoxification of a vast array of chemical compounds in industrial wastewater containing resistant organic substances, pharmaceutical products, pesticides, phenols, and colors (Chhaya and Srivastava, 2020). Doubtlessly, AOP is the most potent oxidant that can be added to the water since it is a combination of oxidation methods (Ahmad and Azam, 2019). However, AOPs that use UV, H_2O_2 , cold plasma, and ozone could be more promising due to the production of higher amounts of hydroxyl radicals compared to separated treatments (Fan and Song, 2020). Due to the low durability of the ozone and plasma in the

environment, and considering that they cannot be stored, they should constantly be produced during usage. The main disadvantage of this technology is the high-power consumption of the ozone generator device. Reducing this consumption is the best justification for optimizing these devices (da Silva *et al.*, 2021). Ozone suitably terminates viruses, bacteria, flavor, chloramines, combined chlorine, and most organic substances. Moreover, catalysts lead to increasing the mass transfer of O_3 (Sanches-Simões *et al.*, 2022). In addition to the states of solid, liquid, and gas in materials, plasma is a state that occurs at extremely high temperatures or by electric discharge in gas. Laroussi *et al.* (2020) produced cold plasma using a resistant barrier with no charge in the room temperature and pressure. For this purpose, they insert a gas mixture containing oxygen between two flat electrodes. Then, a voltage of about several kV was applied. The benefit of this method is the low inserting power, which is between 50 to 300 W, and the large production of plasma. This team exposed two kinds of bacteria with and without outer membranes to cold plasma and examined the effects of plasma on them with the electron microscope. After 10 min, it was observed that UV light and free parts of plasma terminated both bacteria. Plasma production leads to the formation of high-energy electrons providing spatial charge and highly reactive species of Oxygen, Nitrogen, Hydroxyl Radicals (OH), atomic Oxygen (O), and superoxide. The hot plasma is produced by flame, spark, and microwave at high temperatures (Ye *et al.*, 2020). In cold plasma, however, most of the electric energy consumes to increase the electron energy, and the total gas temperature remains at room temperature level. Generally, cold plasma is a mixture of neutral electrons, ions, atoms, and molecules. Different particles in cold plasma demonstrate different energies. It means the electrons are more energetic than other particles (Czapka *et al.*, 2018). Cold plasma is generated by the ionization of fluids, such as the air around a conductor with an electric charge. This type of plasma, known as ozonation plasma, has a temperature range of 300 to 400 K (Li *et al.*, 2022). In physics, the formation of cold plasma is mainly investigated in pressures lower than atmospheric pressure and vacuum lamps. On the other hand, the dielectric (DBD) properties are used in industrial

applications and in the production of ozone for generating a cold plasma from the atmosphere pressure, which is sustainable in the non-laboratory environment (Duarte, 2020). Two electrodes, which at least one of them is covered by dielectric, are used in this method. The distance between these two electrodes is often about a few Millimeter (mm). The voltage and frequency levels can be varied due to the applied gas. The used frequency is often 4 kHz and 20 kHz. Dielectric can be from glass, quartz, ceramic, Teflon, and polymer (Baloul *et al.*, 2019). The water field futurology is mostly focused on the water shortage and resulting political-security crises (Maruyama *et al.*, 2013). However, the emphasis of this study is on the water pollution crisis. This study utilizes water decolorization and microbial decontamination as novel and low-risk methods in water and water resources sanitization with the preservation of the municipal environment approach. The aim of present study is confined to the production of a Low power consumption ozone device for removal of E. coli as well as methylene blue from contaminated waters. The current investigation has been carried out in Kish Island in the year 2022.

MATERIALS AND METHODS

As Fig. 1A displays, the devices designed and manufactured for the purpose of this study to produce plasma and ozone consist of three main sections, including a high-frequency pulse-generator electric circuit, a voltage-increasing transformer, an ozone-generator plasma tube, and some subsections, such as an air blower, programmer timer, device case, circuit connections, etc.

In the other photos related to Figure 1, the circuit components are numbered to indicate the correspondence between the schematic and the photo of the device. Parts B and C and D of the Fig. 1 show the three main designed and made sections, which involve an electronic part (circuit and transformer) called driver, and the Parts D of the Fig. 1 shows tube part, called plasma reactor and ozone cell generator, as well. The task of the driver is to produce high-voltage electricity for the tube part, which has the task of producing plasma for the decomposition of oxygen available in the air and producing ozone. The manufacturing of each section is discussed in the following.

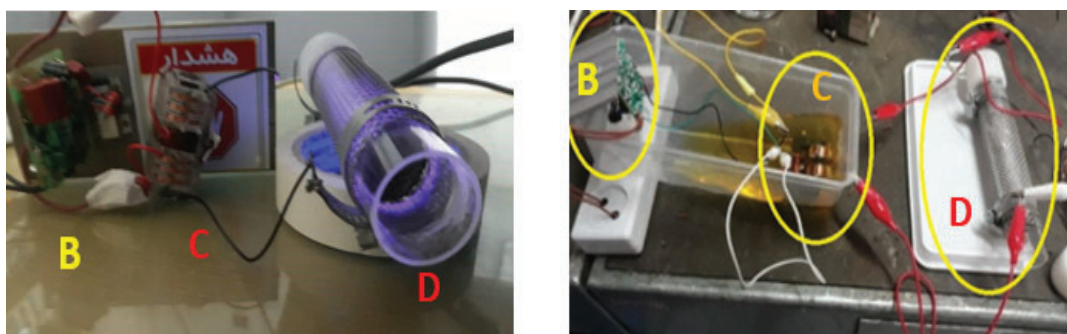
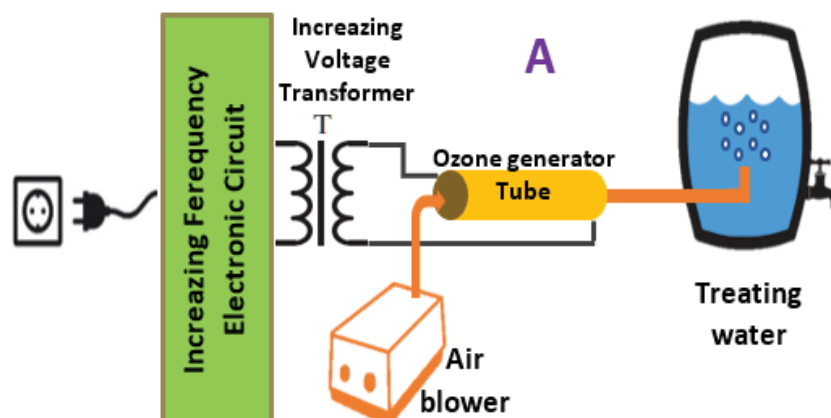


Fig. 1: (A) Main sectors of plasma and ozone generator device (B) 25000 Hz circuit (C) Ferrite-core transformer (D) Plasma, UV, and ozone reactor

Stages of Manufacturing and Testing the Circuit Pilot

A dielectric plasma ozone-generator requires a high-frequency alternating voltage (Wu *et al.*, 2019). Ozone can be produced using the same municipal electricity frequency. However, the transformer and the device sizes would be excessively large due to its low frequency. Therefore, a high-frequency generator electric circuit is used for this purpose (Homola *et al.*, 2020). There are many methods and circuits to produce a high-frequency voltage (Abadi *et al.*, 2022). However, regarding the availability of municipal energy sources (Murdiya *et al.*, 2020), using a half-bridge inverter circuit with two switching transistors and an analog or digital time setting as a voltage converter circuit is the prevalent method (Stryczewska *et al.*, 2013).

According to the Fig. 2 schematic, the designed inverter circuit for increasing the frequency of 220

V municipal electricity from 50 Hz to 50000 Hz can be designed and regulated. Initially, by rectifying the municipal electricity with a diode bridge containing four diodes, and then switching the rectified voltage reached at 310 V to 50 times in second, it turns the straight voltage of DC into a high frequency alternating voltage of AC. This board is re-designed and manufactured with 25 kHz frequency based on switching power supplies and inverter self-resonance using the general design of the electrical ballast circuits of energy-saving Light-Emitting Diodes (LED) and Compact Fluorescent (CFL) lightbulbs for producing ozone and plasma. Except for municipal electricity, the input of the inverter can be supplied by the output of an AC generator with a rectifier, battery, fuel cell, or solar photovoltaic cell (Nehari *et al.*, 2019). Generally, the operation frequency of the inverter is selected as more than 15 kHz (Amjad

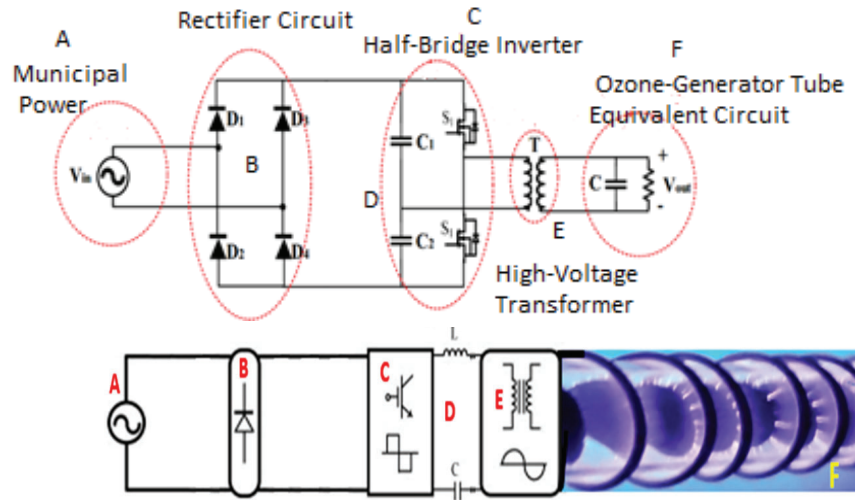


Fig. 2: Schematic and signaling of plasma and ozonation circuits (A) 220 V 50 Hz Municipal Power (B) Diode Bridge Rectifier (C) Two Switching Transistors (D) Self Tank and Regulating Capacitor (E) Ferrite-Core High-Voltage Transformer (F) Formation of Ozone-Generating Plasma In the Reactor

and Salam, 2014). Switching is usually conducted with the help of multiple switch transistors or Metal Oxide Silicon Field Effect Transistors (MOSFET) or Insulated-Gate Bipolar Transistor (IGBT) to achieve high frequency (Murdiya *et al.*, 2017). In this type of converter, the criterion is increasing the number of ozone-generator reactors launches and shutting down. Therefore, a half-bridge topology can be used until 50 kHz frequencies to alter the positive and negative poles or launch and shut down the ozone-generator reactor. The aim of this action and raising the operation frequency is to minifying the transistor and produce the ozone-generator plasma, including micro sparks, and avoid the continuity of creating intense and sinking current sparks, to achieve a low-consumption frequent spark circuit (Kim *et al.*, 2021).

Methods for Designing and Manufacturing of High-Frequency and High-Voltage Transformer

To increase the voltage level, after increasing the municipal electricity voltage in the switching inverter circuit made in the prior section, a voltage-increasing transformer with a high-frequency ferrite core was designed and manufactured (Fig. 3).

According to Fig.3, the electrical energy is transferred by a magnetic field from the middle of transformers that usually involves two primary and secondary windings and a magnetic core, and

the electrical energy is transferred magnetically from one winding to another (Shaarbafi, 2014). By developing the power electronic science and emerging the high-frequency switching converters, giant iron-core transformers operated with municipal electricity frequency were replaced by special small high-frequency ferrite-core transformers (Hurley and Wolfe, 2013). The high-frequency transformer is much lighter and smaller than a low-frequency one since frequency has an inverse relationship with cross-section and the number of windings (Goldman, 1999). The manufactured transformer in this research is coiled for 4000 and 100 rounds on the secondary side (output) and primary side (input), respectively. During operation with the switching circuit, due to its high frequency and high-voltage output, it can launch any CFL energy-saver or fluorescent lightbulb by connecting to them (Schlüter and Shivarova, 2013). According to the Fig. 3A, by getting the CFL lightbulbs close to the circuit and transformer, due to electromagnetic interferences of operating circuits (Coca *et al.*, 2011), the fluorescent tube filled with low-pressure ionizable and inflammable gas automatically turns on since the gas inside the lightbulb can be ionized and inflamed due to the establishment of the high-frequency current and injection of a strong electromagnetic field, even wirelessly and without a direct connection. This subject has been exploited

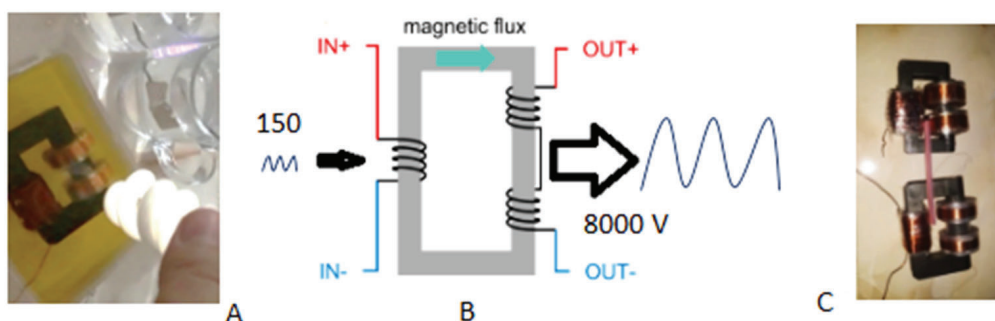


Fig. 3: (A) Operating transformer to amplify high-frequency voltage immersed in insulating oil, (B) Schematic and wiring type of increasing transformer, (C) Practical manufactured samples of transformers that would be optimized by thermal camera

in recent years to make plasma antennas instead of metal ones (Jaafar *et al.*, 2017) and was frequently used in this research as a test that a fluorescent and an energy-saving lightbulb was placed in the vicinity of a high-frequency circuit and high-voltage transformer to reveal the presence of the field and its operating status. One of the heavy tasks of this study was manufacturing more than 50 handmade ferrite transformers obtained by calculation for UU-core and UR-core transformers with 10 mm, 12 mm, and 14 mm diameters for the primary winding with thin 0.5 mm wire and 70 rounds, and the secondary winding with thinner 0.01 mm wire and 3500 rounds. In practice, it was achieved with a 10% difference in accurate numbers and stable performance of the circuit. According to the Fig.3 B, C, the best responses for manufacturing and winding the transformers of this study were obtained when the transformers were precisely symmetrical in geometric terms and the secondary winding was made in the forms of two coils.

Methods for Designing and Manufacturing of plasma reactor and ozone cell generator

By establishing a high potential difference between two metal electrodes, electrons with negative charges influenced by the electrical field move from the cathode to the anode. After the saturation condition due to the dielectric barrier in the path of the electrons, if the potential difference between the two electrodes gets higher, a situation in which the current would be re-increased occurs. The nature of this increase depends on the type and pressure of the gas (Thanu *et al.*, 2019). One of the points of simulation by COMSOL software is that by

knowing the mass of the fundamental particles, for instance, for simulation of plasma formation and analyzing its behavior, argon atoms can be used. Argon is a neutral gas with lower reaction and fewer collisions than air, which is a mixed gas. Argon and other noble gases are chemically ineffective and cannot form any compound. Argon plasma merely contains argon ions and electrons. For this purpose, argon is defined with an atomic number of 18, a mass number of 40 in terms of total mass, 18 electrons, 18 protons, and 22 neutrons. Then, types of electron and argon atoms collisions would be defined. The reason for this increase in electrical current is the increase of the energy and temperature of the electrons in an accelerated movement in the electric field between electrodes over time. As a result, the energy of the electrons that leave the cathode is more than the ionization energy of atoms. Some of them ionize the atoms and produce electrons and ions. These results approve the other studies of plasma generation analysis (Sener, 2021), stating that in case of acquiring adequate energy, these electrons lead to the ionization of other atoms. In other words, the ionization reactions accelerate (Ouyang *et al.*, 2022). Initially, a computer simulation of the high-frequency circuit function was performed using the 2019 version of OrCAD software and the PSPICE simulator. For this purpose, new definitions and fully non-linear elements, such as DIACs, were added to the software library. Eventually, the obtained results were thoroughly coordinated with practical and laboratory signals for the circuit. The 100 times per second energy packs, in which high-frequency signals up to 25000 Hz are applied, appeared, as well.

RESULTS AND DISCUSSION

The methodology of this research was study, optimizing, device manufacturing, and laboratory. Initially, by designing and manufacturing the required circuits, transformers, and reactors, the effect of plasma and ozone generators on the decolorization and disinfection of the water contaminated by *E. coli* and the soluble color of methylene blue was proven and compared. Then, considering the energy consumption optimization for the novel ozone-plasma generator, optimizations, like a transformer with low loss, were done. The optimized circuit, transformer, and reactor were equipped as an industrial machine and then tested again for evaluation of water decolorization and microbial eliminations.

Low Power Consumption of The High-Voltage of High-Frequency

Regarding the energy consumption pattern, modern ozone, UV, and plasma equipment involves three main sections; frequency-increasing circuits, voltage-increasing transformers, and a reactor based on electric discharge in gas. By using optimized compartments containing two metal electrodes and a quartz glass dielectric layer, the particular properties of plasma can be used in ozone generation by turning hot sparks into constant micro discharges on the entire surface of electrodes. Hot ozone-generating sparks consume power up to several thousand milliampere mA. However, ozone-generating cells and tubes made in plasma devices showed a maximum of ten mA current sinking. This lower electricity consumption corresponds with lower loss, which was optimized and monitored during this research by a thermal camera of each manufactured device. Meanwhile, lower loss in the reactor of ozone and plasma corresponds to lower operating temperatures. Therefore, the need for permanent coolers will be reduced. For instance, the simplest cooling fans have 220 V to 200 mA power consumption, equal to ten times as much power as the ozone-generator reactor.

Concordance of Measured Signals with Simulation Results

The simultaneous combination of the high-frequency feed signal with low-frequency is a vital issue in detecting the ozone-generating plasma signals due to the self-resonance circuits. It means that energy is applied on electrodes in high-voltage

packs but simultaneously in two different frequencies of 100 and 25000 Hz. In other words, an 8000 V energy pack with 100 Hz frequency applies in the tube, and plasma is generated suitably. On the other hand, an increasing-voltage transformer follows 25000 Hz. It could be like launching and shutting down a 25000 Hz energy source 100 times per second. Through this research and manufacturing and optimizing of device components, energy signals and high-voltage packs containing high-frequency signals were appropriately simulated, detected, and measured for the first time.

Temperature Optimizing of Circuits, Transformers, and Reactors

An ozone-generating device was manufactured and optimized by frequent production and substitution of its high-voltage power supply. Then, by plasma improvement, an ozone-plasma device was designed and manufactured. The functional optimization was done by the tests of operational continuity and temperature tests, along with the optimization of the design. Optimization of components was performed based on the photos of the infrared camera since overheating of any section refers to power loss.

Power Consumption Optimization of Circuits, Transformers, and Reactors

First, to produce hot and cold plasma, devices were manufactured. Then, the effectiveness of each of them on decolorization and disinfecting of water was examined. Eventually, every combination of the circuit, transformer, plasma cell, or ozone tube was optimized based on power consumption. All devices of this research were manufactured for simultaneous decolorization and disinfecting of water and optimized regarding power consumption. Plasma devices and small and large ozone generators were designed and manufactured up to 5 W, 10 W, and 30 W powers, respectively. In other words, the power consumption of ozone generator devices of this research was as much as a low-consumption lightbulb.

Optimization of Manufactured Devices by Testing the decolorization

Although various plasma reactors were manufactured in this study, no significant results were made for decolorization the contaminated water compared to ozonation decolorization. It was due to water turbidity, the volumetric water sample,

and the low interface with testing plasma (Mohades *et al.*, 2020) Ozonation acted up to 30 times better for decolorization. The comparison with the simple decolorization test was evaluated to optimize the manufactured devices since the impact of ozone on the decolorization of color-contaminated water was observable from the first minute. The decolorization test was measured after dissolving methylene blue in the well water making a mother solution as blue color water with 20 mg/liter concentration and 46 Formazine Turbidity Unit (FTU) turbidity, which turned into clear water by 6 FTU ozonation.

Microbial Test for Manufactured Devices

First, 80cc of jelly-like powder of nutrient Agar solution was boiled for 8 minutes until it melted completely. The resulting liquid was placed in a bain-marie hot water bath at 50 °C. *E. coli* was separated carefully from the contaminated sample and cultivated. This microbial suspension was used to contaminate the water samples. *E. coli* is a rod-shaped bacterium of the coliform group that is distinctive from other coliforms due to its growth and color changing in the culture media. *E. coli* is the microbial contamination index in water and foodstuff. Its presence in drinking water and food indicates contamination with intestine pathogens. Food infections and poisoning due to *E. coli* contamination are globally well-noticed and studied. A counter or filter paper with specific pores with fine lines can be used to count the *E. coli* colonies on the plate.

The *E. coli* bacteria, which has a pungent smell, has a silver-green color in nutrient Agar culture medium with methylene blue reagent. However, this color turns red by the covax reagent. Parallel with microbial tests, microbial ready-to-use kits of ColiZist were applied to perform quick and confirmatory tests. Assurance of the absence of fecal contamination bacteria index in water is critical in preserving public health. Small lidded bottles of the ColiZist kit contain nutrient Agar powder and microorganisms. By adding the testing water, it can show the presence of crucial coliforms and *E. coli* in the water sample at the same time within a day.

Best Result for Disinfection and Confirmatory Tests

Extensive microbial tests were performed in private food and drug laboratory on Kish Island. The testing water was contaminated with more than

a thousand microbial colonies. Only 4 minutes of ozonation had a 99% microbicidal impact on it. The reduction of the color load was thoroughly tangible from the second minute, and the color contamination was reduced from 50 Nephelometric Turbidity unit (NTU) to 5 NTU. The official results of the tests for each water sample in the laboratory confirmed by the Iran Environmental Organization MPN/100ml, before and after the ozonation, are provided in the [Tables 1](#) and [2](#).

Ozonation is practical for the water treatment industry as well as wastewater treatment. After evaluating the effect of generated ozone on eliminating *E. coli* in water and numerous confirmatory microbial tests, the ColiZist ready-to-use culture medium that ozonates the 3-day incubated sample containing thoroughly grown *E. coli* for 5 min showed that an optimized ozone-plasma device can have an appropriate performance in eliminating high concentrations of *E. coli*. Thus, it is suitable for the disinfection stage of sewage and even hospital wastewater treatment. To test this, the 3-day water sample contaminated by *E. coli*, which acted as the control sample in the previous confirmatory tests, was ozonized separately as a wastewater sample with a high *E. coli* concentration. After 4 minutes of ozonation by the manufactured device in this study, the microbial load reduction was tangible.

The Optimal Circuit with 99% Microbicide Impact and 30 W Power Consumption

In this study, more than 40 parameters were considered to manufacture and test the ozone-plasma device mainly stated in terms of voltage, current, frequency, and power. However, in practice and during manufacturing of, for example, the frequency converter electrical circuits, 13003, 13005, 13007, and 13009 transistors were used. Eventually, after optimization of thermal losses and testing the operation continuity, the 13009 transistors were optimized and applied in final circuit manufacturing. The disturbing occurred harmonics and high frequency make the specific type and high quality of 13009 necessary. It makes the manufacturer of high-frequency switches important, as well. Moreover, extensive experimental issues should be considered, during the manufacturing and resin casting of high-voltage increasing transformers. On the other hand, since the frequency of the circuits is high, making

Table 1. Microbial testing of 8 water samples in terms of E.coli before and after the ozonation

Sample type	Water	Water + Color	Water + Microorganism	Water+ Microorganism + Color
<i>E. coli colonies</i>	0	9	*>1100	*>1100
Ozonated sample	Water +Ozone	Water + Color +Ozone	Water + Microorganism +Ozone	Water + Microorganism + Color +Ozone
<i>E. coli colonies</i>	0	0	9	0

Table 2. Microbial testing of 8 water samples in terms of coliform before and after the ozonation

Sample type	Water	Water + Color	Water + Microorganism	Water + Microorganism + Color
Coliform colonies	0	44	*>1100	*>1100
Ozonated sample	Water +Ozone	Water + Color +Ozone	Water + Microorganism +Ozone	Water + Microorganism + Color +Ozone
Coliform colonies	0	4	9	4

massive trial and error seems unavoidable to regulate the circular triode transformers that have 3 or 4 windings with five rounds. Regarding the water disinfecting and decolorization device, the main components with 28 W power consumption involving half-bridge 13009 transistors, UR14 transformer, and heatsinked large plasma tube reactor were optimized. This study provides comprehensive information for other researchers to manufacture and use. Application of various oxidant and disinfectant has been discussed by other researchers (Ahmad and Farooq, 1985; Chu *et al.*, 2008; Chu *et al.*, 2007; Liu *et al.*, 2011). Such oxidants might include various sizes of ozone as well as radical OH. Some of the above-mentioned studies focus on dye removal and some on microbial aspects. The comparison between the present study and earlier studies clearly shows that nanobubble ozone is more effective in removal of coliform as well as color. The oxidants can be used in wastewater treatment as well as urban run-offs. For instance, the performance of oxidants (mainly radical OH) showed that while COD contents of run-offs reduces the speciation of metals might change (Ebraheim *et al.*, 2022; Ebraheim *et al.*, 2021). The present study showed that micro- and Nano bubbling considerably improves gas dissolution compared to conventional bubbles and hence mass transfer. It can also intensify generation of hydroxyl radical due to collapse of the bubbles, which in turn facilitates oxidation reaction under both alkaline as well as acidic conditions.

CONCLUSION

Modern oxidation methods for pre-treatment or

aid-treatment have well-attained their place in the water and wastewater treatment process to reduce microbial and chemical contamination of water. Applying light, plasma, ozone, and UV light is one of the modern and eco-friendly methods for water treatment and disinfection with growing usage. In this research, various types of ozone and plasma generators, with the approach of energy consumption reduction, were manufactured for simultaneous decolorization and disinfecting of the water. First, devices were manufactured to produce both hot and cold plasma. Then, their effects on the decolorization and disinfecting of water were investigated. It was attempted to optimize the design of three main components, including the circuit, transformer, and plasma and ozone reactor, by computer simulation. The operational optimization of the pilot of the ozone generator was done by frequent substitution of its high-voltage power supply, transformer, and reactor. Therefore, an ozone-plasma device with low thermal losses and power consumption was designed and manufactured. The optimized manufactured devices were compared to the decolorization -in-water rate test, and operation continuity was optimized. Both plasma and ozone reactors were made and optimized for plasma treatment and ozonation of the water in the form of tubular tubes and surface radiation. The simulation was performed using OrCAD and PSPICE software. Microbial testing of 8 water samples in terms of coliform in laboratory was confirmed by the Iran Environmental Organization MPN/100ml. The microbicide test on the E. coli and methylene blue contaminated water was performed multiple times for the final device.

Eventually, the function of the optimized device was confirmed by microbial tests in Kish Island Official Water and Drug Laboratory with a 99% reduction of microbial load in water contaminated by *E. coli*. Regarding conducted studies on injecting nanobubbles into the water to increase the efficiency of low-consumption manufactured devices of this research, the injection of ozone in the forms of nanobubbles into the contaminated water is proposed. Application of the present investigation might include both residential and industrial wastewaters.

AUTHOR CONTRIBUTIONS

M.H. Mosstafavi in addition to preparing the article, was responsible for manufacturing the ozone generators and plasma generators devices. A.R. Karbasi and M. Pazoki were responsible for modification and interpretation of the results.

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The current study is a part of the author's doctoral thesis which was defended in 2023 at Tehran University

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.

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ABBREVIATIONS

<i>AOP</i>	Advanced oxidation process
<i>CFL</i>	Compact fluorescent lamps
<i>FTU</i>	Formazine Turbidity Unit
<i>IGBT</i>	Insulated-Gate Bipolar Transistor
<i>Kh_z</i>	Killo hertz
<i>KV</i>	Kilo Volt
<i>LED</i>	Light-emitting diodes
<i>MOSFET</i>	Metal Oxide Silicon Field Effect Transistors
<i>NTU</i>	Nephelometric Turbidity unit
<i>O₃</i>	Ozone
<i>OH</i>	Hydroxyl radical
<i>W</i>	Watts

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ORIGINAL RESEARCH PAPER

Human capital development in university teaching environment: the role of workplace and innovation culture

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ABSTRACT

BACKGROUND AND OBJECTIVES: Innovation can help the human capital of teachers to work more creatively. The job atmosphere consists of the physical environment in which teachers work and the psychological or social-emotional climate created by the interactions and relationships between teachers, students, and school officials. The study focused on the teaching environment of public tertiary teachers and their association with innovation.

METHODS: The study employed a descriptive research method to examine the relationship between the teaching environment and innovation among tertiary teachers. 196 teachers and 28 superior respondents filled out the survey questionnaire. The instrument used the percentage and frequency to analyze the respondent's profile data and verbal descriptions and weighted mean to describe the variables. It used the following scale: Never, Seldom, Sometimes, Often, and Always.

FINDINGS: The respondent profile reveals that 53.1% are females and 46.9% are males. 36.7% of respondents have five years of teaching experience, and 30.6% have a master's degree, while 22.4% have a doctorate degree. Regarding challenging work, teachers and their superiors responded "always" to opportunities to express their ideas, with a mean rating of 4.25 and 4.29, respectively. Teachers also use innovative strategies to improve student performance, with mean ratings of 4.15 and 4.35. Teachers are recognized for a job well done in terms of organizational encouragement, with mean ratings of 3.98 and 4.14, respectively. Teachers possess the professional skills required for resources, with mean ratings of 4.05 and 4.54. Their superiors appreciate extra effort in supervisory engagement, with mean ratings of 4.20 and 4.43. Peers are supportive, with mean ratings of 4.23 and 4.25. Organizational independence was rated "seldom" by superiors on the item that some teachers ingratiate themselves with school officials to the disadvantage of their co-teachers, with a mean rating of 2.43. The result in the Culture of Innovation category shows that school officials allow teachers to try new ideas or strategies, as rated "always" by teachers and their superiors.

CONCLUSION: These findings may provide teacher's human capital development program to align the faculty in their field of specialization, minimize inbreeding and raise the quality of faculty members, and encourage senior faculty to undergo leadership capability training to prepare them how to handle sensitive positions in the university, to give opportunities to be more innovative, to engage them in high-quality research.

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INTRODUCTION

To attain high standards in teaching and learning, it is crucial for faculty members to fully embrace their role as educators and receive support from both their institutions and professional development opportunities (Steinert *et al.*, 2019). One's experience in teaching has a positive correlation with students' achievement gains for most of a teacher's career. As teachers accumulate experience, their students tend to perform better in areas beyond test scores. When teachers work in an environment that fosters support and collaboration, or when they gain more experience teaching the same grade, subject, or in the same district, they tend to become more effective. Experienced teachers can also provide benefits to their colleagues (Podolsky *et al.*, 2019). Ekemam and Okpara (2020) and Santos (2023) found that the few human capital development programs that were implemented had a significantly positive impact on the performance of both staff and students in state universities. They suggested the implementation of more human capital development programs and emphasized the importance of such programs as the best strategy to improve performance in the education sector. The teacher performance was positively and significantly influenced by factors such as competence, motivation, and the learning environment, as well as relationship antecedent variables that impact the quality of education. Furthermore, the quality of education was affected by the performance of teachers (Mulang, 2021). But the teaching-learning process is the main issue faced by public tertiary teachers. More than funds provided by the government are needed to resolve these issues. To address these issues, teachers are required to be innovative and creative for the resolution of these problems. All the social or process encounters and problems provide an opportunity for improvement and change (Innovating Education, 2016). There is a need for improvement in the existing process and make the change sustainable for better outcomes. The daily teaching activities that teachers encounter provide them with numerous opportunities to produce creative solutions and deal with challenges related to performing their duties. Innovation can help teachers to work more creatively. To be innovative, teachers need an environment that encourages them to produce innovative ideas, promotes their personal growth, and allows them to

be creative in their work. In order to be an effective teacher, it is important to be able to oversee the need for adaptation and innovation in everyday teaching situations. Improving teaching and learning requires careful consideration of the teaching environment, which should provide a supportive structure for student learning. Teachers should seek out conditions that allow them to apply their knowledge effectively in the classroom. In this context, the researcher, who is a public tertiary teacher, believes it is important to examine the teaching environment and its relationship to innovation. The job atmosphere consists of both the physical environment in which teachers work and the psychological or social-emotional climate, which is created by the interactions and relationships between teachers, students, and school officials (Corpuz and Salandanan, 2003). The physical environment refers to the physical characteristics of the classroom, such as the condition of the room, the arrangement of furniture and seating, the temperature, and the lighting. A clean, organized, spacious, well-lit, and ventilated, and quiet classroom is conducive to learning, while a dirty, cluttered, warm, poorly ventilated, and noisy classroom is not. To create an effective learning environment, the classroom should be structured in a way that promotes teaching and learning. According to a study by Florido (2006), schools in the Philippines often face challenges due to limited budgets and resources, such as a high student-to-textbook ratio and a lack of chairs or technology equipment. Despite these challenges, teachers in the Philippines have found ways to provide their students with a good education. The way students perceive the overall atmosphere and environment of their school has a significant impact on their writing and numeracy performance. This relationship is partially explained by the psychological connection students have with their school. Additionally, the way staff members perceive the school climate can also impact students' numeracy achievement (Maxwell *et al.*, 2017). A positive classroom climate is essential for fostering personal and subjective learning and for valuing the unique experiences of each learner. It promotes diversity and sees difference as a positive aspect, rather than a deficiency. This type of climate allows for mistakes, tolerates ambiguity, and encourages self-evaluation in a supportive group setting. It also promotes openness, trust, and a sense of belonging and respect for all

individuals, which are necessary for fully developing cognitive and emotional faculties, such as the senses, instincts, imagination, memory, feelings, emotions, and will. The classroom is the setting for teaching and learning. It has a psychological climate, shape by the interactions of key players and a physical environment that can influence learning. A conducive physical environment allows for active participation in learning activities, is arranged in a flexible way, and is safe, clean, peaceful, and free from unnecessary noise. Establishing routines is also important for creating a well-organized classroom, as it helps to maximize instructional time and facilitate smooth transitions between activities. These routines can be established for distributing and collecting materials, starting and ending lessons, and conducting group work, independent work, and other teacher-led activities. Innovation refers to the introduction of new services, processes or products into the market. It encompasses all aspects of an organization, from development and research to marketing and manufacturing, and involves finding effective ways to bring innovative technology to meet market needs (DuBrin, 2019). Innovation is the process of generating new ideas and implementing them in practice. This process typically involves creating ideas through spontaneous creativity, intelligence, information processing, and initial experimentation to determine their potential value and practical application (Samimi and Shahriari Moghadam, 2020; Rahman *et al.*, 2022; Saif *et al.*, 2023; Ratnawati *et al.*, 2023). It is important to note that the innovation process is not complete until the final application has been achieved. Simply having an innovative idea is not enough – it must go through all stages of innovation in order to realize its value (Acar *et al.*, 2019). Innovation involves transformation, improvement, and modernization. In Philippines, educational institutions, particularly higher education at the tertiary level, have embraced innovation. Enhanced faculty and student competence is developed by curriculum enhancement and planning, which is focused on competency-based and outcome-based education, and through the strengthening of partnerships between industry and academia. Grants for faculty development are also accessible to both public and private sector educators to help them pursue research, graduate degrees, and industry immersion. Promotion of excellence is done through supervisory and regulatory functions, such as the

granting of autonomous and deregulated status to high-performing institutions, the extension of financial support to private universities and colleges for internationalization initiatives and the closure of substandard programs. Centers of development and excellence are also recognized, and collaborative avenues such as Philippine Higher Education Research Network (PHERNET) and Higher Education Regional Research Center (HERRC) are being created to support research capacity building (Carillo, 2017). Carillo (2017) also highlighted the importance of innovative and ethical governance in the Philippines, including the use of anti-corruption measures within the bureaucracy to ensure and the compliance of state universities (SUCS) and colleges with Commission on Higher Education (CHED) policies and standards, the regional consolidation of state universities and colleges, the implementation of a strategic performance management system and efficient resource management. Several factors that influence innovation and creativity, include strategy, structure, open communication, support mechanisms, and behavior that encourages innovation. These efforts demonstrate that higher education in the Philippines is undergoing a transformation as it adapts to changing times and evolving expectations and demands, a reality shared by higher education institutions around the world (Martins and Terblanche, 2003). The review of related studies and literature provided the researcher with insights that helped to formulate the concepts for this study. The literature on the features of the teaching environment helped the researcher to understand the relationship between the teaching environment and innovation, particularly in terms of facilitating the teaching, learning process, and improving student progress. Additionally, by reviewing what has been written on the teaching environment in schools, the study was able to identify ways in which innovations can address issues that emerged in the findings. Overall, tertiary education in the Philippines is undergoing a transformation as it adapts to changing times and evolving demands and expectations. As a result, changes are being made to the teaching environment, including the physical environment, psychological climate, innovation, and faculty factors, in order to reflect these changes. This study focused on the features of the teaching environment of public tertiary teachers and their association with innovation. Specifically, it aimed to

examine the profile of the respondents in terms of age, civil status, gender, years of teaching experience, and highest educational attainment, the teaching environment of the teachers in terms of challenging work, freedom, organizational encouragement, resources, supervisory encouragement, workgroup support, and organizational independence, the culture of innovation among tertiary teachers, the relationship between the respondents' profile and the teaching environment, and between the teaching environment and innovation in their school and on the basis of the results of the study, the development of a proposed human capital program. To achieve these objectives, the research survey was conducted in different satellite campuses of Nueva Ecija University of Science and Technology in 2017 and updated 2022 in Philippine. This study seeks to bridge the gap in understanding the relationship between the teaching environment and innovation in public tertiary education institutions. By examining the features of the teaching environment and their association with innovation, this research aims to contribute to the ongoing conversation on how to improve the quality of education and support the professional development of teachers. Through the development of a proposed human capital program, this study hopes to provide actionable insights that can help guide policymakers and educational institutions in fostering a more conducive environment for teaching and learning.

MATERIALS AND METHODS

Survey design and data collection

This study employed the descriptive research method to examine the relationship between the teaching environment and innovation among tertiary teachers at the Nueva Ecija University of Science and Technology. Descriptive research is a method that aims to describe the current state of a situation as accurately as possible and may also explore the

causes of specific phenomena. It involves a thorough and careful description of the studied subject and may also involve comparison and contrast, measurement, classification, interpretation, and evaluation. Descriptive research seeks to fully and accurately describe a given state of affairs (Khalid, 2022). It also involves the data's interpretation and significance (Fraenkel *et al.*, 2012). Fig. 1 displays a map of Southeast Asia, highlighting the location of the Philippines. The Philippines is a country in Southeast Asia comprising over 7,600 islands and is located in the western Pacific Ocean (D'arcy, 2013) and Fig. 2 shows the geographic location of the study area; (a) Philippines, (b) Nueva Ecija. Nueva Ecija is a province in the Philippines located in the central region of Luzon Island. It is bordered by the provinces of Aurora, Bulacan, Pampanga, Tarlac, and Nueva Vizcaya. The province has 27 municipalities and 5 cities, including Cabanatuan City, Palayan City, San Jose City, Gapan City, and Muñoz City and the total number of barangays in the province is 849 (PhilAtlas, 2020). Table 1 shows that the study comprised 198 tertiary teachers as respondents. The total number of superior respondents was 33 within the area of Nueva Ecija Philippines They belonged to the four campuses of Nueva Ecija University of Science and Technology (NEUST) Gabaldon Campus (GNT), San Isidro Campus (SIC), Sumacab Campus and General Tinio Street Campus (GT). However, 196 tertiary teacher respondents, and only 28 superior respondents returned their survey questionnaire. The validation and use of the descriptive method were done using observation and interviews.

The instrument used was developed by Brooks (1999) and has three parts. Part I is a profile of the respondents. Part II, the Teaching Atmosphere Scale, consists of seven subscales measuring various job factors, including organizational independence, workgroup support, supervisory encouragement, challenging work, freedom, sufficient resources,

Table 1: Tertiary teacher respondents

Campus	Teachers	Percentage	Superior	Percentage
Gabaldon	22	11.2%	3	10.71%
General Tinio St.	111	56.63%	15	53.57%
San Isidro	16	8.16%	3	10.71%
Sumacab	47	23.98%	7	25.00%
Total	196	100.00%	28	100.00%

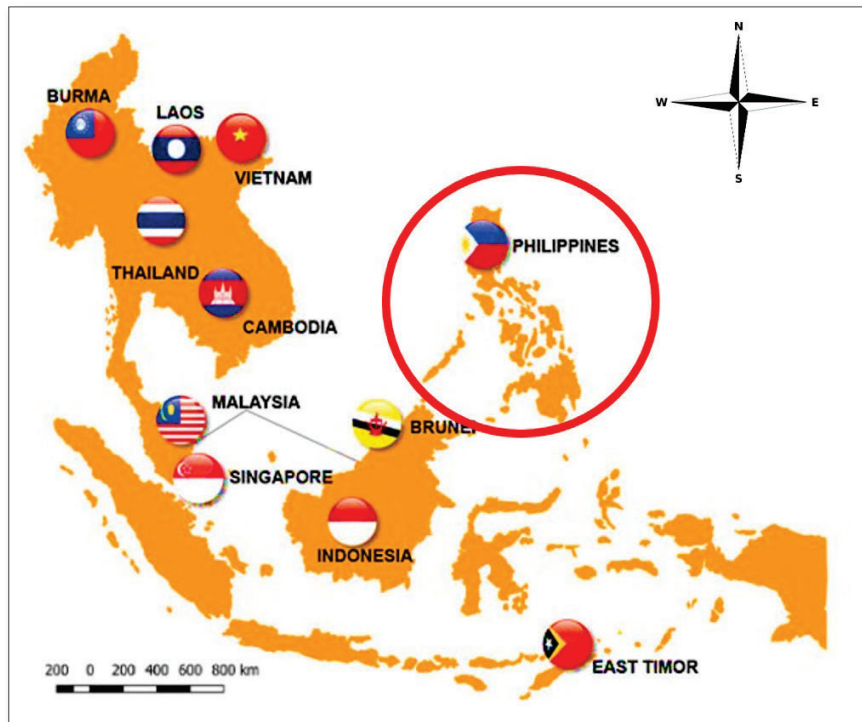


Fig. 1: Geographic location of the study area; the map of south east Asia (D'arcy, 2013)

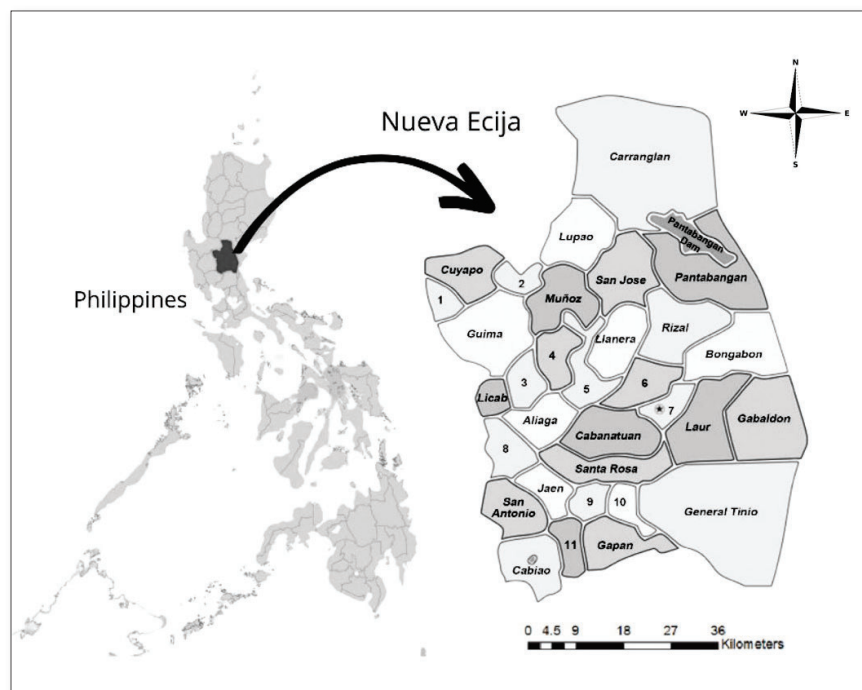


Fig. 2: Geographic location of the study area; (a) Philippines, (b) Nueva Ecija (PhilAtlas, 2020)

and organizational encouragement. These subscales are developed (Good and Lavigne, 2017), and each consists of five items. The researchers used a Likert scale with five response options: “Never” (1), “Seldom” (2), “Sometimes” (3), “Often” (4), and “Always” (5). Part III is an innovation checklist with 10 items, also using the Likert scale and response options as in Part II. We used percentage and frequency to analyze the respondent’s profile data. We used verbal descriptions and weighted mean for the description of the variables and used the following scale: “Never” (scores between 1.00 and 1.79), “Seldom” (scores between 1.80 and 2.59), “Sometimes” (scores between 2.60 and 3.49), and “Often” scores between 3.40 and 4.29, and “Always” (scores between 4.20 and 5.00). To determine the correlation between innovations and job environmental factors, we used the Pearson Product Moment Correlation coefficient. To test the validity and reliability of the instrument, we conducted a test-retest on teachers enrolled in the Graduate School of Araullo University (AU) to ensure that it was culture-free.

RESULTS AND DISCUSSION

Table 2 shows that both the teachers and superiors responded “always” when asked about opportunities to share their ideas, with weighted means of 4.25 and 4.29, respectively. They also responded “always” when asked about using innovative approaches and strategies in teaching, with a weighted mean of 4.35. When asked about putting all their skills to use, the teachers responded “often” and the superiors responded “always,” with weighted means of 4.1 and 4.39 respectively. Additionally, both groups responded “always” when asked whether their job stimulates them to work harder and whether their tasks are challenging,

with weighted means of 4.09 and 4.39, respectively. These results suggest that the teachers find their job stimulating because it allows them to work hard, use their skills and knowledge effectively, and express their ideas freely. The verbal interpretation of “always” indicates that the teachers and superiors feel confident, at ease, and comfortable in their job. Being different does not mean being inadequate. Teachers should embrace challenging work and recognize that mistakes are a natural part of the learning process. This leads to openness to innovative ideas and prevents students and teachers from being judgmental in the evaluation process. Evaluation should be a cooperative process with an emphasis on self-evaluation, which encourages transparency and openness rather than concealment (Alvarez *et al.*, 2016).

Table 3 shows the teachers along with their superiors both rated the job atmosphere as “always” when asked in relation to freedom, with weighted means of 4.15 and 4.35, respectively. This means that the teachers are free to implement innovative strategies that may improve student performance, with a weighted mean of 4.24 and 4.43 for the freedom to decide how to teach. They were also often given opportunities to express their opinions and ideas on how to be better teachers, with weighted means of 4.23 and 4.25, respectively. The results also showed that the teachers had an open environment which is free from defensive behavior, with weighted means of 3.97 and 4.14, and were allowed to access essential information about their service, with weighted means of 3.96 and 4.43. These results suggest that the school gives teachers a high degree of empowerment and autonomy, allowing them to choose and use innovative strategies to provide quality teaching to their students. They also have academic freedom

Table 2: Job atmosphere of Teachers in terms of Challenging work

Work Challenges	Tertiary Teacher		Superior	
The tasks I perform are challenging	4.09	Often	4.39	Always
My job puts all my skills to use	4.26	Always	4.25	Always
My job gives me opportunities to express my ideas	4.38	Always	4.39	Always
My job stimulates me to work harder	4.19	Often	4.39	Always
I use new strategies and approaches in teaching	4.35	Always	4.00	Often
average Weighted Mean (WM)	4.25	Always	4.29	Always

Legend: 1.00-1.79 – Never, 1.80-2.59 – Seldom, 2.60-3.39 – Sometimes, 3.40-4.19 – Often, 4.20-5.00 – Always

to remain true to their intellectual commitments and pedagogical philosophy, which serves the public good and promotes a good job atmosphere. work autonomy can be obtained when employees are allowed to perform their duties with little supervision, which means they are given a certain level of freedom and trust to complete their tasks independently. Nonetheless, it does not imply total freedom or lack of accountability, but it involves striking a balance between independence and accountability to ensure optimal performance. Proper implementation of work autonomy can lead to increased employee satisfaction and motivation, as they feel valued and trusted by the organization (Armas *et al.*, 2019). A conducive learning environment in the workplace is characterized by promoting active engagement and empowering individuals to explore and discover the personal significance of ideas. This type of environment values academic freedom, which enables educators to stay committed to their intellectual and pedagogical beliefs, ultimately contributing to the greater good of the public and fostering a positive work atmosphere. Instead of imposing

ideas, facilitation allows for personal discovery and meaning-making (OECD, 2009).

Table 4 shows that the teachers along with the superiors rated the following areas as “often”: recognition for a job done well (weighted means of 3.98 and 4.14, respectively), feeling that the school administrators show appreciation for their contributions (weighted means of 3.95 and 4.07, respectively), feeling that the school is concerned about their overall satisfaction with their work (weighted means of 3.94 and 4.07, respectively), receiving help when needed (weighted means of 3.94 and 4.07, respectively), and feeling encouraged to approach to the problems as opportunities (weighted means of 3.89 and 3.86, respectively). These results suggest that the school provides an elevated level of motivation and support to its teachers, which is reflected in their efforts and positive attitudes towards achieving the school’s goals and objectives. The school also appreciates and recognizes the excellent work of its teachers, which serves to further inspire and energize them in their roles. Overall, there is a powerful sense of mutual positive intention between the school and

Table 3: Job atmosphere of Teachers in terms of Freedom

Work Freedom	Tertiary Teacher		Superior	
I have the freedom to decide how I am going to teach	4.24	Always	4.43	Always
I am allowed access to vital information about my work	3.96	Often	4.43	Always
I am given opportunities to express my ideas and opinion on how I can be a better teacher	4.23	Always	4.25	Always
I can try out innovative strategies that can result in improving students’ performance in school	4.35	Always	4.50	Always
There is an open environment that is free from defensive behavior	3.97	Often	4.14	Often
average Weighted Mean (WM)	4.15	Often	4.35	Always

Legend: 1.00-1.79 – Never, 1.80-2.59 – Seldom, 2.60-3.39 – Sometimes, 3.40-4.19 – Often, 4.20-5.00 – Always

Table 4: Job atmosphere of Teachers its Organizational Encouragement

Work Encouragement	Tertiary Teacher		Superior	
Help is available when I need it	3.94	Often	4.07	Often
Teachers are recognized for a job well done	3.98	Often	4.14	Often
The school cares about my general satisfaction with my work	3.94	Often	4.07	Often
Teachers are encouraged to view problems as opportunities	3.89	Often	3.86	Often
School administrators show appreciation for the teacher's contribution to the attainment of the goals and objectives of education	3.95	Often	4.07	Often
average Weighted Mean (WM)	3.94	Often	4.04	Often

Legend: 1.00-1.79 – Never, 1.80-2.59 – Seldom, 2.60-3.39 – Sometimes, 3.40-4.19 – Often, 4.20-5.00 – Always

its teachers towards the success of the institution.

It is important for school leaders to foster openness and transparency among their staff, as this helps to build trust and create a positive atmosphere where employees feel valued and comfortable. When employees feel respected and supported, it can improve their confidence and self-esteem in their work, and also give them a sense of belongingness. A supportive and positive job atmosphere is necessary for the full development of employees' appetitive and cognitive faculties, such as their will, emotions, feelings, senses, memory, instincts, and imagination (Schunk *et al.*, 2008). Trust is built through consistent behaviors and actions that allow for evaluation and re-evaluation of each other. In an organizational hierarchy, supervisors have the authority to empower their employees, and it is important for them to create a positive culture that reinforces the contributions and roles of their staff. Without a clear understanding of their roles and skills in the organization, employees may not be able to reach their potential and contribute effectively. Overall, this suggests that a supportive and positive job atmosphere is crucial for motivating and inspiring both teachers and superiors (Henderson

et al., 2008). Table 5 shows that the teachers, as well as their superiors rated several factors as often related to the opportunities at the school and the availability of resources. These included: feeling that they possess the professional skills required (weighted means of 4.05 from teachers and 4.54 from superiors), having opportunities to showcase their creativity (weighted means of 3.73 from teachers and 3.86 from superiors), having access to learning resources to complete tasks (weighted means of 3.81 from teachers and 3.94 from superiors), feeling that there are enough teachers at their school (weighted means of 3.48 from teachers and 3.96 from superiors), and feeling that there are adequate supplies and equipment (weighted means of 3.40 from teachers and 3.36 from superiors). The results suggest that the school tries to provide sufficient resources, including opportunities, materials, and manpower, and that teachers feel they have the necessary skills and are given opportunities to show their creativity. The school also has an adequate number of teachers, equipment, and sufficient supplies, which may indicate a concern for both students and faculty. It is important for teachers to be resourceful and find ways to make things

Table 5: Job atmosphere of Teachers its Resources

Resources	Tertiary Teacher		Superior	
There is an adequate number of teachers in our school	3.48	Often	3.96	Often
Learning needs for the accomplishment of tasks are available	3.81	Often	3.96	Often
Opportunities where teachers can show their creativity are present in our school	3.90	Often	3.86	Often
School supplies and equipment are adequate	3.40	Often	3.36	Sometimes
Teachers possess the professional skills required	4.05	Often	4.54	Always
average Weighted Mean (WM)	3.73	Often	3.94	Often

Legend: 1.00-1.79 – Never, 1.80-2.59 – Seldom, 2.60-3.39 – Sometimes, 3.40-4.19 – Often, 4.20-5.00 – Always

Table 6: Supervisory Encouragement

Supervisory Encouragement	Tertiary Teacher		Superior	
School officials avoid using a negative mindset when teachers approach him/her with new ideas	3.95	Often	4.00	Often
School officials welcome diverse ideas and opinions	3.96	Often	4.07	Often
School officials encourage teachers to be more open to new ideas and innovative teaching techniques	4.15	Often	4.36	Always
School official value my contribution to the well-being of our school	4	Often	4.36	Always
My superior appreciates the extra effort from me	4.2	Often	4.43	Always
average Weighted Mean (WM)	3.73	Often	3.94	Often

Legend: 1.00-1.79 – Never, 1.80-2.59 – Seldom, 2.60-3.39 – Sometimes, 3.40-4.19 – Often, 4.20-5.00 – Always

happen, including finding ways to secure materials and supplies and building trust with their parents and students. A lack of trust can negatively impact the classroom environment (Mulford, 2003). The absence of trust can have adverse effects on the work atmosphere. It can affect employee morale, decrease productivity and motivation, and damage relationships among colleagues. Building and maintaining trust is crucial to creating a positive and healthy workplace environment (Smith, 2019).

Table 6 illustrates that the teachers and superiors rated several factors as “often” and “always” related to their experiences with school officials. These included the feeling that their superiors appreciate their extra effort (weighted means of 4.20 from teachers and 4.43 from superiors), feeling that school officials encourage them to be open to innovative teaching techniques and new ideas (weighted means of 4.15 from teachers and 4.36 from superiors), and feeling that school officials value their contributions to the well-being of the school (weighted means of 4.0 from teachers and 4.36 from superiors). However, both groups rated often on the items of feeling that school officials welcome diverse opinions and ideas (weighted means of 3.96 from teachers and 4.07 from superiors) and feeling that school

officials neglect using a negative perspective when approached with new ideas (weighted means of 3.95 from teachers and 4.00 from superiors). These results suggest that the school provides an important level of motivation and support to its teachers, and that teachers feel that their superiors value their contributions and appreciate their extra effort. However, there may be some room for improvement in terms of avoiding a negative perspective when welcoming diverse ideas and being presented with innovative ideas. Motivation and tangible incentives from school officials can increase performance on tasks, encourage smart thinking, and support both the quantitative and qualitative goals to be achieved effectively. Motivation also directly impacts innovation in an organization, and it is important for organizations to recognize not only achievements but also efforts exerted (Forson et al., 2021).

Table 7 indicates that teachers and their superiors perceive their peers as supportive, with teachers rating the support at a weighted mean of 4.23 and superiors rating it at 4.25. However, there are some discrepancies in the ratings given by teachers and superiors on certain items. For example, while teachers rated their co-teachers as always willing to help with special favors (weighted

Table 7: Work Group Support

Group Support	Tertiary Teacher		Superior	
My peers are supportive of me	4.23	Always	4.25	Always
I can rely on my co-teachers for help when I need it	4.13	Often	4.21	Always
My co-teachers rally to my side when I experience work problem	4.02	Often	3.93	Often
My co-teachers care about my well-being	4.08	Often	4.18	Often
My co-teachers are willing to help me when I need a special favor	4.20	Always	4.14	Often
average Weighted Mean (WM)	4.13	Often	4.14	Often

Legend: 1.00-1.79 – Never, 1.80-2.59 – Seldom, 2.60-3.39 – Sometimes, 3.40-4.19 – Often, 4.20-5.00 – Always

Table 8: Organizational Independent

Work Independent	Tertiary Teacher		Superior	
Accomplishments are not recognized	2.55	Seldom	2.25	Seldom
Some teacher ingratiate themselves with the school official to the disadvantage of their employees	2.81	Sometimes	2.43	Seldom
My salary's not commensurate with my work	2.74	Sometimes	2.18	Seldom
An autocratic style of leadership is evident	2.62	Sometimes	2.11	Seldom
New ideas or innovation are discouraged by school	2.30	Seldom	1.93	Seldom
average Weighted Mean (WM)	2.60	Sometimes	2.18	Seldom

Legend: 1.00-1.79 – Never, 1.80-2.59 – Seldom, 2.60-3.39 – Sometimes, 3.40-4.19 – Often, 4.20-5.00 – Always

mean of 4.20), superiors only rated them as often willing to do so (weighted mean of 4.14). Similarly, while teachers rated their ability to rely on their co-teachers for help when needed as always (weighted mean of 4.13), superiors only rated it as often (weighted mean of 4.21). In terms of the co-teacher's care for the well-being of the teachers, both teachers and superiors rated it as often, with teachers giving it a weighted mean of 4.08 and superiors rating it at 4.18. Regarding co-teachers rallying to support teachers during work problems, teachers rated it at a weighted mean of 4.02 and superiors rated it at 3.93. The findings of the study show that both teachers and their superiors agreed that their peers consistently provide support, with both groups answering "always" to the question of peer support. This suggests that both teachers and their superiors believe that their colleagues are always willing to help, particularly when it comes to innovative teaching techniques. However, there was a discrepancy in the responses to the question of co-teacher support, with teachers answering "always" and superiors answering "often." This may be due to the fact that superiors do not interact with teachers as frequently, and therefore may not be as aware of the level of support that co-teachers provide for one another. Overall, the results indicate that co-teachers are consistently willing to offer support to their colleagues, especially when they encounter problems. According to [Caruso and Woolley \(2008\)](#), workgroups can provide numerous benefits for both individuals and the group as a whole. These benefits

include the ability to break down complex tasks, effectively manage time, improve understanding through discussion and explanation, provide and receive feedback, challenge assumptions, and improve communication skills. All of these skills can be reinforced through participation in a workgroup.

[Table 8](#) illustrates the teachers rated the occurrence of certain negative situations as "sometimes," with a weighted mean of 2.81. In contrast, superiors rated these same situations as "seldom," with a weighted mean of 2.43. These negative situations include teachers ingratiating themselves with school officials to the detriment of their colleagues, a lack of salary commensurate with the work being done (rated by teachers at 2.74 and by superiors at 2.18), an autocratic style of leadership (rated by teachers at 2.62 and by superiors at 2.11), a lack of recognition for accomplishments (rated by teachers at 2.55 and by superiors at 2.25), and a discouragement of new ideas or innovation (rated by teachers at 2.30 and by superiors at 1.93). The findings of the study suggest that teachers may feel that they are not given a high degree of organizational independence by their school. However, the superiors in the department believe that any issues or challenges faced by the teachers are being properly addressed. According to [Corpuz and Salandanan \(2003\)](#), the work atmosphere for teachers includes both the physical environment and the psychological climate, which is shaped by the interactions and relationships between teachers, school officials, and students. The importance of a strong and collaborative relationship between

Table 9: Tertiary teachers' culture of innovation

Culture of Innovation	Tertiary Teacher		Superior	
New ideas are encouraged in our school	4.19	Often	4.14	Often
There is generally a cooperative and collaborative atmosphere in our school	3.99	Often	4.14	Often
Teachers are encouraged to be more open to new ideas and experience	4.14	Often	4.00	Often
The teachers are provided with stimulating tasks that create a sense of personal growth	4.03	Often	3.86	Often
Decision-making does not stifle those teachers who have different styles	3.80	Often	3.71	Often
The school makes sure that creative teachers do not perform specific tasks all day long	3.59	Often	3.29	Sometimes
Teachers are encouraged to communicate with one another	4.11	Often	4.36	Always
School officials welcome diverse ideas and opinions	4.05	Often	4.11	Often
Creative behavior is recognized	4.11	Often	4.11	Often
School officials let teachers try new ideas or strategies	4.20	Always	4.2	Always
average Weighted Mean (WM)	4.02	Often	4.00	Often

Legend: 1.00-1.79 – Never, 1.80-2.59 – Seldom, 2.60-3.39 – Sometimes, 3.40-4.19 – Often, 4.20-5.00 – Always

teachers and the school administration to ensure the success of the institution. When there is mutual positive intention and agreement on goals, teachers are more likely to be motivated and invested in their work. This can lead to a more supportive and productive work environment for everyone (Bosso, 2015).

Table 9 presents the perceptions of tertiary teachers and their superiors regarding the culture of innovation in their school. Both groups generally rate the various aspects of the culture of innovation as happening often. The average weighted mean (WM) for tertiary teachers is 4.02, and for superiors, it is 4.00, both falling within the "Often" range. Both teachers and superiors report that new ideas are

encouraged in the school, there is a cooperative and collaborative atmosphere, teachers are encouraged to be more open to new ideas and experiences, and they are provided with stimulating tasks that create a sense of personal growth. They also agree that decision-making does not stifle teachers who have different styles, and school officials welcome diverse ideas and opinions. Creative behavior is recognized by both groups, and school officials consistently let teachers try new ideas or strategies. However, there is a slight difference in their perceptions regarding the encouragement of communication among teachers, with teachers rating it as happening often and superiors rating it as always. Additionally, teachers and superiors differ in their views on

Table 10: Tertiary Teachers' Profile and Job Atmosphere

Job atmosphere		Age	Civil status	Gender	Number of teaching services	Educational attainment
Challenging Work	Correlation	-.024	.037	.078	-.044	.041
	Coefficient					
	Sig. (2-tailed)	-.024	.037	.078	-.044	.041
	N	196	196	196	196	196
Freedom	Correlation	-.017	-.006	-.083	.028	.015
	Coefficient					
	Sig. (2-tailed)	.818	.937	.271	.713	.840
	N	196	196	196	196	196
Organizational Encouragement	Correlation	-.031	-.049	.044	.123	.206**
	Coefficient					
	Sig. (2-tailed)	.685	.516	.558	.102	.006
	N	196	196	196	196	196
Resources	Correlation	.077	.227**	-.124	.188*	-.051
	Coefficient					
	Sig. (2-tailed)	.309	.002	.100	.012	.502
	N	196	196	196	196	196
Supervisory Encouragement	Correlation	.045	.011	.040	-.001	.154*
	Coefficient					
	Sig. (2-tailed)	.548	.881	.596	.986	.041
	N	196	196	196	196	196
Work Group Support	Correlation	.061	-.033	-.090	.195**	.106
	Coefficient					
	Sig. (2-tailed)	.417	.662	.235	.009	.159
	N	196	196	196	196	196
Organizational Independent	Correlation	.028	.125	.007	.227**	.259**
	Coefficient					
	Sig. (2-tailed)	.708	.096	.931	.002	.001
	N	196	196	196	196	196
Innovation	Correlation	-.024	.037	-.044	.036	.082
	Coefficient					
	Sig. (2-tailed)	.754	.627	.560	.637	.278
	N	196	196	196	196	196

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

Table 11: Job atmosphere and innovation

Job atmosphere		Innovation
Challenging Work	Pearson Correlation	.153*
	Sig. (2-tailed)	.042
	N	196
Freedom	Pearson Correlation	.147*
	Sig. (2-tailed)	.048
	N	196
Organizational Encouragement	Pearson Correlation	.310**
	Sig. (2-tailed)	.000
	N	196
Resources	Pearson Correlation	.186*
	Sig. (2-tailed)	.013
	N	196
Supervisory Encouragement	Pearson Correlation	.195**
	Sig. (2-tailed)	.009
	N	196
Work Group Support	Pearson Correlation	.082
	Sig. (2-tailed)	.276
	N	196

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

whether the school ensures creative teachers do not perform specific tasks all day long; teachers believe this happens often, while superiors think it only happens sometimes. The findings indicate a strong culture of innovation in the school, with both teachers and their superiors perceiving a supportive and encouraging environment for creativity and new ideas. According to [Castellote \(2017\)](#), innovation is the process of creating new ideas and putting them into practice. It is how creative ideas find their way into everyday practices. The basic steps in a typical innovation process include idea creation through spontaneous creativity, ingenuity, information processing, and initial experimentation to establish the ideas' potential value and application to produce a new product, service, or approach. Importantly, the innovation process is not complete until a final application has been achieved. A new idea, even if a great one, is not enough. The idea must pass through all stages of innovation before the value is realized.

[Table 10](#) illustrate that Civil status is significantly related to job atmosphere as to resources. Married teachers tend to have a better job atmosphere as to resources. Married individuals are family oriented; hence they are looking at the job atmosphere concerning resources (i.e., manpower, materials,

and opportunities). They would like to see some permanency as to tenure on their work. The number of teaching services is significantly related to job atmosphere, resources, workgroup support, and organizational independence. Teachers with more years of teaching service tend to have a better job atmosphere regarding resources, work group support, and organizational independence. Teachers with more years of teaching service already possess professional skills, have already developed camaraderie with fellow teachers, and are already experienced teachers; therefore, they tend to have more to share as far as innovation is concerned. Educational attainment is significantly related to organizational and supervisory encouragements and organizational independence. Teachers with higher educational attainment are more likely to have a better job atmosphere regarding organizational and supervisory encouragement and organizational independence. The teachers with higher educational attainment believed that practicing good management helps build and sustain enthusiasm for their work, and supportive supervisory practices empower the teachers to learn new ideas. Good management systems make it easier for teachers to do their work. [Deshpande \(2014\)](#) evaluated that a caring climate also had a significant indirect

impact on organizational commitment through the mediating role of job satisfaction and job performance through the mediating role of job satisfaction and organizational commitment. In addition, job satisfaction had a significant direct impact on organizational commitment, which also had a significant indirect impact on job performance (Santos 2020). Finally, organizational commitment had a significant direct impact on job performance.

Table 11 shows that job atmosphere in terms of challenging work, freedom, organizational encouragement, resources, and supervisory encouragement are significantly related to innovation. Complex, challenging, and interesting tasks and goals encourage essential motivation, which is a critical component of innovation; teachers must feel secure enough to forward their best ideas; support for new ideas by the supervisor is critical for the further development and implementation of these ideas. Especially supportive leaders who listen and give feedback on ideas; the perception of support from top management is important. This support entails both espoused support when top management communicates norms that encourage innovation, risk, and experimentation and enact support. Teachers who perceived their work as stimulating, enjoying autonomy, or empowering received support from supervisors and organization and were given opportunities to show creativity and adequate needed materials are most likely creative and willing to try new ideas and strategies. Martins and Terblanche (2003) stated that the determinants that influence creativity and innovation are strategy, structure, open communication, support mechanisms, behavior that encourages innovation.

CONCLUSION

Teacher's job is both stimulating and empowering, as it provides them with the opportunity to work harder and express their ideas. The school also offers a high degree of autonomy and encourages their growth and development. The school ensures that there are sufficient resources available to the teachers, including manpower, materials, and opportunities. The school's superiors believe that the culture of innovation is highly prevalent, with school officials allowing teachers to try out new ideas and strategies, such as project-

based learning, flipped classrooms, and the use of technology to enhance student engagement and performance. From the perspective of the teachers, they see evidence of this culture when their creative behavior is recognized and supported. Factors such as civil status, years of teaching experience, and highest educational attainment are significantly related to the job atmosphere in terms of resources, workgroup support, and organizational independence. Additionally, the job atmosphere in terms of challenging work, freedom, organizational encouragement, resources, and supervisory encouragement is significantly related to innovation. There is a noticeable difference in the perception of teachers and their superiors in terms of the job atmosphere in terms of freedom and supervisory encouragement. The superiors tend to have higher ratings on these aspects, possibly due to the fact that they are the subjects of the questions. The school where the respondents work is known for its emphasis on freedom for its constituents, and the superiors encourage their teachers to grow and develop as leaders. Continuing post-graduate studies is important for teachers not only for professional development, but also to stay current with modern trends in education. Public tertiary schools should focus on research in areas such as individual performance and school culture, which can lead to innovations and advancements for teachers, superiors, and students. These findings can be used to inform policy decisions related to faculty development, infrastructure development, and policy guidelines that will benefit the school, teachers, and superiors. To further enhance the innovation culture, schools should consider implementing innovative strategies that may improve student performance, such as personalized learning, collaborative problem-solving, and fostering a growth mindset among students. By doing so, schools can create a more dynamic and engaging learning environment that caters to individual student's needs and abilities. In addition, implementing a Tertiary Teachers' Human Capital Development Program can provide targeted training and support to help teachers develop their skills, knowledge, and innovative capacities. This program should focus on enhancing teachers' pedagogical skills, incorporating technology in the

classroom, and promoting collaboration among teachers to share best practices and innovative strategies. Such a program can contribute to the continuous improvement of the teaching environment and the overall innovation culture in public tertiary institutions. However, the study has some limitations, such as the sample size and the generalizability of the results. The findings may not be representative of all public tertiary institutions, and future research should expand the sample to include a wider range of institutions to enhance the generalizability of the results. Moreover, the study relied on self-reported data, which may be subject to biases and inaccuracies. Future research could use multiple sources of data, such as observations, interviews, and documentary analysis, to provide a more comprehensive understanding of the teaching environment and innovation in public tertiary institutions. Based on the study's findings and limitations, it is recommended that the university or school develop a program for promotions, awards, and incentives for faculty members who make extra efforts to achieve innovations that will benefit the university or school and its students. Additionally, implementing a Tertiary Teachers' Human Capital Development Program can help address the identified limitations and support the continuous improvement of the teaching environment and innovation culture. Future research should also explore the impact of different factors, such as leadership styles, organizational culture, and external factors, on the teaching environment and innovation in public tertiary institutions. This will provide a deeper understanding of the dynamics at play and inform the development of more effective strategies to enhance teaching and learning experiences in these institutions.

AUTHOR CONTRIBUTIONS

The author independently undertook the entire process of creating this paper. This includes developing the initial concept, conducting research, analyzing data, and writing the manuscript. The author also assumed responsibility for revisions and finalizing the paper, ensuring its accuracy and coherence. As such, the author is solely responsible for the content and overall quality of this work.

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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.

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ABBREVIATIONS

*	Correlation is significant at the 0.05 level (2-tailed)
**	Correlation is significant at the 0.01 level (2-tailed)

AU	Araullo University
CHED	Commision on Higher Education
GNT	Gabaldon Campus
GT	General Tinio Campus
HERRC	Higher Education Regional Research Center
NEUST	Nueva Ecija University of Science and Technology
PHERNET	Philippine Higher Education Research Network
SIC	San Isidro Campus
SUCS	State Universities and Colleges
WM	Weighted Mean

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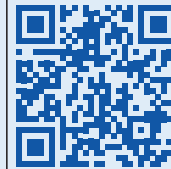


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ORIGINAL RESEARCH PAPER

The impact of human capital, institutional quality, and innovation on the regional gross domestic product: panel data approach

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ABSTRACT

BACKGROUND AND OBJECTIVES: Differences in the fundamental factors of production and technology are cited as the reason for the disparity in growth rates by primary research. Improving the quality of human capital through education, the quality of institutions such as the public policies and innovation play an important role in economic growth. Also, technological innovation creates circumstances for any region to extract more value from limited resources to support sustainable economic growth. In this study, the effect of human capital, institutional quality, and innovation are investigated on regional gross domestic product per capita in oil-exporting countries. Moreover, the effect of institutional quality has been investigated on the regional gross domestic product through government consumption expenditures.

METHODS: The panel data method is used to investigate the effect of human capital, institutional quality, and innovation on regional gross domestic product per capita from 2011 to 2021. The Levin-Lin-Chu test was employed to determine the reliability of the variables. The panel cointegration are used to ensure the existence of long-term relationship between the dependent variable and the independent variables. In order to select the pooling and panel method, Flemer's test was used, and Hausman's test was used to select fixed and random effects methods. Also, statistical and econometric analysis is done with Stata17.0 software.

FINDINGS: The results of the random effects method in the first and the second models indicated that the human capital index has had a positive and significant effect on gross domestic product per capita at the level of 1% and its coefficient are 0.878 and 0.905, respectively. So, human capital improvement facilitating the absorption of technology, and boosting the productivity of production factors and increases economic growth. Also, the institutional quality has had a positive and significant effect on gross domestic product per capita at the 1% level in the first model and its coefficient is 0.182. Moreover, the coefficient of interaction effects of institutional quality and government consumption expenditure in second model is 0.073 and is statistically significant at the 1% level. According to this, Institutional quality shape the economic environment of countries and improves the economic performance. The Innovation index has had a positive and significant effect on gross domestic product per capita at the level of 1% and its coefficient in the first and the second models are 0.324 and 0.331, respectively. Therefore, strengthening the innovation system expanding the supply of new products and services.

CONCLUSION: The results indicate that, growth rate of gross domestic product per capita averaged at 2.12% over the sample period with standard deviation of 3.66 among the selected oil-exporting countries. Based on the results, improving the human capital through education and the acquisition of diverse skills have led to an increase in gross domestic product per capita at the level of 1%. In addition, the institutional quality limit government spending and direct financial resources towards healthy investments. According to this, institutional quality has increased regional gross domestic product through government consumption expenditures at the level of 1%. In addition, improving the system of innovation by maximizing the use of existing resources and boosting productivity has increased production.

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INTRODUCTION

The vast disparity between national growth rates has prompted economists to do extensive research on growth models. Differences in the fundamental variables of production and technology are cited as the basis for the disparity in national growth rates by primary research. In recent theoretical and experimental investigations of growth, it has been demonstrated that the internal components and mechanisms of an economy, including human capital, the external effects of physical capital, technological innovation, and institutional quality, can influence economic growth (Slesman *et al.*, 2015; Teixeira and Queiros, 2016; Ogbeifun and Shobande, 2022). The accumulation of production factors and increasing productivity will improve economic growth (Limam and Miller, 2007). Improving the quality of human capital index through education, training, and the acquisition of diverse skills plays a crucial role in sustainability of economic growth within the framework of endogenous growth models (Shobande, 2021; Shidong *et al.*, 2022; Ogbeifun and Shobande, 2022; Kozlovskiy *et al.*, 2020; Mansour, 2023). Furthermore, human capital will moderate the relationship between the Internet and economic growth (Ficawoyi, 2019; Pourehtesham, 2022). In addition, increased access to health and treatment services enhances the physical and mental health of individuals, hence enhancing the quality of human resources and boosting economic growth. As a result, increasing the health of the workforce will be one of the strategies to create human capital (Kurt, 2015). Another group will achieve economic growth through the external effects of physical capital (Romer, 1986; Khan *et al.* 2022). In the third set of endogenous growth models, emphasis has been placed on the ongoing growth of new production ideas or growth generated by technical innovation. By evaluating the patent right for innovative production concepts in order to continue them, it expands the production knowledge available to the public and provides the foundation for continuing growth. In these approaches, innovative ideas are suggested as the growth engine. The use of an idea by one person does not restrict others from adopting it simultaneously. These types of concepts create a strong connection between idea-based growth models and rising scale-based efficiency (Grossman and Helpman, 1991). Also, technological innovation creates circumstances for any

region to extract more value from limited resources to support sustainable economic growth (Acemoglu, 2008). Economic development has entered a high-quality phase due to the increase in the supply of innovation and enhance the innovation environment. This has created the attractiveness of an innovative economic system and creates a modern globalization space (Babenko *et al.*, 2020). Theoretical literature of endogenous growth models is based on the external of physical capital, the accumulation of human capital, and technological innovation. In various studies, the effects of infrastructure for research and development, invention, and innovation on economic growth have been examined (Aghion and Howitt, 1990; Grossman and Helpman, 1991; Huallachain, 2007; Pece *et al.*, 2015; Dalali *et al.*, 2016; Ogbeifun and Shobande, 2022). In the late 1990s, the theory of new institutional economics was introduced, prompting academic circles to focus more on the role of institutions in the economic progress of countries. Institutional quality, such as the political system, the behavior of rulers, public policies, corruption control, and culture and religion, have been cited as significant determinants of economic performance disparities between countries (Kaufmann *et al.*, 1999; Kurtz and Schrank, 2007; Slesman *et al.*, 2015). In addition, various variables, including physical capital, human capital, institutional quality, public consumption expenditure, trade, natural resource, and technology absorption capacity, influence economic growth and regional integration (Islam, 2003; Alatas and Çakir, 2016; Teixeira and Queiros, 2016; Widarni and Bawono, 2021; Ogbeifun and Shobande, 2022). Improving the quality and effectiveness of economic institutions, regulating social relations in the field of environmental protection and ensuring the environmental security of society, and drafting environmental laws can also be the main way to achieve a green economy (Timoshenkov *et al.*, 2020; Samimi and Shahriari Moghadam, 2020). In addition, enhancing the quality of human resources through education, training, and the acquisition of diverse skills, the role of innovation and technology absorption capacity, the role of institutional factors such as the political system, the behavior of rulers, public policies, corruption control, and culture and religion are significant contributors to variances in the economic performance of countries, and institutions shape the economic environment of countries. According to this, the purpose of this study is to investigate the effect of

human capital, institutional quality and innovation on regional gross domestic product (GDP) per capita using panel data method in oil-exporting countries from 2011 to 2021. In addition, the institutional quality limit government spending and direct financial resources towards healthy investments. So, the effect of institutional quality has investigated on regional gross domestic product through government consumption expenditures. In this regard, the present study aims to answer the question that “Does human capital, institutional quality, and innovation have an effect on the regional gross domestic product?”. Also, “Does institutional quality have an effect on the regional gross domestic product through government consumption expenditures”.

Background of research

[Shidong et al. \(2022\)](#) examined the moderating role of human capital and renewable energy in promoting economic development by using comparatively new panel estimation techniques “continuously updated fully modified” (Cup-FM) and “continuously updated bias-corrected” (Cup-BC) of G-10 countries. The overall results demonstrate that human Capital and renewable energy stimulate higher economic development. Manifestly, the interaction of both variables reports a more substantial impact on economic development, implying that human capital development is a stimulus to boost the positive effects of renewable energy sources on economic growth. Based on the findings, the stakeholders are recommended to invest in human Capital and renewable energy adoption. [Ogbeifun and Shobande \(2022\)](#) examined the relationship between human capital accumulation and economic growth in OECD countries from 1986 to 2018 using the Two-Stage Least Squares (2SLS) method. According to the findings human capital, savings rate, and trade openness have a positive impact on economic growth. [Shobande \(2021\)](#) examined the relationship between human capital accumulation and economic growth in Organization for Economic Cooperation and Development (OECD) countries from 1986 to 2018 using the Two-Stage Least Squares (2SLS) method. Human capital, savings rate, and trade openness have a positive impact on economic growth, according to the findings. Using the Autoregressive Distributed Lag (ARDL) approach, [Widarni and Bawono \(2021\)](#) evaluated the impact of human capital and technology on Indonesia’s

growth from 1984 to 2019 using data from Indonesia. Increasing human capital and advancing technology have a positive effect on economic growth, according to the research. [Mozafari \(2021\)](#) investigated the impact of human capital on Iran’s economic growth from 2013 to 2018 using the Generalized Method of Moments (GMM) technique. According to the findings increasing the number of human capitals has enhanced economic growth. Also, physical capital, government spending, and industrialization have had a positive effect on economic growth, whereas commercial freedom has had a negative effect. [Timoshenkov et al. \(2020\)](#) have analyzed the obstacles to Ukraine’s transition to a green economy and have determined the development and improvement of Ukraine’s environmental legislation as a mandatory condition for this transition. In this research, the main goals of amending the environmental law are to improve the quality and effectiveness of economic institutions, to regulate social relations in the field of environmental protection and to ensure the environmental security of society, and to formulate environmental laws as the main way to achieve these goals. [Babenko et al. \(2020\)](#) have examined the current state of China’s innovation development using a comparative analysis of macroeconomic indicators in period 2013 to 2019. The results show that the expansion of market mechanisms and the stimulation of micro-level innovation is an important role in China’s leadership using macroeconomic regulation leverage. [Barkhordari et al. \(2019\)](#) investigated the effects of the knowledge-based economy on the economic growth of Middle East and North Africa (MENA) countries using the Generalized Method of Moments (GMM), from 2010 to 2015. The results indicate that knowledge-based economy enhance growth performance. [Ficawoyi \(2019\)](#) investigated the effect of telecommunication infrastructure on economic growth in countries with better access to education compared to countries with less access using a panel method consisting of 45 sub-Saharan African countries from 1993 to 2015. It shows that in countries with better access to education, the Internet contributes to economic growth; while cell phones don’t seem to do that. These results show that while education is considered central to the Internet, it appears to be irrelevant to mobile phone use. [Aleemran and Aleemran \(2017\)](#) investigated the impact of information and communication

Table 1: A summary of empirical studies

Source	Period	Method	Result
Ogbeifun and Shobande (2022)	1986-2018	2SLS	Human capital, savings rate and trade openness have a positive effect on economic growth in OECD countries.
Widarni and Bawono (2021)	1984-2019	ARDL	Human capital and technology have had a positive effect on economic growth in Indonesia.
Mozafari (2021)	2013-2018	GMM	Human capital, government spending and industrialization have had a positive effect on economic growth in Iran.
Barkhordari et al. (2019)	2010-2015	GMM	Components of knowledge-based economy have positive effects on economic growth in MENA countries.
Teixeira and Queiros (2016)	1960-2011	Panel data	Human capital and its interaction with structural change in knowledge-based industries have had significant effects on economic growth in OECD countries.
Alatas and Çakir (2016)	1967-2011	Panel data	Human capital has had a positive effect on the economic growth in developing countries.
Slesman et al. (2015)	1983-2009	GMM	Better-quality political and economic institutions can have positive effects on economic growth in 39-member countries of the Organization of Islamic Cooperation (OIC).
Pece et al. (2015)	2000-2013	Multiple regression models	Innovation, foreign direct investment, human capital and exports have had significant effects on economic growth in Central and Eastern Europe countries.
Galindo and Mendez (2014)	2014	Panel data	Entrepreneurship and innovation have a positive impact on economic growth in developing countries.

technology on economic growth in the D8 group of countries using causal-analytical. According to the research findings, information and communication technology has a positive and significant effect on the economic growth of these countries. [Alatas and Çakir \(2016\)](#) evaluated the empirical relationship between human capital and economic growth using the panel data method, in 65 countries during the period 1967-2011. In this study, the human capital index of every individual is evaluated based on schooling, education efficiency, and infant mortality (per 100 births). The results indicate that human capital has had a positive significant effect on economic growth. [Teixeira and Queiros \(2016\)](#) studied the relationship between human capital and structural change on economic growth in OECD countries from 1960 to 2011 using a dynamic panel data approach. According to this study human capital and its interaction with structural change in knowledge-based industries have had significant effects on economic growth. Furthermore, these interacting effects have been more pronounced in highly developed countries. [Pece et al. \(2015\)](#) studied the role of innovation on the long-term economic development of the countries of Central and Eastern Europe (Poland, Czech Republic, and Hungary) using the multiple regression model from 2000 to 2013. The results demonstrate a positive

correlation between innovation and economic growth. [Galindo and Mendez \(2014\)](#) analyzed the impact of entrepreneurship and innovation on the economic growth using the panel data approach in selected developing countries from 2002 to 2007. The results show that entrepreneurship and innovation contribute positively to economic growth. Experimental research using econometric approaches, have explored the effects of variables such as physical capital, human capital, invention and innovation, institutional quality, public consumption expenditure, natural resource and the openness of the economy on economic growth and regional integration. The novelty of this study is to investigate the impact of human capital, institutional quality, and innovation as components of the knowledge-based economy on gross domestic product per capita in the oil-exporting countries over the period of 2011 to 2021, using panel data approach. In addition, the institutional quality limit government spending and direct financial resources towards healthy investments. Based on this, the effect of institutional quality on the region's gross domestic product has been investigated through government consumption expenditures. The current study has been carried out in oil-exporting countries for the period of 2011 to 2021.

MATERIALS AND METHODS

Model specification

In this study, the effect of human capital, institutional quality and innovation has been investigated on the regional GDP per capita in oil-exporting countries using the panel data method from 2011 to 2021. Panel data has more information, more variability, higher degrees of freedom and higher efficiency than time series and cross-sectional data. Flimer's test is used to distinguish between pooling and panel data (Baltagi, 2005). In addition, the effect of institutional quality on the region's GDP has been investigated through government consumption expenditures. The components of the knowledge-based economy affecting the gross domestic product are: 1) human capital that in a knowledge-based economy differs from traditional education and has a lifelong quality (Dadgar et al., 2019). Developing education and increasing the number of educated and specialized individuals by contributing to the growth of technology, facilitating the absorption of technology, and boosting the productivity of labor and capital increases economic growth and shifts the total supply curve downwards (Heidari et al., 2011). Many countries' disregard for the issue of development and the dissemination of new skill-based education leads to economic instability and negative growth (Hofmarcher, 2021); 2) Institutional quality, which includes the political system, the behavior of rulers, public policies, corruption control, and culture and religion, have been cited as significant determinants of economic performance disparities between countries (Kaufmann et al., 1999; Kurtz and Schrank, 2007; Slesman et al., 2015; Izadkhasti, 2019). In addition, institutional factors such as the political system, the behavior of rulers, public policies, corruption control, and culture and religion are significant contributors to variances in the economic performance of countries, and institutions shape the economic environment of countries; 3) Innovation that can be defined as the application of any new idea to the organization, whether the new idea is applied to products, processes, or services, or whether it is included into the organization's management and marketing systems (Bundy, 1994). Strengthening the innovation system by expanding the supply of new products and services and employing innovative production and distribution techniques will enhance the overall supply and reduce economic inflation.

In addition, enhancing the system of innovation by maximizing the use of existing resources and boosting productivity will cut production costs and curb economic inflation (Najafi and Azarbaijani, 2016). The World Business School and the World Intellectual Property Organization (WIPO) created the Global Innovation Index (GII) to determine how to identify the approaches and components that constitute innovation. Innovation index consists of two categories of internal innovation components, namely institutions, human capital, and research, infrastructure, market complexity, and business complexity, and two categories of external innovation components, namely technological output and creative output. 4) Information and Communication Technology, causes to shift in the traditional modes of consumption, production, and company governance. Also, will facilitate the development of a quantitative knowledge-based economy by reducing costs, removing geographical barriers, enhancing the flow of information, and decreasing transactional uncertainty (Gressgard et al., 2014). The growth of information technology reduces unemployment through reducing production costs, enhancing competitiveness, expanding the market, increasing the amount of production, and creating jobs. Increasing the usage of technology will also decrease production costs and shift the whole supply curve downward (Memarnejad and Dizaji, 2019). This study will therefore explore the effect of the information and communication technology index on economic growth. Based on theoretical literature and following Grossman and Helpman (1991); Dargahi and Qadiri (2012); Ogbeifun and Shobande (2022), the first model is specified in Eq. 1. The hypotheses related to Eq. 1 are as follows:

1) Human capital has a positive effect on the regional gross domestic product; 2) Institutional quality has a positive effect on the regional gross domestic product; 3) Institutional quality has a positive effect on the regional gross domestic product.

$$\begin{aligned} \ln GDPP_{i,t} = & \alpha + \beta_1 \ln Caf_{i,t} + \beta_2 \ln Gov_{it} \\ & + \beta_3 \ln Oil_{i,t} + \beta_4 \ln Hdi_{i,t} + \beta_5 \ln Inv_{i,t} \\ & + \beta_6 \ln Ict_{i,t} + \beta_7 \ln Inq_{i,t} + \eta_i + \varepsilon_{i,t} \end{aligned} \quad (1)$$

Where, $\ln GDP_{i,t}$ is logarithm of gross domestic

product per capita (at constant 2015 prices); $\text{LnCaf}_{i,t}$ is logarithm of physical capital formation as a percent of GDP representing private and public sector investment); $\text{LnGov}_{i,t}$ is logarithm of government consumption expenditure as a percent GDP as an indicator of the government's role in the formulation of macro policies, $\text{LnOil}_{i,t}$ is logarithm of oil revenues as a percent of GDP, $\text{LnHdi}_{i,t}$ is logarithm of human capital index, $\text{LnInvi}_{i,t}$ is logarithm of innovation index, $\text{LnInqi}_{i,t}$ is logarithm of institutional quality index, $\text{LnIct}_{i,t}$ is logarithm of information and communication technology in the country i in the period of t , η_i is the fixed effects of the countries and ε_{it} is the stochastic error term. In addition, the institutional quality limit government spending and direct financial resources towards healthy investments. So, the interaction effect of institutional quality and government consumption expenditures on gross domestic product per capita will be investigated in Eq. 2. Also, the hypothesis related to Eq. 2 is as follows:

2) Institutional quality increases regional gross domestic product through government consumption expenditures.

$$\begin{aligned} \text{LnGDPP}_{i,t} = & \alpha' + \beta_1' \text{LnCaf}_{i,t} + \beta_2' \text{LnGov}_{i,t} \\ & * \text{LnInq}_{i,t} + \beta_3' \text{LnOil}_{i,t} + \beta_4' \text{LnHdi}_{i,t} \\ & + \beta_5' \text{LnInv}_{i,t} + \beta_6' \text{LnIct}_{i,t} + \eta_i' + \varepsilon_{i,t}' \end{aligned} \quad (2)$$

Where, $\text{LnGov}_{i,t} * \text{LnInq}_{i,t}$ is the interaction effect of institutional quality index and government consumption expenditures as a percent of GDP. The conceptual model of study is depicted in Fig. 1.

Data collection

To estimate the models, time series data are taken from World Bank data series (World Bank, 2023) and World Intellectual Property Organization (WIPO) reports (Global Innovation Index, 2021) for the period of 2011 to 2021 in selected oil-exporting countries. The data related to gross domestic product per capita, physical capital formation as a percent of GDP, government consumption expenditures as a percent of GDP, oil rents as a percent of GDP, are collected from World Bank data series for the period of 2011-2021. The data related to human capital index, institutional quality, innovation index, and information and communication technology are collected from World

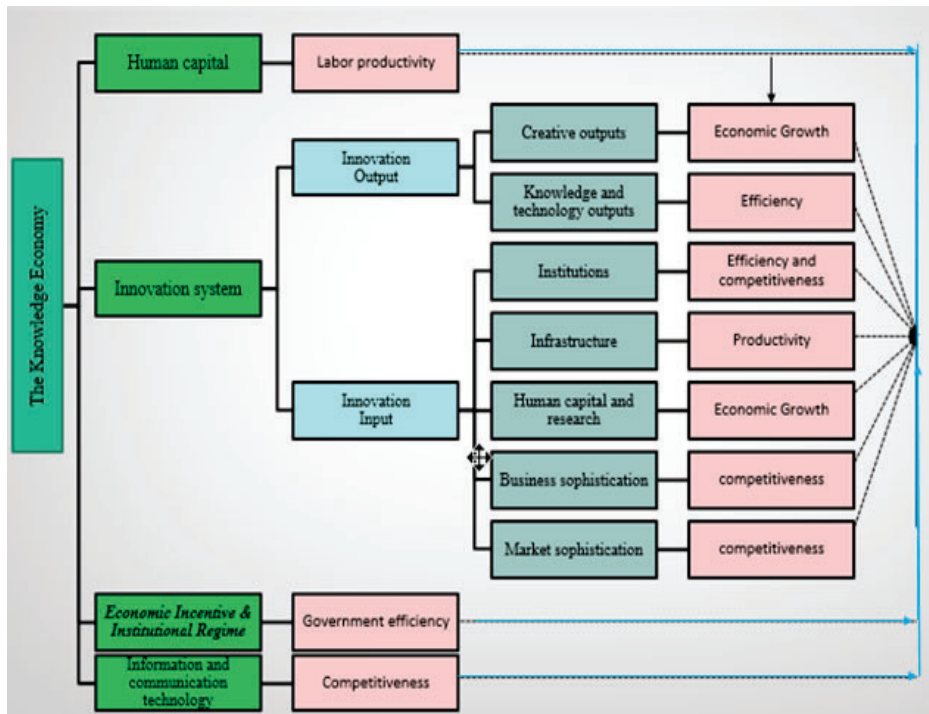


Fig. 1: The conceptual model of research

Table 2: Pedroni's cointegration tests

Tests Statistics	Model 1		Model 2	
	Panel	Group	Panel	Group
Variance ratio	-2.404*	-	-2.531*	-
Rho statistic	5.403*	6.980*	5.437*	6.998*
PP statistic	-0.721	-1.775*	-0.987	-2.226*
ADF statistic	8.993*	9.103*	8.956*	7.635*

Notes: ADF and PP are Augmented Dickey-Fuller and Phillips-Peron statistic, respectively. * The null hypothesis that there is no cointegration is rejected at the 5% level. In the Pedroni test, the critical value at the 5% level is -1.64.

Intellectual Property Organization (WIPO) reports for the period of 2011-2021. The oil exporting countries include Organization of the Petroleum Exporting Countries (OPEC) and OPEC+ countries. OPEC member countries include Algeria, Iran, Iraq, Kuwait, Libya, Solomon Islands, Qatar, Saudi Arabia, United Arab Emirates, Ecuador, Nigeria, Angola, Venezuela and Congo. OPEC+ member countries also include Russia, Mexico, Azerbaijan, Bahrain, Sudan, South Sudan, Malaysia, Kazakhstan, Brunei and Oman. Due to the incomplete data of some countries, such as Iraq, Libya, Venezuela, Sudan, etc., finally, the countries of Algeria, Iran, Kuwait, Qatar, Saudi Arabia, the United Arab Emirates, Ecuador, Russia, Mexico, the Republic of Azerbaijan, Bahrain, Malaysia, Kazakhstan and Oman have been selected in this research.

Analytical framework

The panel data method is used to estimate the models, because this method has more information, more variability, higher degrees of freedom and higher efficiency than time series and cross-sectional data. Flimer's test is used to distinguish between pooling and panel data (Baltagi, 2005). If the calculated Flimer's test is greater than the critical value, the null hypothesis is rejected and the panel data method is used in the estimation. Also, it is necessary to use the Hausman test in order to determine the method of estimating fixed or random effects (Baltagi, 2005). If the null hypothesis is rejected, the model is estimated using the fixed effects method. To ensure the existence of long-term relationship between the dependent variable and the independent variables, the panel cointegration tests provided by Pedroni (2004) are used before estimating the model to avoid false regression. Pedroni's cointegration test includes four panel cointegration statistics and three group panel cointegration statistics, which include: Variance

ratio, Rho panel statistics, Phillips-Peron panel statistic (PP statistic), Augmented Dickey-Fuller panel statistic (ADF statistic). In the Pedroni test, the critical value at the 5% level is -1.64. According to the results in Table 2, there is a cointegration relationship in both models at the 5% level. Therefore, a long-term relationship could be noticed between the dependent variable and the independent variables. Statistical analysis and econometrics are performed using Stata 17.0 software.

RESULTS AND DISCUSSION

Descriptive statistics

In this study, the descriptive statistics reported in Table 3, are based on the data are extracted from the World Bank data series and World Intellectual Property Organization (WIPO) reports for the period of 2011-2021. The logarithm of gross domestic product per capita (at constant 2015 prices) is dependent variable and its average, minimum and maximum values are 9.465, 8.251 and 11.084 respectively. Other variables are independent variables that based on theoretical foundations affect regional gross domestic product. Logarithm of physical capital formation as a percent of GDP representing private and public sector investment and its average, minimum and maximum values are 3.300, 2.552 and 3.927 respectively. Logarithm of government consumption expenditure as a percent of GDP is an indicator of the government's role in the formulation of macro policies and its average, minimum and maximum values are 2.749, 2.118 and 3.401 respectively. Logarithm of oil revenues as a percent of GDP and its average, minimum and maximum values are 2.533, 0.172 and 4.063 respectively. In order to achieve the research objectives, the effect of four variables, including human capital, institutional quality, innovation and information and

communication technology as components of the knowledge-based economy (that are measured on a 0-100 score by WIPO) have been used on the regional gross domestic product. The average, minimum and maximum of the logarithm of the human capital index are equal to 4.379, 4.131 and 4.504, respectively. The average, minimum and maximum of the logarithm of institutional quality index are equal to 3.678, 2.484 and 4.270, respectively. The logarithm of Innovation index is averaged at 3.513 with a minimum of 2.965 and a maximum of 3.864. The average, minimum and maximum of the Logarithm of innovation index. Finally, the average, minimum and maximum of the logarithm of information and communication technology are equal to 2.684, 1.363 and 3.175, respectively.

Unit root test

To examine the durability of the model variables, the unit root test was performed before estimating

the Models. Models followed by the Levin-Lin-Chu (LLC) test to determine the reliability of the variables, and the results are reported in Table 4. The results show the existence of a unit root in the gross domestic product per capita and the Innovation index. Other variables are stable at the level. In order to avoid spurious relationships and to ensure the existence of long-term relationship between the dependent variable and the independent variables, the panel cointegration tests provided by Pedroni (2004) are used before estimating the model.

Panel cointegration tests

Gross domestic product per capita is dependent variable and physical capital formation as a proportion of GDP, government consumption expenditures as a proportion of GDP, oil revenues as a proportion of GDP, human capital index, institutional quality index, innovation index, and information and communication technology index are independent

Table 3: Summary of descriptive statistics

Variables	Obs.	Mean	Std. dev.	Min	Max
Ln (Gross domestic product per capita)	154	9.465	0.796	8.251	11.084
Ln (Physical capital formation (%GDP))	154	3.300	0.247	2.552	3.927
Ln (Oil revenues (%GDP))	154	2.533	0.892	0.172	4.063
Ln (Government consumption expenditure (%GDP))	154	2.749	0.283	2.118	3.401
Ln (Human capital index)	154	4.379	0.546	4.131	4.504
Ln (Institutional quality)	154	3.678	0.426	2.484	4.270
Ln (Innovation index)	154	3.513	0.186	2.965	3.864
Ln (Information and communication technology)	154	2.684	0.322	1.363	3.175

Table 4: Results of the durability of the model variables

Variables	Levin-Lin-Chu test			Levin-Lin-Chu test		
	At the level	Probability	Results	At the first order difference	Probability	Results
Ln (Gross domestic product per capita)	-3.64	0.24	I(1)	-4.82	0.085	I(0)
Ln (Physical capital formation (%GDP))	-6.91	0.000	I(0)	-	-	-
Ln (Oil revenues (%GDP))	-8.78	0.000	I(0)	-	-	-
Ln (Government consumption expenditure (%GDP))	-7.68	0.000	I(0)	-	-	-
Ln (Human capital index)	-5.13	0.000	I(0)	-	-	-
Ln (Institutional quality)	-6.83	0.000	I(0)	-	-	-
Ln (Innovation index)	-4.04	0.32	I(1)	-8.44	0.000	I(0)
Ln (Information and communication technology)	-10.55	0.000	I(0)	-	-	-

variables. In order to avoid spurious relationships and to ensure the existence of long-term relationship between the dependent variable and the independent variables, the panel cointegration tests provided by Pedroni (2004) are used before estimating the model. According to the results in Table 2, there is a cointegration relationship in both models at the 5% level.

Flimer and Hausman test

Based on the F-test in Table 5, the value of F-test in the first and the second models are 674.2 and 738.6, respectively. So, the null hypothesis is rejected at the %1 level in the first and the second models and the panel data method is confirmed. The value of Hausman test in the first and second model is 5.90 and 6.33, respectively. The null hypothesis is not rejected in the first and the second models at the %5 level, so random effects method is confirmed. In this study, the dependent variable is the GDP per

capita (constant 2015 US\$). Independent variables are physical capital formation as a percent of GDP, government consumption expenditure as a percent of GDP, oil rents as a percent of GDP, innovation index, human capital index, and information and communication technology. All variables are in logarithmic form. The results of the fixed and random effects estimation in the first and second models are reported in Table 5. According to Hausman test in Table 5, random effects method is confirmed in the first and the second models.

Random effects panel estimation results

Random effects method is confirmed in the first and the second models. According to the results with random effects method in Table 5, human capital index has had a positive and significant effect on gross domestic product per capita at the 1% level and its coefficient in the first and the second models are 0.878 and 0.905, respectively. In other words, a

Table 5: Results of equations estimation using panel data method

Variables	Model 1		Model 2	
	Fixed-effects	Random effects	Fixed-effects	Random effects
Ln (Physical capital formation (%GDP))	0.042* (0.024)	0.042 (0.029)	0.041* (0.024)	0.041 (0.028)
Ln (Government consumption expenditure (%GDP))	-0.197*** (0.038)	-0.190*** (0.045)	-0.410*** (0.082)	-0.476*** (0.093)
Ln (Oil rents (%GDP))	-0.038*** (0.011)	-0.034** (0.013)	-0.037*** (0.012)	-0.035*** (0.013)
Ln (Human capital index)	0.785*** (0.152)	0.878*** (0.178)	0.816*** (0.151)	0.905*** (0.172)
Ln (Innovation index)	0.297*** (0.049)	0.324*** (0.057)	0.306*** (0.048)	0.331*** (0.055)
Ln (Information and communication technology)	0.007 (0.011)	0.007 (0.013)	0.008 (0.012)	0.008 (0.013)
Ln (Institutional) quality index	0.133*** (0.043)	0.182*** (0.050)	-	-
Ln (Institutional quality index) * Ln (Government consumption expenditure (%GDP))	-	-	0.055*** (0.017)	0.073*** (0.019)
Cons	5.158*** (0.773)	4.45*** (0.910)	5.506*** (0.763)	5.01*** (0.879)
R-sq.	Within = 0.47 Between = 0.66 Overall = 0.62	Within = 0.46 Between = 0.74 Overall = 0.70	Within = 0.47 Between = 0.67 Overall = 0.64	Within = 0.47 Between = 0.74 Overall = 0.71
F-test* (prob)	674.2*** (0.000)		738.6*** (0.000)	
Hausman test (prob)	5.90 (0.551)		6.33 (0.502)	
Observations		154		
Number of countries		14		

Notes: The figures enclosed in parentheses beneath the regression coefficients represent standard errors. *, **, and *** are significant at the 10 %, 5 %, and 1 % levels respectively.

one percent increase in the human capital index in the first model causes an increase in gross domestic product per capita by 0.878 percent. Also, a one percent increase in the human capital index in the second model causes an increase in gross domestic product per capita by 0.905 percent. So, the first hypothesis related to Eq. 1 is confirmed and human capital has a positive and significant effect on the regional gross domestic product at the level of 1%. These results are consistent with the finding of Kurt (2015); Teixeira and Queiros (2016); Shobande (2021); Ogbeifun and Shobande (2022); Shidong *et al.* (2022). This finding indicates that improving the quality of human capital index through education, training, and the acquisition of diverse skills plays a crucial role in sustaining economic growth within the framework of endogenous growth models. The institutional quality has had a positive and significant effect on gross domestic product per capita at the 1% level in the first model and its coefficient is 0.182. According to this, a one percent increase in the institutional quality index in the first model causes an increase in gross domestic product per capita by 0.182 percent. Therefore, the second hypothesis related to Eq. 1. is confirmed and institutional quality has a positive and significant effect on the regional gross domestic product at the level of 1%. These results are consistent with the finding of Kaufmann *et al.*, (1999); Kurtz and Schrank, (2007) and Slesman *et al.*, (2015). The improvement of the institutional quality such as the political system, the behavior of rulers and public policies, is accomplished by increasing political stability and the absence of violence in the society, securing property rights, enhancing the government's effectiveness, enhancing the quality of laws and regulations, reducing corruption, increasing long-term investments, and expanding employment opportunities (Dutta *et al.*, 2013; Slesman *et al.*, 2015). In addition, the institutional quality limit government spending and direct financial resources towards healthy investments. Also, the coefficient of interaction effects of institutional quality and government consumption expenditure in the second model is 0.073 and is statistically significant at the 1% level. Therefore, the hypothesis related to Eq. 2. is confirmed and interaction effects of institutional quality and government consumption expenditure has a positive and significant effect on the regional gross domestic product at the level of 1%. According

to this, institutional quality index has increased regional gross domestic product through government consumption expenditures. Innovation index has had a positive and significant effect on gross domestic product per capita and its coefficient in the first and second model are 0.324 and 0.331, respectively. So, an increase of one percent in Innovation index in the first and the second models causes an increase in gross domestic product per capita by 0.324 and 0.331 percent. So, the third hypothesis related to Eq. 1. is confirmed and Innovation index has a positive and significant effect on the regional gross domestic product at the level of 1%. These results are consistent with the finding of Grossman and Helpman (1991); Acemoglu (2008); Galindo and Mendez (2014); Pece *et al.*, (2015); Barkhordari *et al.* (2019). The use of an idea by one person does not restrict others from adopting it simultaneously. These types of concepts create a strong connection between idea-based growth models and rising scale-based efficiency (Grossman and Helpman, 1994). In addition, improving the system of innovation by maximizing the use of existing resources and boosting productivity will decrease production costs and curb economic inflation (Najafi and Azarbaijani, 2016). Information and communication technology infrastructures will facilitate the development of a quantitative knowledge-based economy by reducing costs, removing geographical barriers, enhancing the flow of information, and decreasing transactional uncertainty (Gressgaard *et al.*, 2014). The coefficient of Information and communication technology infrastructures in the first and the second models is equal to 0.007 and 0.008, respectively, which is insignificant at the 10% level. Moreover, Physical capital formation as a percent of GDP has had a positive and insignificant effect on gross domestic product per capita and its coefficient in the first and the second models are 0.042 and 0.041, respectively. In both models, Oil revenues has had a negative effect on gross domestic product per capita and its coefficient are -0.034 and -0.035, respectively. Oil revenues are one of those factors that can be seen as a blessing or a curse in determining economic growth (Khan *et al.* 2022 and Dramani *et al.* 2022). Accordingly, oil rent as a percent of GDP has had a negative effect on economic performance. This result is consistent with the results of Mavrotas *et al.* (2011) and Dramani *et al.* (2022). Government

consumption expenditure as a percent of GDP in the first and the second models has had a negative effect on gross domestic product per capita and its coefficient are -0.190 and -0.476, respectively. This result is consistent with the results of [Pourehtesham \(2022\)](#). Therefore, an increase in public spending on profitable projects can promote economic growth, but an increase in government current expenses can negatively affect economic performance. According to this, the relationship between public sector spending and economic growth over the past few decades is still relevant today and is still a matter of debate among policymakers and researchers ([Poku et al., 2022](#)). In some studies, such as [Ogbeifun and Shobande \(2022\)](#) used the two-stage least squares (2SLS) method and [Widarni and Bawono \(2021\)](#) used the Autoregressive Distributed Lag (ARDL) method to investigate the effects of human capital and technology on economic growth.

CONCLUSION

Differences in the fundamental variables of production and technology are cited as the basis for the disparity in national growth rates by primary research. Theoretical literature of endogenous growth models is based on the external of physical capital, the accumulation of human capital, and technological innovation. Moreover, since the late 1990s, institutional quality, such as the political system, the behavior of rulers, public policies, corruption control, and culture and religion, have been cited as significant determinants of economic performance disparities between countries. In this study the effect of human capital, institutional quality and innovation are investigated on regional gross domestic product per capita in 14 oil exporting countries from 2011 to 2021 using panel data method. In addition, the institutional quality limit government spending and direct financial resources towards healthy investments. According to this, the effect of institutional quality index has investigated on regional gross domestic product per capita through government consumption expenditures. Also, statistical and econometric analysis is done with Stata17.0 software. Based on Pedroni cointegration test there is a long-term relationship between the dependent variable and the independent variables. The results of random effects method in the first

and the second models indicated that human capital has a positive and significant effect on the regional gross domestic product per capita at the level of 1%. So, improving the quality of human capital index through education, training, and the acquisition of diverse skills plays a crucial role in sustainability of economic growth within the framework of endogenous growth models. The institutional quality has had a positive and significant effect on gross domestic product per capita at the 1% level in the first model. According to this, Institutional quality, such as the political system, the behavior of rulers, public policies, corruption control, and culture and religion, have been cited as significant determinants of economic performance disparities between oil exporting countries. Moreover, Institutional quality index has increased regional gross domestic product through government consumption expenditures. So, the institutional quality limit government spending and direct financial resources towards healthy investments. The results also show that Innovation index has had a positive and significant effect on gross domestic product per capita in the first and the second models. According to this, technological innovation creates circumstances for any region to extract more value from limited resources to support sustainable economic growth. In this way, strengthening the innovation system by expanding the supply of new products and services and employing innovative production and distribution techniques will enhance the overall supply. The study therefore concludes that, physical capital formation as a percent of GDP has a positive and insignificant impact on gross domestic product per capita. Of course, oil rents as a percent of GDP has had a negative and significant effect on gross domestic product per capita in both models. Thus, oil revenues are one of those factors that can be seen as a blessing or a curse in determining economic growth. In addition, the role of natural resources in economic growth largely depends on the amount of rent it generates. Finally, Government consumption expenditure as a percent of GDP has had a negative and significant effect on gross domestic product per capita. Therefore, an increase in public spending on profitable projects can promote economic growth, but an increase in government current expenses can negatively affect economic performance.

Policy implications

Considering that the descriptive statistics growth rate of GDP per capita averaged at 2.12% over the period from 2011 to 2021 in 14 oil exporting countries. Thus, it seemed necessary to recommend these countries to improve the economic performance: 1) apply policies to increase the level and quality of human capital through education, training, and the acquisition of diverse skills; 2) improving institutional quality such as the political system, the behavior of rulers, public policies, corruption control, and culture and religion; 3) Strengthening the innovation system by expanding the supply of new products and services and employing innovative production and distribution techniques. In addition, oil revenues are one of those factors that can be seen as a blessing or a curse in determining economic. So, the role of oil revenues in economic growth largely depends on the amount of rent it generates. In the end, it is suggested that, by disciplining the government's current expenditures, the share of infrastructure expenditures should increase.

AUTHOR CONTRIBUTIONS

H. Izadkhasti, conducted the research materials, methods, introduction, and literature review, analyzed and evaluated the data, and wrote the manuscript text, citations, and final version.

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CONFLICT OF INTEREST

The author declares 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.

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ABBREVIATIONS

ADF	Augmented Dickey-Fuller
ARDL	The Autoregressive Distributed Lag
Cup-FM	Continuously updated fully modified
Cup-BC	Continuously updated bias-corrected
GDP	Growth Domestic Product
GMM	Generalized method of moments
LLC	Levin-Lin Chu test
MENA	Middle East and North Africa
OECD	Organization for economic cooperation and development
OPEC	Organization of the Petroleum Exporting
WDI	World Development Indicators
WIPO	World Intellectual Property Organization
2SLS	The two-stage least squares

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ORIGINAL RESEARCH PAPER

The mediating effect of climate change on the relationship between energy resources and cost-saving sustainability and energy security in urban context

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ABSTRACT

BACKGROUND AND OBJECTIVES: Energy is widely acknowledged as a critical aspect of economic development, and a country's ability to sustain economic growth depends on the security of its energy supply. Malaysia's persistent energy demand and diminishing local energy supplies have recently increased energy industry operators' and policymakers' concerns about the country's energy supply security. Finding economical energy options with secure production and a minimum environmental impact has long been the key goal for developing countries. For developing countries, energy security is a challenging task to meet rising energy demands in a long-term, environmentally sustainable manner. The study aims to examine the mediating effect of climate change on energy resources to achieve cost-saving sustainability and energy security in Sabah, Malaysia.

METHODS: This study adopts quantitative research in which a public survey was conducted between April 28 and May 10, 2023, focusing on how Sabah's energy resources, including nuclear, fossil, and renewable fuels, relate to Sabah's cost-effective sustainability and energy security. In total, 100 questionnaires were distributed to different geographic or regional regions that are likely to differ from one another in terms of their beliefs or perceptions, educational backgrounds, income levels, and occupations. According to this study, the population of Sabah, Malaysia, will be 3.39 million in 2022. The sampling strategy used in the present research was non-probability convenience sampling. However, only 80 valid questionnaires were used as the sample size for this paper based on the Smart PLS sample size table. The response rate was 86.96%. A smaller sample was chosen in the study rather than a more thorough census due to the magnitude of the population.

FINDINGS: The findings showed that protection motivation, theory consistency theory, and behavioral reasoning theory play important roles in planned behavior when looking at practical, long-term solutions to the problems of cost-effective sustainability, energy security, and climate change as mediating factors. The results showed five (5) hypotheses have been accepted with p-value at 0.000 to 0.031. Unfortunately, there are twelve (12) hypotheses were not supported with p-value at 0.085 to 0.563 due to most of Sabah's people had a poor understanding of and lack of acceptance of the need for energy.

CONCLUSION: The study empirically confirms and conceptually proves that policy on the conceptual framework of environmental literacy and pro-environmental behavior should be adopted and reviews the country's existing energy policy, the renewable energy policy, and the legal framework in resolving renewable energy sources that are still underutilized, environmentally responsible, and have a great deal of potential to satisfy the energy needs

DOI: [10.22034/IJHCUM.2023.04.05](https://doi.org/10.22034/IJHCUM.2023.04.05) of both established and emerging nations.



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INTRODUCTION

Sabah's capacity is primarily made up of antiquated, expensive, and unreliable diesel plants, and the state's energy demand is growing at a rate of over 7% a year. Driven by the expansion of both the commercial and household sectors, unexpected breakdowns in Sabah result in costly service interruptions, especially on the east coast, which is almost dependent on diesel plants (McNish *et al.*, 2010). In addition, Sabah and Sarawak, two states in East Malaysia (also known as Malaysian Borneo), only have rates of 77.00% and 67.00%, respectively. Peninsular Malaysia has a high electrical access rate of 99.72%. Nearly 0.8 million Malaysians, the majority of whom live in East Malaysia's rural areas, lack access to electricity (Liang, 2016). The National Renewable Energy and Action Plan of 2009 and the Fifth Fuel Diversification Strategy of 2001 feature renewable energy (RE) targets that Malaysia has been ineffective in meeting due to RE's excessive price and a lack of private investment (Bujang *et al.*, 2016). The statistic showed that almost 0.8 million Malaysians do not have access to power supply, and most reside in East Malaysia's rural districts (Liang, 2016). While working on alternative types of energy, it regrettably did not address any issues relating to Nuclear Energy (NE) (Ghazali *et al.*, 2019). Energy is recognized as one of the factors in economic development, and a country's ability to maintain its economic growth depends on the security of its energy supply. Due to Malaysia's relentless energy demand and depleting domestic energy resources, energy industry players and policymakers have recently become more concerned about the country's energy supply security. The main goal has always been to identify economical energy options, secure supply, and have little influence on the environment. According to Kumar and Tewary (2022), the world is currently working to achieve Energy Security (ES), which is disrupted by population growth and unprecedented urban development. Natural gas, coal, and oil make up the majority of Malaysia's conventional power generation system and the total national primary energy supply. According to Ludin *et al.* (2018), Malaysia's challenges include Climate Change (CC), fossil fuel extraction, resource depletion, and a lack of renewable energy sources. Malaysia must develop ways to provide a sustainable and reasonably priced power supply in the future because energy demand rises proportionally to growth in the development product and economic

growth. Coal and natural gas are the primary fuels used in Malaysia's power sector, which is dependent on fossil-based energy sources. Finding a way to attain sustainability, or to guarantee the security and dependability of the energy supply, while taking the effects of energy production on the environment into account, is a problem. On the path to a sustainable future, the energy sector's two primary problems are securing the energy supply and reducing energy's role in climate change (Abbasi and Abbasi, 2011; Kaygusuz, 2012). It is staggering to learn that 1.4 billion people today lack access to electricity, with 85% of them living in rural areas. As a result, it is anticipated that from 2.7 billion now to 2.8 billion in 2030, there will be more rural populations reliant on the traditional use of biomass (Kaygusuz, 2012). Climate change is one of the main problems of the twenty-first century (Puno *et al.*, 2021; Payus and Sentian, 2022; Arredondo-Trapero *et al.*, 2023; Frimawaty *et al.*, 2023; Jaishree *et al.*, 2023; Soeprbowti *et al.*, 2023). In the context of Sabah, climate change needs to be addressed towards cost savings and energy sustainability using cleaner energy resources, i.e., renewable energy and nuclear energy, apart from fossil fuel usage. One of the 13 states in Malaysia, Sabah, regularly has a catastrophic power outage. Additionally, in the majority of Sabah's territory, the power network is not connected to any other power networks. The energy mix in Malaysia is contributed by five major sources in this strategy: natural gas, coal, oil, hydroelectricity, and renewable energy. With a well-balanced energy mix, the economy and the power sector are less vulnerable to changes in the fuel supply. Even today, just a small portion of the electricity produced comes from renewable sources. The government had set a goal to generate at least 5% of the nation's electricity from renewable sources before the implementation of this programme, but this objective has never been met (Bujang *et al.*, 2016). The study aimed to fill the knowledge gap about the variables affecting energy resources, Cost-Saving Sustainability (CSS), and Energy security in Sabah, Malaysia, in 2023.

LITERATURE REVIEW

The utilization of renewable and non-renewable energy sources in Malaysia for energy security (ES) and climate change mitigation has been studied (Ghazali *et al.*, 2019; Drobyazko *et al.*, 2021; Ramli *et al.*, 2022; Moghadam and Samimi, 2022). Numerous

inconsistent and fragmented views of energy security can be found in the academic and policy literature (Cherp and Jewell, 2014). The ambiguity suggests that the lack of an operational definition of energy security hinders public and scientific discourse. A lack of clarity directly translates into a lack of distinct indicators for energy security. As a result, further research is needed to solve the problems of cost-effective sustainability and energy security in the context of using renewable and non-renewable energy sources to mitigate climate change. Renewable energy sources derive their power from the continuous and natural flow of energy that occurs in our immediate environment. These consist of bioenergy, solar energy from direct sources, geothermal energy, hydropower, wind, and ocean energy (tide and wave). Badsar and Karami (2021) conducted a study in Zanjan County, Iran, investigating the direct and indirect effects of knowledge on farmers' willingness to employ renewable energies. The findings showed that farmers' motivation to employ renewable energies was influenced by their knowledge, both directly and indirectly. The study identified reaction cost and internal rewards as the two variables that contributed the most significantly. Energy or fuel consumption per capita, energy or fuel (oil) expenditures, and the price elasticity of demand for energy or a particular fuel are all examples of demand-side indicators. An increase in energy security, such as through increased supply and demand energy efficiency through demand response or demand-side flexibility, would boost the energy system's resistance against unanticipated energy price spikes of foreign origin. Increasing energy security can be accomplished by lowering the macroeconomic growth-dampening impact of price shocks (Couder, 2015). Climate change and energy security are global issues that are regularly discussed in public policy debates all over the world (Toke and Vezirgiannidou, 2013). Malaysia is now doing pre-feasibility studies, policy studies, regulation reviews, and probable site selection as part of the evaluation process. There are some serious concerns regarding Malaysia's readiness to use nuclear power. The primary issues have always been nuclear waste disposal, challenges with nuclear power plant (NPP) decommissioning, and the potential risks and hazards of NPP. Traditional fossil fuel-based energy sources like coal, oil, and natural gas are what drive

economic growth. Fossil fuel combustion for power generation to meet residential, commercial, and industrial demand accounts for over 40% of it (Abdul Latif et al., 2021). Burning fossil fuels to produce electricity to power homes and businesses Fossil fuels accounted for 82.9% of Malaysia's energy mix in 2017, according to capacity data from the Energy Commission of Malaysia (Abdullah et al., 2019). The percentages of coal, natural gas, and fuel oil/diesel in the fossil fuel input are 44.2%, 38.0%, and 0.6%, respectively, and industrial demand accounts for over 40% of it (Abdul Latif et al., 2021). The current climate change policy is substantially behind the available scientific evidence. One of the most urgent issues with climate change policy is the gap between research and policy. Long-term stock and flow links cause many of the detrimental effects of climate change to be delayed (Chan et al., 2022; Malla et al., 2022); in addition, slow institutional responses to climate change are a result of underlying causes and effects in the climate system (Munck af Rosenschöld et al., 2014). Despite the recent increase in scientific interest in climate change adaptation as a governance challenge requiring measures from civil society, business, and especially government, nation-states have not universally adopted climate adaptation policies (Ford and Berrang-Ford, 2011). Climate change adaptation has been described as a "wicked problem par excellence" by some (Anderson and Walters, 2023; Wohlgezogen et al., 2020), one that cannot be accurately articulated or solved due to vested interests and widely divergent problem formulations. It is a crucial field of study for two reasons. First, reducing energy-related emissions will be critical for climate mitigation. Furthermore, many governments regard energy as a priority policy subject because it is a key generator of economic growth and prosperity. This issue is gaining attention because of the consequences of climate change and the need to shift security paradigms away from military security and towards human security; concerns about the role of sustainability and environmental degradation in human security also play a role (Dalby, 2002; Peoples and Vaughan-Williams, 2020; Samimi and Shahriari Moghadam, 2020). In this case, energy is acknowledged as one of the key factors in economic development, and a country's ability to maintain its economic growth depends on the security of its energy supply. Due to Malaysia's relentless energy

demand and depleting domestic energy resources, the security of Malaysia's energy supply has recently come to the attention of energy sector players and policymakers (Flouros, 2022; Maulidia *et al.*, 2019; Sahid *et al.*, 2013; Salleh *et al.*, 2020).

MATERIALS AND METHODS

Survey design and data collection

The study investigates how the effects of climate change might impact the Sabahan people in terms of energy resources (ER), cost-saving sustainability, and energy security by using quantitative approaches. According to Rahi (2017), the explanatory research design was used to examine how the residents of Sabahan were affected by climate change in terms of energy security, cost-saving sustainability, and resource availability. Given this, the quantitative approach is a scientific methodology, and the positivist paradigm serves as its foundation. This approach focuses on gathering new data from a wide population on the issue at hand and analysing the data without considering the emotions and sentiments of the individual or the context of their environment. The deductive approach, where theory is not derived from observation but is based on conceptual and theoretical frameworks, can also be used to describe research that is based on empirical observation and theory that has been developed through conceptual and theoretical frameworks (Ngulube *et al.*, 2015). The population of Sabah, Malaysia, will be 3.39 million in 2022 (Statista Research Department, 2022), depending on the geographic and regional location. Non-probability sampling was the chosen sample method for the current research. Convenience sampling will be used in this study because it allows

the researcher to include people who are easy to reach through an instant text messaging mobile platform like WhatsApp. A total of 100 questionnaires were distributed to respondents, with a minimum sample size of 80, across Sabah's interior, south, and north regions. Samples were collected over 1 month in April 2023, with respondents being given checkboxes for informed consent, demographic questionnaires, and a list of questions. Cohen (1992) illustrates the minimum sample size needed to detect minimum R^2 values of 0.10, 0.25, 0.50, and 0.75 in any of the endogenous constructs in the structural model for significance levels of 1%, 5%, and 10%, considering the typically employed level of statistical power of 80% and a specific number of arrows pointing at a construct in the PLS path model. In this conceptual framework model study, the maximum number of independent variables and mediating variables in the measurement and structural models is seven. That being the case, to reach 80% for detecting R^2 values of at least 0.25 (with a 5% margin of error), With seven pointing arrows in the framework of this research, the recommended minimum sample size would be 80 to reach a statistical power of 80% for detecting R^2 values of 0.25 with a 5% probability of error. The two fundamental categories into which data gathering procedures are commonly classified are primary data collection techniques and secondary data collection methods.

Analytical framework

Fig. 1 shows the mediating effect of climate change on the relationship between energy resources on the cost saving sustainability and energy security

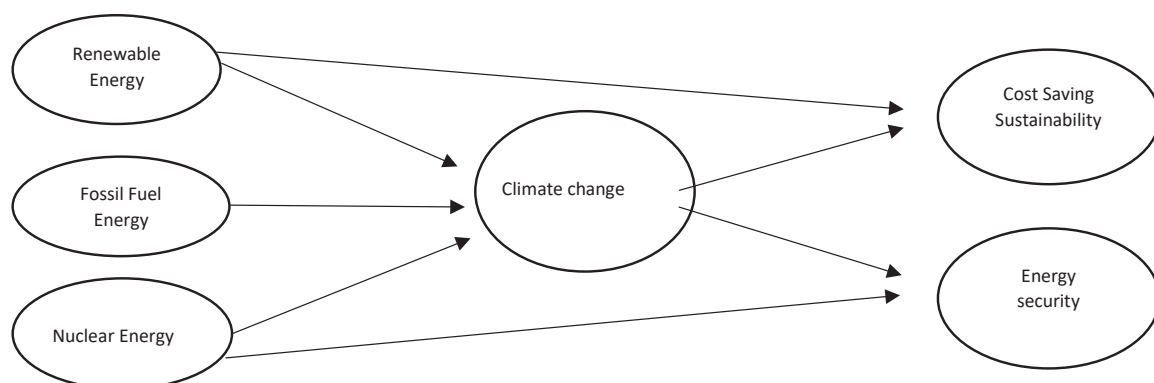


Fig. 1: Conceptual Framework of climate change on the relationship between energy resources on the cost saving sustainability and energy security

in urban context.

Based on the existing literature, a one-stage normative model was developed, which served as the basis for the investigational objectives of this study (Bigerna *et al.*, 2021). The conceptual framework (Fig. 1) shows the relationship between the independent and dependent variables and the intervening variables. The conceptual framework is made up of three independent factors, two dependent variables, and one mediating variable that give an overview of the essential interaction between nuclear energy, Fossil Fuels Energy (FFE), and renewable energy in terms of cost-effectiveness, sustainability, and energy security (Razmjoo *et al.*, 2021). The Malaysian state of Sabah's cost-saving sustainability and energy security are covered by the study's dependent variable because they have grown to be a significant concern to address through environmental awareness (Surianshah, 2021). In the meantime, climate change mediates cost-saving sustainability (Aktan *et al.*, 2023). In this study, the independent variables will be nuclear, fossil, and renewable energy sources (Voumik *et al.*, 2023). The consistent literature is utilized to establish a connection between renewable and non-renewable energy resources to address the impact of climate change on cost-saving sustainability (CSS) and energy security (Voumik *et al.*, 2023). The climate change Theory is relevant to the availability and abundance of fossil fuels on the earth and dominant primary energy sources since there is now broad agreement that human activity is what is causing the observed rise in atmospheric concentrations of carbon dioxide and other infrared-absorbing trace gases, which are warming the universe (Bandh *et al.*, 2021; Holechek *et al.*, 2022; Soeder *et al.*, 2021). Although some academics contend that there is still a lack of evidence to support a causal relationship between conspiracy theory belief and behavior, others have claimed that conspiracy theories about climate change hamper pro-environment action (Biddlestone *et al.*, 2022). Even though the most recent assessment from the Intergovernmental Panel on climate change (Khan, 2022) shows how human-caused climate change has already severely harmed societies all over the world (Pörtner *et al.*, 2022). Conspiracy theories challenging the reality of climate change's occurrence, causes, and effects are still prevalent (Ibbetson, 2021). Recent findings addressing global warming, often known as

anthropogenic global warming, support the hypothesis that the greenhouse effect, which humans have exacerbated, is what caused the globe to warm up, particularly since the Industrial Revolution (Letcher, 2022; Martinez, 2022; Mozaffari, 2022). Protection Motivation Theory provides a conservative framework to explain pro-environmental decisions by considering a wide range of predictors, such as the costs and rewards of both current (maladaptive) behaviour and anticipated adaptive behavior (Bockarjova and Steg, 2014). Therefore, the Protection Motivation Theory may improve the comprehension of the driving forces behind pro-environmental attitudes and behaviors, which may then be used to encourage pro-environmental choices to lower environmental hazards, particularly the use of fossil fuels in combating climate change (Singh and Vaibhav, 2020; Samimi and Shahriari Moghadam, 2018). Behavioral Reasoning Theory is best applied to mediating constructs, such as (i) reasons for adoption, (ii) reasons against adoption, and (iii) attitudes towards technology, to understand how consumers think about the adoption of renewable energy (RE) systems (Elahi *et al.*, 2022; Fouad *et al.*, 2022; Loaiza-Ramrez *et al.*, 2022). A significant step towards less carbon-intensive and sustainable energy systems is consumer adoption of renewable energy sources (Ahmed *et al.*, 2022; Claudy *et al.*, 2013).

RESULTS AND DISCUSSION

Descriptive statistics and analysis for variables entering the analysis

Table 1 shows the geographic distribution of the (N = 80) individuals that were picked at random from across Sabah and Malaysia. Based on the above table, among the 80 participants, there were 45 male participants (56.25%) and 35 female participants (43.75%) in the study. Based on the above table, among the 80 participants, there were 45 male participants (56.25%) and 35 female participants (43.75%) in the study. The age groups of 25 to 34 years (21.3%) and 45 to 54 years (31.3%) generated the bulk of responses from the respondents. When it involved education, individuals who had completed at least a diploma or degree in postsecondary education fared better, scoring 32.5% and 28.7%, respectively. The public and private sectors responded with 27.5% and 26.3% in the profession or occupation category, followed by the unemployed, homemakers, and

retirees with 21.3%. Geographically, the bulk of Sabah respondents were from the West Coast, where they made up 48.8%, and the East Coast, where they made up 17.5%. However, 15% of respondents were from West Malaysia.

Reflective Measurement Model Results

Reliability Analysis

This additional reliability test was carried out based on the findings of earlier pilot research, which determined that when the sample size increased to $N = 80$, the data had an acceptable level of internal agreement between the statements assessing a given construct. Table 2 shows that using Cronbach's alpha, the outcome reacted with the sample size increasing to $N = 80$ from the initial pilot study at $N = 50$, indicating that the constructs have an acceptable level of agreement when the coefficient is more than 0.70. The findings establish that, aside from range, the variance and standard deviation of the data from the sample size or effect size had a significant impact on Cronbach's alpha's reliability. The growth in some areas demonstrates the stability

of standard deviation and variance, which, other than range, exhibit an upward correlation with the Cronbach Alpha reliability coefficient (Amirrudin *et al.*, 2021). Table 2 presents an explanation of how the measurement model converged. A greater value denotes a higher level of reliability, and the values of AVE and CR range from 0 to 1. The validity of convergence is confirmed when the AVE is greater than or equal to 0.5 (Shrestha, 2021). In the above case, the composite reliability is greater than 0.60, and all AVE values are higher than 0.50. Renewable energy (RE) has an AVE score of 0.511 and a fossil fuel energy value of 0.522, except for the nuclear energy (NE) record value of 0.472. Fornell and Larcker (1981) assert that the construct's convergent validity is still sufficient if AVE is less than 0.5 but composite reliability is higher than 0.6.

Construct Validity

Table 3 shows that fossil fuel energy (0.722) exceeds the other correlation values below it, which are presented in the fourth column. In other words, the square root of AVE for the construct fossil fuel

Table 1: Result of the respondent's profile

Demographic	Category	Frequency	Percent (%)
Gender	Male	45	56.3%
	Female	35	43.8%
Age	18 – 24 years	12	15.0%
	25 – 34 years	17	21.3%
	34 – 44 years	15	18.8%
	45 – 55 years	25	31.3%
	Above 55 years	11	13.8%
	High School	19	23.8%
Highest Education Level	Diploma	26	32.5%
	Degree	23	28.7%
	Master / PHD	12	15.0%
Income	RM0 – RM2,999	41	51.2%
	RM3,000 – RM5,999	15	18.8%
	RM6,000 – RM9,999	13	16.3%
	Above 10,000	11	13.8%
	Non-Government Organization (NGO)	7	8.8%
Profession / Occupation	Public Sector	22	27.5%
	Private Sector	21	26.3%
	Self-employed/ Business owners	9	11.3%
	Unemployed/ Homemakers/Retired	17	21.3%
	Political	4	5.0%
Region/Location	West Coast Sabah	39	48.8%
	East Coast Sabah	14	17.5%
	Northern Sabah	4	5.0%
	Southern Sabah	3	3.8%
	Interior Sabah	8	10.0%
	West Malaysia	12	15.0%

Table 2: Result of the reliability analysis

Construct	Measurement Items	Outer Loading	Cronbach's alpha	Composite reliability (rho_a)	Composite reliability (rho_c)	Average variance extracted (AVE)
Renewal Energy	RE1	0.659	0.756	0.810	0.833	0.511
	RE2	0.835				
	RE3	0.418				
	RE4	0.760				
	RE5	0.819				
Fossil Fuel Energy	FFE1	0.730	0.762	0.777	0.842	0.522
	FFE2	0.692				
	FFE3	0.516				
	FFE4	0.818				
	FFE5	0.813				
Nuclear Energy	NE1	0.366	0.725	0.820	0.800	0.472
	NE2	0.399				
	NE3	0.751				
	NE4	0.872				
	NE5	0.863				
Climate Change	CC1	0.854	0.886	0.906	0.917	0.690
	CC2	0.661				
	CC3	0.892				
	CC4	0.878				
	CC5	0.846				
Cost-Saving Sustainability	CSS1	0.519	0.810	0.837	0.870	0.579
	CSS2	0.802				
	CSS3	0.747				
	CSS4	0.867				
	CSS5	0.820				
Energy Security	ES1	0.382	0.810	0.873	0.872	0.592
	ES2	0.807				
	ES3	0.740				
	ES4	0.921				
	ES5	0.876				

-*gnivas-tsoC =SSC ;egnahC etamilC=CC ;ygrenE raelcuN =EN ;ygrenE leuF lissoF =EFF ;ygrenE elbaweneR=ER Sustainability; ES= Energy Security

Table 3: Discriminant Validity – Fornell – Larcker Criterion

	CC	CSS	ES	FFE	NE	RE
CC	0.830					
CSS	0.667	0.761				
ES	0.410	0.605	0.769			
FFE	0.721	0.584	0.480	0.722		
NE	0.741	0.669	0.501	0.672	0.687	
RE	0.504	0.458	0.617	0.527	0.458	0.715

-* CC = Climate Change; CSS = Cost-Saving Sustainability; ES = Energy Security; FFE= Fossil Fuel Energy; NE=Nuclear Energy; RE= Renewable Energy

energy (0.722) will be higher than its correlation with the other constructs in the study. Additionally, the fifth column showed that nuclear energy (0.687) is higher than the other correlation value underneath it. As for renewal energy (0.715), it is higher than the other correlation values, thus indicating that the discriminant validity of the study was present.

Cross - Loading Analysis

The cross-loading was evaluated to determine whether the assertions of a construct were loading towards other constructs. It is crucial since it allows us to examine whether or not the remarks focused more on the intended statistic or another construct. The statements that are affected by cross-loading should

Table 4: Cross – Loading Analysis

Constructs	CC	CSS	ES	FFE	NE	RE
CC1	0.854	0.520	0.326	0.603	0.609	0.397
CC2	0.661	0.391	0.275	0.413	0.348	0.327
CC3	0.892	0.564	0.215	0.645	0.624	0.500
CC4	0.878	0.568	0.409	0.676	0.692	0.397
CC5	0.846	0.677	0.447	0.617	0.720	0.459
CSS1	0.337	0.519	0.413	0.379	0.423	0.208
CSS2	0.513	0.802	0.480	0.387	0.483	0.343
CSS3	0.452	0.747	0.303	0.418	0.465	0.270
CSS4	0.609	0.867	0.495	0.524	0.602	0.453
CSS5	0.575	0.820	0.586	0.493	0.549	0.414
ES1	0.091	-0.022	0.382	0.155	0.047	0.266
ES2	0.225	0.430	0.807	0.310	0.310	0.468
ES3	0.338	0.472	0.740	0.365	0.443	0.451
ES4	0.400	0.604	0.921	0.458	0.520	0.512
ES5	0.415	0.600	0.876	0.466	0.446	0.610
FFE1	0.428	0.425	0.216	0.730	0.364	0.261
FFE2	0.515	0.451	0.413	0.692	0.514	0.570
FFE3	0.379	0.392	0.321	0.516	0.331	0.095
FFE4	0.629	0.422	0.276	0.818	0.659	0.339
FFE5	0.603	0.417	0.468	0.813	0.504	0.541
NE1	0.206	0.062	0.239	0.196	0.366	0.091
NE2	0.157	0.157	0.267	0.364	0.399	0.148
NE3	0.602	0.491	0.323	0.487	0.751	0.270
NE4	0.592	0.616	0.490	0.517	0.872	0.377
NE5	0.713	0.639	0.388	0.644	0.863	0.507
RE1	0.221	0.265	0.419	0.207	0.260	0.659
RE2	0.381	0.390	0.435	0.401	0.390	0.835
RE3	0.061	0.066	0.298	0.224	0.049	0.418
RE4	0.457	0.347	0.478	0.497	0.412	0.760
RE5	0.499	0.431	0.543	0.464	0.383	0.819

* CC = Climate Change; CSS = Cost-Saving Sustainability; ES = Energy Security; FFE= Fossil Fuel Energy; NE=Nuclear Energy; RE= Renewable Energy

Table 5: VIF Values for the Structural Model

	CC	CSS	ES	FFE	NE	RE
CC	0.000	2.841	2.841	0.000	0.000	0.000
CSS	0.000	0.000	0.000	0.000	0.000	0.000
ES	0.000	0.000	0.000	0.000	0.000	0.000
FFE	2.050	2.428	2.428	0.000	0.000	0.000
NE	1.874	2.440	2.440	0.000	0.000	0.000
RE	1.422	1.456	1.456	0.000	0.000	0.000

be deleted in such a circumstance. Table 4 illustrates the evaluation of cross-loadings, commonly known as “item-level discriminant validity,” as a different method for proving discriminant validity. In other words, for example, the indicator (factor loading) of the fossil fuel energy construct must be higher than the other indicator in another construct, i.e., renewal energy and nuclear energy. It demonstrates that the data utilized was discriminately valid.

Structural Model Results

Collinearity Assessment

A strategy for identifying common method bias is offered based on variance inflation factors produced by a comprehensive collinearity test. According to Li *et al.* (2023), the occurrence of a variance inflation factors greater than 3.3 is proposed as an indication of pathological collinearity and also as an indication that a model may be contaminated

by common method bias. Table 5 shows that even with a model meeting the typical convergent and discriminant validity evaluation standards based on a confirmation factor analysis, the full collinearity test is useful in identifying common method bias. Following a thorough collinearity test, Table 5 displays the variance inflation factors produced for all of the latent variables. Therefore, all VIFs from a full collinearity test are equal to or less than 3.3. The model is deemed to be free of common method bias. It also reveals that the full collinearity test is effective in detecting common method bias with a model that, despite passing the usual convergent and discriminant validity evaluation standards based on a confirmation factor analysis, is nonetheless valid.

Path Coefficients

The use of bootstrapping was needed to test the path coefficient hypothesis. It made it easier to assess the statistical significance of the coefficients. Table 6 and Fig. 2 demonstrate how the structural equation model validates each of the hypotheses. On further assessment, the hypothesis was tested to ascertain the significance of the relationship. H1 evaluates whether there is a significant relationship between renewable energy and cost-saving sustainability in Sabah. The results revealed that renewable energy is insignificantly correlated with cost-saving sustainability in Sabah ($B = 0.107$, $t = 0.870$, $p 0.05$). Hence, H1 was not validated. Table 6 and Fig. 2 results indicated that

to have a statistically significant p-value less than the specified alpha of 0.05, the very minimum for the 2-tail test, the T-statistics value should be at least 1.96, which shows that most of the indicators in the latent variable have less than 1.96. The results are the least intriguing when it comes to statistical significance. The findings should specify the size of the effects of the treatment, not only whether or not they had any effect on the subjects (Clifford *et al.*, 2021). However, the p-value does not allow for or is not meant to allow the researcher to determine how strong the correlations between the variables are. It is a good use for effect-size measures. While the number of papers and statistical estimates of impact sizes determined using parametric tests is continuously rising, reporting effect sizes with non-parametric testing is still uncommon (Misra *et al.*, 2021). In null hypothesis testing, an effect size estimate is a measure that should be reported alongside the p-value. Poole *et al.*, (2022) define a Type I error as rejecting the null hypothesis (H_0) when it is true (also known as a “false positive” or “false alarm”). Researchers choose an adequately low alpha level in their analysis to minimize the possibility of discovering a difference that is not present in the data and to control for Type I errors. Contrarily, a Type II error (also known as a “false negative”) is when the null hypothesis (H_0) is not rejected even though it is wrong and ought to be. In this case, increasing the sample size is an efficient strategy to lower the likelihood of obtaining a Type II error.

Table 6: Path Coefficients

Hypothesis	Path Coefficients (β)	Sample mean (M)	Standard Deviation (STDEV)	T statistics (O/STDEV)	P Values
RE -> CSS	0.107	0.131	0.123	0.870	0.384
FFE -> CSS	0.078	0.085	0.130	0.603	0.546
NE -> CSS	0.344	0.334	0.145	2.377	0.018
RE -> ES	0.487	0.451	0.183	2.662	0.008
FFE -> ES	0.130	0.122	0.128	1.015	0.310
NE -> ES	0.306	0.335	0.177	1.725	0.085
RE -> CC	0.108	0.133	0.116	0.933	0.351
FFE -> CC	0.364	0.353	0.101	3.598	0.000
NE -> CC	0.446	0.435	0.104	4.287	0.000
CC -> CSS	0.302	0.292	0.139	2.163	0.031
CC -> ES	-0.155	0.130	0.161	0.965	0.335
RE -> CC -> CSS	0.033	0.035	0.037	0.895	0.371
FFE -> CC -> CSS	0.110	0.105	0.064	1.709	0.088
NE -> CC -> CSS	0.135	0.129	0.071	1.896	0.058
RE -> CC -> ES	-0.017	-0.011	0.029	0.578	0.563
FFE -> CC -> ES	-0.057	-0.047	0.061	0.928	0.354
NE -> CC -> ES	-0.069	-0.063	0.076	0.915	0.360

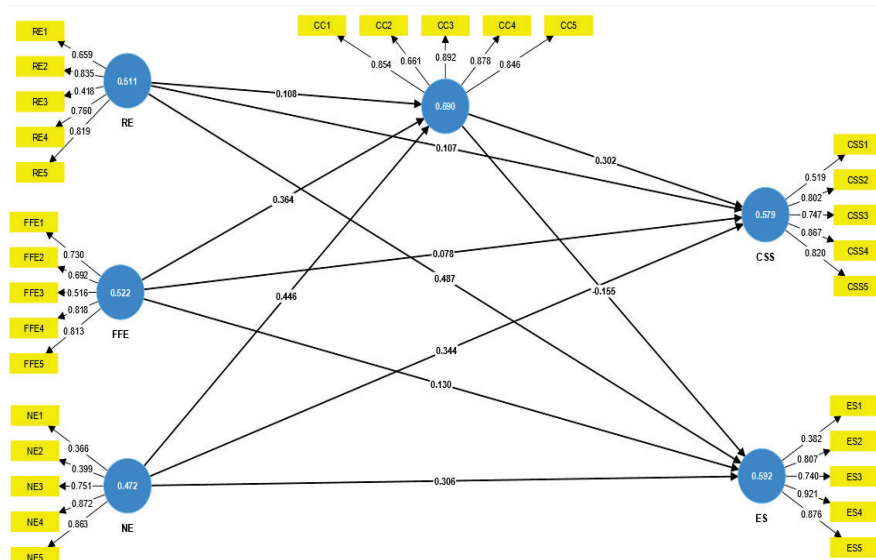


Fig. 2: The Structural Model – Path Coefficients

The findings are presented in Table 7, which demonstrates that the effect of mediation of climate change between energy resources (renewable energy, fossil fuels energy, nuclear energy) on the cost – saving sustainability (and energy security in Sabah, Malaysia). The result showed 40.0% choose to be neutral, while 32.5% and 7.5% strongly agree and agree respectively to pay for an additional utility cost and technology purchases. However, about 12.5% and 7.5% strongly disagree or disagree respectively on their readiness to pay more renewable energy sources of power. According to the research by Bai *et al.*, (2023); Azlina *et al.*, (2018), price and household income play a major role in determining willingness to pay. Demand for renewable energy is inversely correlated with bid price, but positively correlated with income. Asif *et al.* (2023) and Mustafa *et al.* (2023) customers' intention to adopt renewable energy is positively correlated with their level of technical awareness. The findings showed that people are more likely to convert to renewable energy sources when the benefit-cost ratio is higher. Renewable energy installations may demand greater financial outlays than the minimum. Economic incentives are recommended by van Beesten *et al.* (2023) and Gao *et al.* (2020); Bamwesigye (2023) to lessen the users' financial burden. Studies on the willingness to pay for renewable energy (RE) as an alternative energy source have revealed negative feedback from users in Australia, the United Kingdom, Greece, and China (Dalton *et al.* 2008; Faiers and Neame 2006; Zografakis *et al.*, 2010).

Nuclear energy (NE) relates to cost-saving sustainability. The information was sufficient to conclude that nuclear energy (NE) and cost-saving sustainability were positively influenced ($\beta = 0.344$, $p < 0.05$). The maximum beta values which indicate $\beta = 0.344$, which are acceptable and show a strong relationship between the latent variables. The information was sufficient to conclude that renewable energy (RE) and energy security were positively related ($\beta = 0.487$, $p < 0.05$). The findings are significant since they show that even the rise in the use of renewable energy (RE) has been much slower than expected because the new technology offers fewer comparative benefits than straightforward-to-use and manage energy alternatives. The highest Beta value, which is $\beta = 0.487$, indicates that the adoption of renewable energy grows at a pace of 48.7%. A strong correlation between the latent variables is this hypothesis indicated by the highest beta of 0.05 and 0.20. Therefore, the information was sufficient to conclude that fossil fuel energy and climate change were related ($\beta = 0.364$ $p < 0.05$). The strongest association between fossil fuel energy and climate change is the greatest Beta value ($\beta = 0.364$). A strong correlation between the latent variables is this hypothesis indicated by the highest beta of 0.05 and 0.20. There is a significant relationship between nuclear energy and climate change. The information was sufficient to conclude that nuclear energy and climate change were related ($\beta = 0.446$ $p < 0.05$). A Beta value $\beta = 0.446$, show a strong relationship between the latent variables.

The data, in particular, were sufficient to conclude that climate change and cost-saving sustainability were related ($\beta = 0.302$, $p < 0.05$). The highest beta value, $\beta = 0.302$, demonstrates that climate change

and cost-saving sustainability are significantly related to the protection motivation theory. This theory uses predictors, such as the costs and rewards associated with pro-environmental attitudes and behavior, to

Table 7: Summary of discussion findings

No.	Hypothesis Testing	T statistics ($ O/STDEV $)	P values	Decision
H1	There is a significant relationship between renewable energy (RE) relate to cost saving sustainability (CCS) in Sabah.	0.870	0.384	Not Supported
H2	There is a significant relationship between fossil fuel energy (FFE) relate to cost saving sustainability (CCS) in Sabah.	0.603	0.546	Not Supported
H3	There is a significant relationship between nuclear energy (NE) relate to cost saving sustainability (CCS) in Sabah.	2.377	0.018	Supported
H4	There is a significant relationship between renewable energy (RE) and energy security (ES) in Sabah.	2.662	0.008	Supported
H5	There is a significant relationship between fossil fuel energy (FFE) and energy security (ES) in Sabah.	1.015	0.310	Not Supported
H6	There is a significant relationship between nuclear energy (NE) and energy security (ES) in Sabah.	1.725	0.085	Not Supported
H7	There is a significant relationship between renewable energy (RE) and climate change (CC) in Sabah.	0.933	0.351	Not Supported
H8	There is a significant relationship between fossil fuel energy (FFE) and climate change (CC) in Sabah.	3.598	0.000	Supported
H9	There is a significant relationship between nuclear energy (NE) and climate change (CC) in Sabah.	4.287	0.000	Supported
H10	There is a significant relationship between climate change (CC) and cost saving sustainability (CSS) in Sabah.	2.163	0.031	Supported
H11	There is a significant relationship between climate change (CC) and energy security (ES) in Sabah.	0.965	0.335	Not Supported
H12	There is a significant relationship between renewable energy (RE) relates to climate change (CC) towards cost saving sustainability (CSS) in Sabah.	0.895	0.371	Not Supported
H13	There is a significant relationship between fossil fuel energy (FFE) relate to climate change (CC) towards cost saving sustainability (CSS) in Sabah.	1.709	0.088	Not Supported
H14	There is a significant relationship between nuclear energy (NE) relates to climate change (CC) towards cost saving sustainability (CSS) in Sabah.	1.896	0.058	Not Supported
H15	There is a significant relationship between renewable energy (RE) relate to climate change (CC) towards energy security (ES) in Sabah.	0.578	0.563	Not Supported
H16	There is a significant relationship between fossil fuel energy (FFE) relate to climate change (CC) towards energy security (ES) in Sabah?	0.928	0.354	Not Supported
H17	There is a significant relationship between nuclear energy (NE) relate to climate change (CC) towards energy security (ES) in Sabah?	0.915	0.360	Not Supported

explain pro-environmental decisions. It shows that Mahmood, (2020) claim that nuclear energy (NE) usage has surged by more than 40%, producing 12% of global power and meeting 5% of primary energy demands in 2018. According to research done in Malaysia by Dahlan *et al.*, (2014), generation mixes include nuclear power plants improve system dependability, produce less CO₂, and have lower operating and investment costs. An empirical study by Ozcan and Ulucak, (2021) showed that more nuclear energy generation in the Indian energy system would be helpful for mitigating climate change because it immediately reduces environmental pollutants. However, most studies of the diffusion of renewable energy adopt a top-down strategy, concentrating solely on the policymakers and omitting the opinions of the general public (Çelikler, 2013; Moula *et al.*, 2013; Karatepe *et al.*, 2012). In Malaysia, air pollution has grown to be a significant environmental issue. In this nation, air pollution is brought on by the burning of coal, lignite, petroleum, natural gas, wood, and animal and agricultural waste. The substantial increase in primary energy use since the 1990s has increased CO₂ emissions. Furthermore, the research suggests that environmental degradation occurs before economic growth.

H3: There is a significant relationship between nuclear energy relate to cost saving sustainability in Sabah.

H4: There is a significant relationship between renewable energy and energy security in Sabah.

H8: There is a significant relationship between fossil fuel energy and climate change in Sabah.

H9: There is a significant relationship between nuclear energy and climate change in Sabah.

H10: There is a significant relationship between climate change and cost saving sustainability in Sabah.

The data was insufficient to conclude that renewable energy and cost-saving sustainability were not related ($\beta = 0.107$, $p > 0.05$). The results revealed no relationship between renewable energy relates to cost-saving sustainability. The standardized coefficient shows how significant or insignificant the independent variables are in clarifying the correlation between renewable energy and cost-saving sustainability. A lesser beta of 0.05 and 0.20 indicates a weaker connection between the latent variables. The lowest Beta value, which is $\beta = 0.107$, indicates that renewable energy is an insignificant factor in cost-saving sustainability. The lesser the value of a technology is to consumers, the lower its adoption rate and the higher its cost. The lack of perceived value addition among customers is impeding the adoption of small-scale renewable energy. Therefore, the hypothesis H1 is not accepted. The information concluded that

fossil fuel energy and cost-saving sustainability were insignificantly related ($\beta = 0.078$, $p > 0.05$). The findings showed that the energy from fossil fuels has no bearing on cost-saving sustainability. When examining the relationship between fossil fuel energy and economically viable sustainability, the Beta's (standardized coefficient) demonstrate that the independent variables are less significant or insignificant than the others. The use of fossil fuels may be less influenced by cost-saving measures. The lowest Beta value, which is $\beta = 0.078$, indicates that fossil fuel energy is an insignificant factor in cost-saving sustainability. Therefore, the H2 is not accepted. There is an insignificant relationship between fossil fuel energy and energy security ($\beta = 0.130$, $p > 0.05$). The results demonstrated that energy security is unaffected by fossil fuel energy. A lesser beta of 0.05 and 0.20 indicates a weaker connection between the latent variables. The lowest Beta value, which is $\beta = 0.130$, indicates that the fossil fuels grow lower at a pace of 13.0%. In this instance, this relationship related to the environment has undergone a dramatic transition, and the scarcity of fossil fuels is no longer the concern claimed by Blondeel, Bradshaw, Bridge, and Kuzemko (2021). The H5 is not accepted. Nuclear energy and energy security has a negligible relationship. ($\beta = 0.306$, $p > 0.05$). Nuclear energy does not affect energy security (ES), according to the findings. Despite having a strong Beta value of $\beta = 0.306$, the p-value score needed to be accepted in the hypothesis analysis, and there is sufficient to infer that nuclear energy (NE) and energy security (ES) are not associated. This relationship related to the energy environment and nuclear energy (NE) has negative consequences on people, animals, the environment, and ecological systems (Liang, 2021). The H6 is not accepted.

H1: There is an insignificant relationship between renewable energy relate to cost saving sustainability in Sabah.

H2: There is an insignificant relationship between fossil fuel energy relate to cost saving sustainability in Sabah.

H5: There is an insignificant relationship between fossil fuel energy and energy security in Sabah.

H6: There is an insignificant relationship between nuclear energy and energy security in Sabah.

CONCLUSION

The energy industry will also be able to fully capitalize on possibilities brought about by the energy transition attributable to the DTN's driven Low Carbon Nation Aspiration. The energy industry will need to align with domestic developments and be well-positioned to support the Wawasan Kemakmuran Bersama 2030 (WKB 2030) and Twelfth Malaysia Plan, 2021–2025.

Energy transition describes a fundamental change in energy systems in favor of greener energy sources. This transition entails a change from a consumption pattern dominated by fossil fuels with high carbon emission intensity to one with a higher rate of renewable energy utilization and lower carbon emission intensity. Rapid technology advancement and aggressive climate change legislation are projected to accelerate the present energy transition. To ensure that all Malaysians have a decent standard of living through development for all, address wealth and income disparities, and create a united, prosperous, and dignified Malaysia, WKB 2030 serves as the primary reference point for the country's progressive national socioeconomic goals development and growth priorities. The energy sector is impacted by five Key Economic Growth Activities (KEGAs), including the green economy, renewable energy (RE), and sustainable mobility. Improving the resilience of the nation's fiscal and economic situation by fostering new energy-related industries would also help achieve the goal of decreasing reliance on petroleum-based revenue and commodity trade. By utilizing the nation's abundant energy resource resources, equitable regional development will be supported by prioritizing the distribution of energy-related costs and benefits across income groups, ethnicities, regions, and supply chains. The "Dasar Tenaga Negara" (DTN) includes oil, natural gas, coal, hydropower, solar, photovoltaic, bioenergy, and other cutting-edge energy sources within its wide range of non-renewable and renewable energy sources. The final use of energy in every sphere of the economy, including transportation, industry, housing, and commerce, is likewise covered by "Dasar Tenaga Negara" (DTN). The country will reap significant benefits from the prompt and efficient execution of the "Dasar Tenaga Negara" (DTN) programs. This includes improve social outcomes for Malaysians by fostering balanced regional development and securing future-proof jobs for workers. Protecting low-income households' access to affordable energy and advancing rural electrification will be priorities. Greater domestic energy independence and fuel diversification will promote a more robust energy industry and enable improved control over energy as a major strategic resource for the nation. Energy affordability has advantages such as improved energy access and reliability. In terms of the energy sector's environmental sustainability, significant gains are expected in the future. These advantages will be distributed equally to all parties involved, including the rakyat, industry, and government. The "Dasar

Tenaga Negara" (DTN) includes oil, natural gas, coal, hydropower, solar, photovoltaic, bioenergy, and other cutting-edge energy sources within its wide range of non-renewable and renewable energy sources. The final use of energy in every sphere of the economy, including transportation, industry, housing, and commerce, is likewise covered by "Dasar Tenaga Negara" (DTN). The country will reap significant benefits from the prompt and efficient execution of the "Dasar Tenaga Negara" (DTN) programs. This includes improve social outcomes for Malaysians by fostering balanced regional development and securing future-proof jobs for workers. Protecting low-income households' access to affordable energy and advancing rural electrification will be priorities. Greater domestic energy independence and fuel diversification will promote a more robust energy industry and enable improved control over energy as a major strategic resource for the nation. Energy affordability has advantages such as improved energy access and reliability. In terms of the energy sector's environmental sustainability, significant gains are expected in the future. These advantages will be distributed equally to all parties involved, including the rakyat, industry, and government.

AUTHOR CONTRIBUTIONS

J.S. Dionysius performed the literature review, experimental design, analyzed and interpreted the data, H.L. Vasudevan prepared the manuscript text, and manuscript edition. J.S. Dionysius and H.L. Vasudevan performed the experiments and literature review, compiled the data and manuscript preparation. J.S. Dionysius performed in the data analysis and findings while H.L. Vasudevan compiled the data analysis and findings for the manuscript edition.

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CONFLICT OF INTEREST

The authors declare that no potential conflicts of interest in publishing this work. Furthermore, the authors have witnessed ethical issues such as plagiarism, informed consent, misconduct, data fabrication, double publication or submission, and redundancy.

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ABBREVIATIONS

$\bar{Y}\bar{Y}$	Average of observed data
R^2_{adj}	Adjusted coefficient of determination
$\bar{Y}\bar{Y}$	Average of observed data
AVE	Average variance extracted
R^2R^2	Coefficient of determination
CC	Climate Change
CSS	Cost-saving Sustainability
DTN	Dasar Tenaga Negara
FFE	Fossil Fuel Energy
HP	Hypothesis
KEGA	Key Economic Growth Activities
α	Level of significance
NE	Nuclear Energy
<i>p-value</i>	Probability value
<i>r</i>	Pearson correlation coefficient
<i>R-value</i>	Pearson correlation coefficient
RE	Renewal Energy
SSE	Sum of Squared Errors
WKB	Wawasan Kemakmuran Bersama

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ORIGINAL RESEARCH PAPER

Identifying the antecedents and consequences of phubbing

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ABSTRACT

BACKGROUND AND OBJECTIVES: The influence of smartphones in face-to-face interactions has presently affected the methods of human interaction in various social environments and has led to the emerging phenomenon of phubbing. Phubbing has been the focus of researchers as the employee's perception that his/her supervisor is distracted by their smartphone while talking or being in close proximity to each other in the work environment. Therefore, it can be stated that phubbing is negatively related to subordinates' trust in their supervisor. So the present study aimed to identify the antecedents and consequences of phubbing in Yazd municipality.

METHODS: The present study was applied in terms of purpose and qualitative in terms of research methodology and based on the grounded theory approach. We decided to apply this method because the core objective is to choose the individuals who are acquainted with such phenomena. Consequently, it will be easier to comprehend the topic so that the samples can provide appropriate answers accordingly. In the present study, for performing data collection, semi-structured in-depth interviews with the 5w1h technique were conducted with 12 people, including managers and employees who respond to citizens' requests in the central building of Yazd Municipality. The researched community consists of The Experts selected were those who had relevant articles, at least three years of beneficial work experience in Yazd Municipality, and relevant knowledge of phubbing. Targeted sampling has been done based on the researcher's considerations. The present study was performed March 2023.

FINDINGS: The findings show that there are many empirical factors influencing phubbing in organizations, so that the role of employees and their functional duties are considered a very influential factor for phubbing in organizations. Employees should be able to have a detailed understanding of their needs and their behavior in the organization in interactions so that they can convey the best experience to them in order to influence their behavior. If the set of municipality facilities can perform their duties well, a positive experience can be created in the employee's mind. Therefore, human resources, physical space and functional aspect will provide a very effective role in creating a positive experience and provide a suitable mental background for employee preferences. In the present study, data analysis was performed using Maxqda software version 20 in three stages of primary, central, and selective coding, which resulted in the identification of 6 categories, 21 central concepts, and 123 final codes. Therefore, technological factors, social factors, personal/individual factors, cultural factors, and psychological factors were identified in this research.

CONCLUSION: The results of the data analysis indicated that there were many experimental factors influencing phubbing in organizations so the role of employees and their functional responsibility were considered to be a highly influential factor for phubbing in the municipality. The interviewees believed that employees must quickly feel secure and comfortable after becoming a member of the organization and they must adapt themselves to the norms of the environment. Therefore, considering that fobbing has attracted the attention of many researchers, as far as the authors are aware, its antecedents and consequences have not been identified, from this point of view, the research has innovation.

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INTRODUCTION

During the past century, human life has been transformed by modern technology (Sarmurzina et al., 2023; Moghadam and Samimi, 2022; Ehzari et al., 2022). While modern technology has become more accessible, reliable, and affordable, the way of living has gradually been shaped and transformed by technology in our society (Armstrong and Taylor, 2023; Parsafar et al., 2023; Mambwe et al., 2021). People do not experience a sudden change, but they feel that it has made their life better, easier, and faster. Communication has consistently had a critical role in human history (Briggs et al., 2023). Moreover, information and communication technology has substantially affected individuals' daily lives and disturbed the way they interact in general (Tajpour et al., 2023). Before the 1870s, people communicated with their peers distantly through correspondence or virtual networks (Wenzlhuemer, 2007). However, the limitation of these communication methods enabled the sender to send only one message only once and in one direction (Salamzadeh et al., 2023). The same as telegram, the telephone was also invented to help people communicate over long physical distances and provided further progress for instant two-way communication (Coe, 1995). The telephone invention minimized geographical location obstacles and enabled users to communicate in real-time with people in distant locations, which was considered an advantage over the telegram. The influence of the telephone was crucial in shaping human beings' behavior. In the first days of mobile phones, people learned how to communicate by setting specific times to talk (Şenbil, 2009).

Communication has had a vital function in human history (Lee and Dong, 2023). Smartphones are broadly used all over the world for various purposes, including calling, texting, using an application (software), checking the news, visiting social networks, sending emails, listening to music, watching TV, or playing games (Busch and McCarthy, 2021). Phubbing is a colloquial term that refers to the use of mobile phones during simultaneous interactions (Roberts and David, 2017, 2020). It is derived from the words "phone" and "snubbing"; it can also be defined as "the act of looking at your phone in a social environment instead of paying attention to others" (Ugur and Koc, 2015, p. 1023). Phubbing negatively affects an extended range of relational consequences in interpersonal relationships,

including formation, perception, interaction quality, and relationship quality (Krasnova et al., 2016). Various studies have investigated the effects of phubbing on friendship and romantic relationships (Balta et al., 2018). For example, Roberts and David (2016) found that phubbing indirectly affects depression in personal situations. Moreover, Wang et al. (2017) found that partner phubbing was negatively related to relationship satisfaction. Therefore, this low satisfaction with the relationship led to more sense of depression. Recently, Abeele et al. (2019) found that using a mobile phone has a negative relationship with intimacy in conversation. Finally, Çikrikci et al. (2019) found that communication disorder as a dimension of phubbing leads to less satisfaction with life. Contrary to the growing number of studies in the field of (private) relationships, only a few studies have examined the effect of phubbing on relationships in the workplace (Al-Saggaf and O'Donnell, 2019). The findings of a seminal study by Cameron and Webster (2011) on multiple communication in the workplace indicated that employees experience more distrust and assume workmates as more uncivil when these employees are simultaneously involved in several interactions in the workplace. Since phubbing is known as a specific behavior in communicating with another individual, the relevant preliminary study has shown the possible adverse effect of supervisor phubbing during face-to-face meetings in a personal conversation (Yasin et al., 2023). Recently, Roberts and David (2017, 2020) realized that employees' perceptions of supervisor phubbing negatively anticipated their perceptions of supervisor trustworthiness. Organizations are social systems that aim to meet social and individual needs and they require efficient members to survive (Hosseini et al., 2020). One of the important responsibilities of organizational managers is to increase the job performance of their human resources (Tajpour et al., 2023). Employees' inadequate perceived trust in the supervisor was followed by a lower sense of psychological meaningfulness and engagement in the organization (Rajabipoormeybodi et al., 2019). Preliminary studies show that phubbing can be equally harmful in an organizational context and a private (social) context; therefore, it may lead to adverse organizational outcomes (Khan, 2022). Few available studies suggest that workplace phubbing is an urgent issue because its outcomes for organizations can be profound (Yousaf et al., 2022). The use of social

networks has become increasingly common among youngsters. For example, the use of Instagram has been increasingly associated with addiction to smart phones, confirming that smartphone addiction is associated with various physical problems and psychosocial disorders (Romero- Rodríguez *et al.*, 2020). Studies, including Hinojo-Lucena *et al.* (2020), determine factors that prove the existence of a relationship between excessive use of Instagram and smartphone addiction. Shellenbarger (2013) states that frequent use of smartphones in front of others can reduce the extent of eye contact between the parties engaged. Lack of eye contact will reduce the sense of emotional communication. Furthermore, several studies have shown that using a smartphone when interacting with others is considered “impolite and socially inappropriate” (Abeele *et al.*, 2016). It is consistent with Cameron and Webster’s (2011) study, arguing that employees who are subject to phubbing report that it reduces their trust in the focal person. Phubbing damages the ability to talk face-to-face and create face-to-face relationships with others, and its consequences break and destroy these social relationships (Xu *et al.*, 2022). Therefore, paying too much attention to others’ phones may make you feel rejected and deprived of meeting with Farad. This can have a significant impact on a person’s mental health (Tanhan *et al.*, 2023). Research also shows that people who suffer from phabbing tend to have their phone always available to connect with social media networks, thereby filling the void of face-to-face communication. This is the beginning of a vicious cycle (Chi *et al.*, 2022). Also, the covid-19 pandemic caused people’s social relations to decrease drastically, and digital tools fill part of this communication gap (Yang *et al.*, 2023). These days, the phenomenon of fabbing is common in families, and in the meantime, Corona, along with many other factors, led to the spread of fabbing in the society, and it seems that we will be facing this phenomenon for a long time after the post-corona era. In other words, the expansion of technology has led to the extent of communication with a shallow depth, which has brought many positive consequences such as increasing knowledge and public awareness, but in addition to the positive consequences, the extent of communication with a shallow depth has brought negative consequences, including the disruption of social relations. Since the municipality and its subordinate organizations include institutions with

many connections with citizens, it is an essential issue in the technology era due to the high speed of facilitation. On the other hand, municipal activities are also facing communication technology more than ever. As a result, it is imperative to investigate the issue of phubbing in Yazd Municipality due to the increase in the use of communication instruments, especially smartphones. Although establishing multiple communications in the presence of another may not influence perceived professionalism, it has a negative effect on individuals’ emotional relationships (Kameron and Webster, 2011). Similarly, phubbing can potentially limit proper supervisor-employee interactions and is presumably associated with lower levels of employee trust in their supervisors. In the spring of 2012, Macquarie Australia’s dictionary and McCann’s advertising agency gathered a group of language experts to name a common phenomenon in the smartphone age (Al-Saggaf, 2022). They called this phenomenon Phubbing, and it is the act of ignoring someone who is talking to you by looking at your cell phone, or the act of interrupting personal relationships in a social setting by looking at your phone instead of paying attention to someone else. Defined (Sun and Samp, 2022). Therefore, studies show that this term has recently attracted the attention of researchers. According to existing standards, 75% of the value of communication is listening and paying attention, but due to this disorder, real dialogues have been overshadowed. To the extent that people use their mobile phones excessively while walking, driving, even people in sensitive jobs. Phubbing has its roots in internet addiction (Yasin *et al.*, 2023). People who suffer from this disorder have a mobile phone as an identity for them and they sneak into their mobile phone at least 4 times a day. Apart from mental and psychological issues, neck pain, wrist pain, distraction, self-negation are other complications of technological progress and, as a result, virtual space in human society. Therefore, it seems necessary to examine the antecedents and consequences of phubbing in organizations. Accordingly, the purpose of the present study is to identify the antecedents and consequences of phubbing in Yazd municipality. This research can add to the mainstream literature in the following ways: 1) It extends the phubbing literature and relates it to organizational inefficiency. It also emphasizes that managers should pay more attention to phubbing, and 2) identifies the indicators and components of

phubbing in the organization. In the continuation of this research, literature review and research methods are discussed. Also, the research findings are considered. Finally, the findings are discussed and the research results are stated.

Literature review

Phubbing

Technology development has established the new phenomenon of phubbing behavior due to the constant use of smartphones (Liu *et al.*, 2022). Frequent use of smartphones can influence permanent social interactions (Putrinada, 2023). Phubbing can be described as someone looking at their mobile phone while talking to others, fiddling with their mobile phone, and avoiding interpersonal interaction. Phubbing is an act in that a person in the middle of a social interaction suddenly turns his eyes downward and disappears into the smartphone (Aagaard, 2020). The researchers assert that compulsive technology-related uses and “compulsive purchase” have become significant social issues for marketers and social policymakers. However, studies show that addictive smartphone behaviors are firmly related to other behavioral disorders (Brigham *et al.*, 2023). Researchers suggest that smartphones also arouse compulsive technology-related behaviors (Hsiao, 2017). Compulsion can be described as the consumers’ tendency to download the program non-reflectively, immediately, and kinetically. This type of behavior can respond to the inability of people to control the desire created by the symptoms of smartphone addiction. It may be because of smartphone addiction, and it involves a challenge for businesses that develop apps. Thus, the individual is possibly inclined to show that he is socially responsible (Garrido *et al.*, 2021).

Phubbing a social exclusion law

Nowadays, phubbing is widespread in societies, mutually enhanced, and socially accepted so that it can be considered in many social situations (e.g., when eating with someone, while taking a break, having a drink or coffee with colleagues, in family interactions) (Pancani *et al.*, 2021). Phobers (i.e., those who ignore face-to-face interaction) seem to experience higher levels of technology-related addictions (e.g., cell phone addiction, social media addiction, Internet addiction, mobile game addiction), psychological disorders (for example, cell phone addiction), depression, social interaction anxiety, social withdrawal, and

nomophobia (Rahman *et al.*, 2022). Phubbing appears in non-judgmental behaviors, including sudden and mostly uncertain interruptions in progressing conversations along with averted looks and body posture. Such verbal and non-verbal traits develop moments of interpersonal indifference and may be considered periodic stages by interaction partners (Williams, 2009). Williams’ model assumes that the experience of social rejection leads to immediate emotional harm and threats to basic human needs in three consecutive stages: reflective stage of delayed mutual strategies, reflective stage, and long-term consequences on individual health (resignation stage). The present study was conducted with the purpose of examining the reflective effects of phubbing in third parties. The reflective stage of social rejection is determined by immediate negative mood, stress or anger, and a threat to human needs for belonging, self-esteem phubbing, control, and meaningful existence. Based on this model, emotional consequences are universal. In other words, despite individual differences (e.g., gender; Blackhart *et al.*, 2007) or contextual changes (e.g., fundamental motivations for rejection; Zadro *et al.* (2004), social rejection leads to immediate negative mood. In the reflective stage, targets use various mutual strategies to overcome the negative consequences of social rejection (Williams, 2009). Targets may also reveal aggressive or embarrassing behaviors to re-establish a sense of control over the situation. Findings revealed that this phenomenon leads to negative mood and dissatisfaction with the four needs. Therefore, it confirms the proposed general assumption about the reflective stage. On the contrary, according to the time-demand-threat model, the reflective effects of phubbing have not been studied. Also, findings from other studies on phobias are in line with the hypothesized processes of this stage. For example, the experience of phubbing seems to result in increased online interaction, which can be considered an attempt to regain social inclusion. David and Roberts (2017) stated that the experience of phubbing led to more use of social media. Studies have also shown embarrassing behaviors relevant to one’s partner, which may lead to a mutual strategy to regain control. Abeele *et al.* (2016) found that participants paid less attention to their peers compared to the time when they used their smartphones during the interaction. Therefore, recent studies that directly apply the time-demand-threat model to phubbing, support the

occurrence of reflective effects. Thus, more activities are required to replicate the findings relevant to the reflective effects of phubbing and extend the model testing to such effects and resignation. Moreover, undesirable affective reactions to observed events of social rejection seem to reach a similar magnitude as reported by immediate targets of rejection. They also showed that social deprivation is created by the need for belonging, self-esteem phubbing, control, and meaningful existence in observers. The occurrence of such reflective effects in the third person shows that humans are sensitive to the violation of norms relevant to social inclusion in their environment. Furthermore, they have presented calm behaviors toward targets as a demonstration of interpersonal empathy and concern. However, observers may also reduce rejected individuals due to potentially biased thoughts about the target's responsibility for rejection (Park and Park, 2014). Besides, there are still no studies on the effects of phubbing on observers. Since phubbing is a type of social rejection caused by the use of smartphones, one might expect to observe similar reflective effects in the studies of rejection that are unrelated to smartphone use. Studies investigating gender differences in smartphone use suggest that (observed) phubbing may affect women and men in totally different ways. Research has shown that women are more sensitive compared to men to signs of social rejection and apply reflective mutual strategies easier than men when faced with potential threats of rejection (Thabassum, 2021). Despite the assumption of universality expressed in the time threat mode, some studies have found gender differences in the reflective stage. Studies regarding the use of smartphones have shown that women are more prone to problematic use of smartphones compared to men (Busch and McCarthy, 2021). Moreover, women tend to stay tuned with their mobile devices based on relational motives, including communication and relationship maintenance; nevertheless, men use their smartphones more for information storage and entertainment. Considering that phubbing has attracted the attention of many researchers, as far as the authors are aware, its antecedents and consequences have not been identified. Therefore, the purpose of this research is to identify the antecedents and consequences of phubbing among employees of Yazd Municipality. The current study has been carried out in Yazd- Iran in 2023.

MATERIALS AND METHODS

Survey design and data collection

The present study is applied in terms of purpose and qualitative in terms of data collection. In this type of research plan, gain a real insight regarding the issues and the nature of the topic. This may refer to some authentic experiences pertinent to the issues under examination that are particularly helpful while describing hidden and unanticipated subjects. It can also be influential for specific research (Palalic, 2017). Besides, we decided to apply this method because the core objective is to choose the individuals who are acquainted with such phenomena. Consequently, it will be easier to comprehend the topic so that the samples can provide appropriate answers accordingly (Nikraftar et al., 2022). It is also recommended because of the objective of the study and the internal judgment. Unlike quantitative studies, qualitative research is less likely to provide arranged procedures, particularly in terms of sampling (Palalic, 2017). Therefore, according to the nature of the research question, the researcher has solved the problem using the interpretive paradigm and inductive logic. Hence, researchers are trying to find an answer to the question, what are the antecedents and consequences of phubbing in Yazd municipality? In the first part of the present study, literature related to the concepts of antecedents and consequences of phubbing was extracted from library sources, and the selection criterion includes having the word phubbing and its derivatives. The second part included interviews with 12 people, consisting of managers and employees responding to citizenship requests in the central building of Yazd Municipality, which was performed in March 2023. The selection criterion of the experts was to have relevant articles, at least three years of related working experience in Yazd municipality, and knowledge of phubbing. Sampling was conducted purposefully and continued until the researcher reached the theoretical saturation. In the present study, the interviews were carried out through in-depth semi-structured interviews, and the 5w1h technique was applied to answer questions such as: how, why, what, where, who, and when (Hosseini et al., 2021). The extracted codes reached saturation after the 12th interview. The number of samples was adequate for the interview section. Data analysis was performed through the three stages of primary, central, and selective coding. In the present study, coding was performed using Maxqda 20. The following measures

have been conducted in the present study to examine the validity of the research instruments:

Adaptation by the participants: The participants evaluated central and selective coding stages and provided their opinions.

Colleagues' review

The relevant professors reviewed the findings and provided their comments on the central and selective coding stage.

A collaborative study

Simultaneously, the participants were engaged in analyzing and interpreting the data.

The reliability of the study has been conducted as stages up to 12 samples reached the theoretical saturation. According to the agreement between the two coders, the reliability coefficient was 70%. The strategy of the present study is to propose a proper solution for the data theory problem of the Strauss and Corbin Foundation, in which the researcher follows a process theory and explains the actions and interactions that happen over time. According to the systematic approach proposed in the data theory of the Glaser et al. (2013) Foundation, the researcher carries out the coding process up to the selective coding stage and develops a theory during the data collection process.

An explanation of the antecedents and consequences of phubbing in Yazd municipality

There are three approaches for identifying the antecedents and consequences of phubbing in Yazd municipality: adaptation, adaptation-design, and design. The design approach has been used in this study. The process of designing and identifying the antecedents and consequences of phubbing and their validation has completed the following stages:

Preliminary plan

In this step, decisions will be made on the philosophical foundations, values and ruling paradigm, organizational aims and strategies, the definition of phubbing, approaches, applications, and components of the model, as well as identifying the antecedents and consequences of phubbing and the favored criteria for their extraction, processes, and methods of carrying out work and sample members.

Planning the initial list of identifying the antecedents and consequences of phubbing through individual interviews

At this stage, the researcher seeks to identify the antecedents and consequences of phubbing in Yazd municipality through individual interviews. The number one draft of the initial code list of phubbing antecedents and consequences was compiled after analyzing and performing interviews with the group of experts, applying the content analysis method to identify the antecedents and consequences of phubbing. After conducting twelve interviews, the researcher has reached the point of theoretical saturation; therefore, he can claim that the participants of the present study have demographic characteristics, such as gender, age, education, etc. Given the demographic information, it was found that 10% of the participants were women and 90% were men in terms of gender, and in terms of education, 4% had a Ph.D. degree, 24% had a master's, and 72% of the participants had a bachelor's degree. Interviews were performed by asking six questions about "Antecedents and Consequences of phubbing" (open interview); then, the three stages of primary, central, and selective coding were also employed. The interview questions include: What is the definition of phubbing in your opinion? What factors lead to phubbing? What are the causes of phubbing? What were the involving factors in the occurrence of phubbing? What are the consequences of phubbing? What are the Context Conditions of phubbing in your opinion, explain in details? Twelve participants were interviewed in this section using a theoretical interview with the purpose of identifying the antecedents and consequences of phubbing. Before the qualitative analysis, it is essential to present these data so that the analysis can be performed easily. Accordingly, in the present study, interviews have been analyzed in tabular format. The general concept of the interviews was extracted after listening to the interview text and verifying the notes. The sample of spoken evidence, leading to the primary codes, is listed in Table 1. The oral sample from which the primary codes were extracted is listed in Table 1. Then, each person was assigned codes M1 to M12. After studying and editing, all concepts were adjusted to 21 components and 121 codes (List No. 1). Subsequently, the extracted phrase was briefed and simplified; then, the duplicated sentences were eliminated. Therefore, six categories, 21 concepts, and

Table 1: Oral samples from interviews for the primary coding

Row	Oral samples	Primary codes
1	Addictive behavior including gambling, or those who are addicted to playing internet games, or those who are addicted to the internet, can be taken into consideration, so we must investigate whether people experience withdrawal symptoms when they do not suffer phubbing, apart from the consumption of a type of substance, addiction may establish dependence on objects or daily activities.	Addictive behavior dependence on objects or daily activities
2	Some other disorders such as anxiety disorders can have a function in the occurrence of phubbing, because many people who may have social phobia or the fear of speaking or being in public may have phubbing. It is possible that a person in the workplace has phubbing because of the fear of speaking in public or because of social anxiety and is unable to develop proper social relationships with others.	Anxiety disorders Fear of being in public at the workplace No social communication with others

123 final selection codes were achieved. Eventually, the components were categorized using Maxqda software 20, which is displayed in Table 2.

A Comparison of the obtained list with the list of Antecedents and Consequences of phubbing

There was no list or template to simultaneously examine the antecedents and consequences of phubbing at this stage. Accordingly, the initial codes related to the antecedents and consequences of phubbing, which were provided in the previous stage, were compared with the findings of previous studies. Thus, new components were identified and added to the initial list of antecedents and consequences of phubbing. Similar to the process conducted in the interview section, the codes were extracted by analyzing the sources line by line. As a result of the content analysis, list number 2, including extracted codes, was prepared.

Presenting a definition of the concepts of Antecedents and Consequences of phubbing and preparing list number 3

At this stage, the researcher examined the combination of the antecedents and consequences about phubbing from the list number one and two. Then, draft No. 3 of the list of antecedents and consequences of phubbing was developed by integrating findings from interviews and other sources. The identified codes were categorized based on conceptual closeness in the form of the concepts of antecedents and consequences of phubbing.

Evaluation and edition of the list of antecedents and consequences of phubbing by a group of experts

An attempt was made in the interviews to achieve

the information required by the people using a narrative method. A focus group was created, and relevant people were identified in the section on extracting the categories of antecedents and consequences of phubbing after a complete explanation of the problem and research objectives. Then, the experts were provided with the initial categories and the respective influential factors. Consequently, their views regarding increasing or decreasing these categories were registered. Finally, the model of antecedents and consequences of phubbing was presented in Yazd Municipality. Yazd is the capital of Yazd province and one of the metropolises of Iran. Yazd is known as the first raw clay city in the world and it is registered as the first historical city of Iran and the 22nd historical monument of Iran in the UNESCO World Heritage List. The city of Yazd is considered one of the medical and cultural hubs of Iran. Considering that service organizations, including municipalities, are institutions that have a lot of contact with citizens and their activities directly affect city residents, in the age of technology the speed and thus the frequency of meetings and facilitation of communication increase, is one of its characteristics. Also, on the other hand, considering the temptation of entering the age of technology and using electronic services to facilitate the lives of citizens, the activities of organizations are facing communication technology more than ever. Therefore, investigating the issue of phubbing in organizations is important due to the increasing use of communication tools, especially smartphones.

RESULTS AND DISCUSSION

The research method of the grounded theory is qualitative, and it uses a series of systematic procedures

Consequences of Phubbing

Table 2: Axial coding results

Consequences		
Component	The axial concept	Selected codes
Results and Consequences	Lack of Responsibility and Love for Work	Lack of responsibility, lack of regular competition, lack of trustworthiness, change in work style, increase in mental and emotional stress and tension, decrease in happiness as the correction of beliefs are not corrected and not rationalized.
	Lack of Consistency	Failure to enhance collaboration and self-compatibility, lack of sense of mutual responsibility, change in people's personality, reduction of participation, reduction of trust.
	Sense of Indifference Toward Organization	Isolation, lack of care for opinions, not accepting new ideas, not having important opportunities, not paying attention to new views.
Strategies		
Component	The axial concept	Selected codes
Technological Factors	Addiction to cyberspace	Addiction to mobile phones, addiction to checking text messages, addiction to checking cyberspace, no concentration in public interactions, dependence on virtual space, Internet coercion, Internet bullying.
	Being modernized	Aware of opportunities, risk-taking, creative, enthusiastic about change, development of communication infrastructure, emphasizing technology instruments, improving things, applying new methods of obtaining information, being modernized.
	Network infrastructure and information technology	Media knowledge, educational information.
An axial phenomenon		
Component	The axial concept	Selected codes
Social Factors	Isolation	Social phobia, fear of speaking, fear of being in the community, social isolation, loneliness, ignorance, sense of rejection, sense of neglect, social fear, silence, social isolation, shame and embarrassment
	No Social Acceptance	Social anxiety, being deprived of speaking, lack of development of social relationships, lack of constructive interaction, inability in friendship and intimacy
	No Communication	Lack of social communication skills, lack of communication skills, lack of speaking skills, lack of understanding and empathy, inappropriate mental perceptions of society, weak social relationships, weak social interactions, lack of social interaction and communication
	Social Norms	Lack of social support, unbalanced personality, lack of social acceptance, weak responsibility, social norms, lack of social contract, social isolation
Intervening conditions		
Component	The axial concept	Selected codes
Personal/Individual Factors	Hyperactivity	ADHD disorder, hyperactivity, addictive behavior.
	Low Self-Esteem	Ignorance and lack of mutual understanding, lack of sense of belonging, sense of being useless, need for reassurance, sense of rejection, low self-confidence, low self-esteem, low sense of belonging, lack of control.
	Emotions	Emotional feelings, shyness, weak faith and belief, no idea about one's role, lack of patience.
Context Conditions		
Component	The axial concept	Selected codes
Cultural Factors	Lack of awareness	Lack of education, lack of awareness, lack of skills, inappropriate relation between job and employee, unconscious behavior.
	No freedom of speech	Not sharing ideas, not being aware of work problems, not paying attention.
	Lack of cultural compatibility	Lack of social thinking, weakness in formulating cultural indicators, lack of improving cultural indicators, lack of attention to cultural advantages, culture improvement.
	Destructive working behaviors	Busy job, unprofessionalism at the job, destructive behavioral habits, not objective- oriented, Negative and destructive behaviors, reduced interactions
Causal Conditions		
Component	The axial concept	Selected codes
Psychological Factors	Depression	Depressive disorders, depression, damage to mental health, rejecting others.
	Stress	Work stress, work pressure, anxiety.
	Mental Disorder	Obsession, compulsive behaviors, IRS disorder, excessive reassurance, mental disorder.
	Mental Distress	Skill without violence, non-conflict, syphosis spectrum disorders, anxiety, restlessness, aggression.

to develop a theory on the phenomenon of the study inductively. This strategy was applied to achieve a complete description of the attitudes and perceptions of experts on the antecedents and consequences of phubbing. The participants' perception of the process, content, strategies, context, and consequence of the research findings as well as the relationships between them were investigated through a semi-structured interview. For this purpose, the systematic design of the grounded theory approach was employed. For data analysis, primary coding (identification of 123 codes and 21 components) and axial coding (category statistics and the identification of the relationship between categories and determining the axial phenomenon, description of causal conditions, generalization of strategies, intervening conditions, consequences, and results of strategies) have been applied.

a) Causal conditions, which includes the events that result in the occurrence or growth and expansion of a phenomenon. Incidents, events, and happenings that lead to the occurrence or development of a phenomenon. Causal conditions or what is sometimes called antecedent conditions are often described together with words including when, while, and because in data.

b) The main component of the process: this component always appears in the data, and other principal components are related to it.

c) Context conditions: they include a set of conditions that influence the antecedents and consequences of phubbing.

d) Intervening conditions: factors that influence the antecedents and consequences of phubbing as facilitators and contributors.

e) Strategies: they include the measures taken to control and manage the axial phenomenon, which are the extracted steps and the relationships between them. Strategies are a fundamental theory, a method of theorizing with an action/interaction bias, whether the topic of study is of individual, group, or collective, action/interaction types in it, the purpose of which is to manage, control, fulfill, and show sensitivity to the phenomenon. According to the inference made on the relationship between the components and the issues discussed in the research method section, the model of Fig 1 was drawn.

f) The key factors of the antecedents and

consequences of phubbing were obtained after the codes were extracted using the Atlas T software in a round-trip process. Then, the codes were converted into more conceptual factors in each interview, and the documents were reviewed. Fig. 1 represents the obtained pattern by the paradigm model. In this section, the main objective of designing the pattern of antecedents and consequences of phubbing is displayed in a complete and more abstract model.

After designing the paradigm model of the antecedents and consequences of phubbing, it is worth mentioning that the first step of the model for the occurrence of the antecedents and consequences of phubbing in Yazd municipality is causal conditions. This stage can be considered as the preliminary or pre-implementation stage. At this stage, the organization does not specifically develop the occurrence of phubbing, but it tries to provide the preliminaries. This stage includes factors leading to phubbing. After investigating the interviews and extracting the initial and final codes, it can be said that the factors related to phubbing in organizations were recognized as the underlying factors of the phubbing process in organizations. This means that these factors are necessary to establish phubbing in organizations. There is no doubt that the requirements are responsive to new issues. Therefore, the results are in line with Williams (2009) and Zadro *et al.* (2004) findings. Nowadays, organizations need complex requirements and infrastructure to be successful, with employees that are not restricted to specific locations and are greatly dependent on communication and human interaction (Tajpour and Razavi, 2023). The results obtained from the interviews indicate that in order to be successful and reduce phubbing in the organization, they are required to enhance the internal communication of their employees, provide them with essential training, motivate them, and adjust the internal structure of their employees, and managers should initially develop positive thinking in the organization and modify the implementation methods within themselves. If they can establish requirements among employees, then they should have internal preparation for prosperity and reduction of destructive behaviors. One of the concepts desired by the researcher in this section is the responsibility-oriented, knowledgeable, and motivated workforce to reach perfection in providing services. The purpose of reducing phubbing in organizations is to satisfy

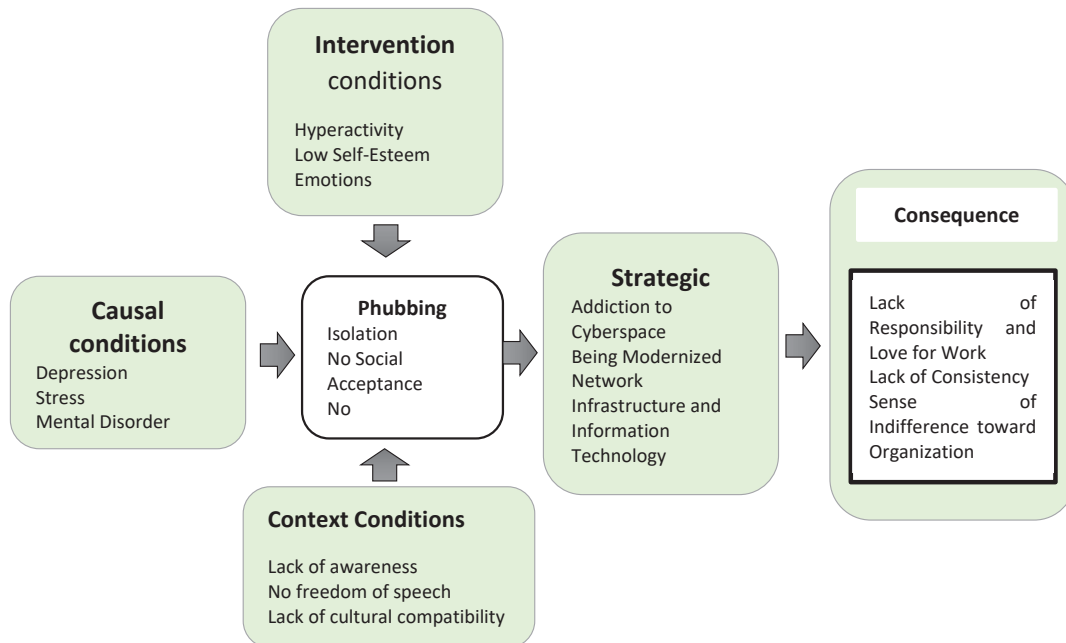


Fig 1 : paradigm model of antecedents and consequences of phubbing

employees, so attracting and retaining employees supports one of these concepts. Çikrikci *et al.* (2019) examined the relationship between phubbing, big five personality traits, and life satisfaction and they concluded that there is a relationship between life satisfaction, phubbing, communication disorders, and neuroticism. It has been shown that phubbing has a significant relationship with life satisfaction. They also showed that communication disorders play a mediating role in the relationship between neuroticism and life satisfaction. The next step is the emergence of phubbing as a central phenomenon. Indeed, the results from the interview analysis led the researcher to the conclusion that the existence of positive behavior in the organization is based on the experience, perception, and expectation of employees from the services they receive. It means that based on their experiences and interactions with organizations, regarding the services and their quality and quantity, employees will find a new understanding of the services and their providers and create deep approach with the organizations in mind so that they feel satisfied. Although reaching positive behaviors in the organization is related to many factors, the services provided to the employees and the support provided by the officials can serve a highly significant function in the employees'

satisfaction and perception of the relevant service. The findings presented by Zamani *et al.* (2020) showed that the phubbing scale is saturated with the two factors of communication disorder and mobile phone obsession. The correlation between communication disorder and mobile phone obsession with social network addiction and relationship quality was not consistent with theoretical orientations. Furthermore, another factor is the intervening conditions, which contain the concepts that bring about the occurrence of phubbing to decrease and increase in the way of strategies. The components achieved from the interviews led to the development of principal concepts and categories of intervening conditions. Today, employees require special rules and regulations, and managers should be able to establish a culture by providing and applying legal frameworks and presenting detailed information to employees, and informing employees of the laws in the organization and their responsibilities as well as organizational aims. Laws and regulations have an important role in making the conditions easier for the implementation of strategies for organizations. The interviewees believe that if the employees are completely aware of their duties and responsibilities, the extent of destructive and inconsistent behaviors will decrease. Therefore, the results are in line with

Tajpour *et al.*(2023) and Wenzlhuemer(2007) findings. Nuñez *et al.* (2020) concluded that phubbing is a type of social rejection caused by smartphones, and the negative effects of that behavior in social interactions are more than what is being assumed. The present study expands the research on a modern communication phenomenon by enhancing the theoretical foundation and obtaining important theoretical and practical concepts relevant to the aims, sources, and observers of phubbing. Another part of the paradigm model includes the strategies that should be conducted to implement phubbing in Yazd Municipality. Nowadays, human communities are formed of organizations with different goals and tasks. The most important thing to achieve effective goal is the management (Sabokro *et al.*,2018). Employees have their own demands, preferences, expectations, and criteria, particularly when the behavior of managers in organizations can respond to their demands. Undoubtedly, all employees have the right to choose and should be respected and valued. Creating value for employees will result in positive behaviors, and it makes society and government organizations pay more attention to the employees in all types of working fields and respect their ideas, create additional value for employees, pay attention to the individual potentials of the employees and take essential measures for improving them. Therefore, the results are in line with Armstrong and Taylor (2023), Liu *et al.*(2022), Busch and McCarthy(2021) and Roberts and David(2017) findings. Al-Saggaf and O'Donnell. (2019) concluded that phubbing is considered an impolite, offensive act and a violation of social norms. Such perceptions weaken empathic concern, intimacy, interpersonal trust, and conversational quality. Underlying conditions are among the factors relevant to phubbing in organizations, and they have been recognized as the underlying factors of the phubbing process in organizations. It means that such factors are necessary for the occurrence of phubbing. Such factors must exist in this model so that appropriate actions and strategies can be implemented. Therefore, the results are in line with Pancani *et al.*(2021) Balta *et al.*(2018) and Blackhart *et al.*(2007) findings. Yasin *et al.* (2023) concluded that employees who believe their supervisor used the phone frequently during interpersonal interactions with them felt more socially rejected so that lower organization-oriented self-esteem can be predicted. Finally, the consequences

are taken into consideration in the paradigm model of the results of phubbing in the organization. The components of the model during this process lead to triple consequences, which are consistent with the results of phubbing in the organization. Lack of enthusiasm for work and lack of consistency have negative results for the organization and eventually society.

CONCLUSION

The aim of the current research was to identify the antecedents and consequences of phubbing on the employees of Yazd Municipality. Therefore, the results show that excessive use of mobile phones is inevitable during face-to-face communication or phubbing behavior. Organizations, such as the municipality, require complex requirements and infrastructure to succeed in this field. Employees of the municipality are not considered exclusive members of specific locations and are intensely dependent on human resources interactions and face-to-face communication but away from phubbing behavior. There is no doubt that the requirements are responsive to new issues. Employees require special rules and regulations; hence, managers should be able to establish a culture by providing and applying legal frameworks, presenting detailed information to employees, and informing employees of the laws in the organization and their responsibilities as well as organizational aims. Organizational regulations must move toward establishing employees' attention to the working space and paying attention to employees' ideas in organizational decisions instead of paying attention to mobile phones among managers and the pervasiveness of this behavior among employees. The role of laws and regulations can facilitate the implementation of strategies for the proper interaction of municipal employees. Reduction in the phubbing in the municipality will multiply the internal communication of employees, and the essential training space during the implementation of responsibilities. It will also motivate them and improve the internal structure of employees. Therefore, managers should initially develop positive thinking in the organization. Decline in the phubbing behavior among municipal employees can lead to positive behaviors in the organizational environment of the municipality and also enhance the methods of performance. Due to the occurrence of phubbing in the municipality, active employees show aggressive

and negative behaviors, lose the sense of being valued and noticed, and suffer from emotional and behavioral disorders. Although reaching positive behaviors in the organization is related to many factors, the services provided to the employees and the support provided by the officials can be significantly functional in the employees' satisfaction and perception of the relevant service.

Limitations and future suggestions

It is suggested that discriminatory, egotistical, and prideful behaviors should be replaced by friendly and peaceful, and altruistic relationships so that employees feel valuable in a calm and positive environment and while having an optimal and efficient performance, destructive and undesirable behaviors such as phubbing are not observed, and human interactions are displayed properly at the level of organizations. In the present study, as the number of variables was high and the relationships between them were complex, other factors could not be involved. Accordingly, the effect of many variables, including the number of managers and employees, the level of people's faith in the cultural values defined in the organization and society, environmental factors, etc., were not taken into consideration. Furthermore, the results from statistical analysis also showed that a percentage of managers' approaches belong to other variables that were not included in the present study.

AUTHOR CONTRIBUTIONS

A.R Rajabipoor Meybodi and A. Jamadi author performed the conceptualization and literature review, compiled the data, and manuscript preparation. E. Hosseini and Z.S Doaei author performed the Methodology, analyzed, and prepared the manuscript text and editing references.

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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.

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ABBREVIATIONS

5W1H	What, Who, Where, When, Why and How
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ORIGINAL RESEARCH PAPER

Addressing the barriers and difficulties in achieving educational institutions accreditation

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ABSTRACT

BACKGROUND AND OBJECTIVES: The accreditation process is pivotal to ensuring high educational standards, but it often faces various challenges. The innovative study seeks not only to identify these hindrances in the accreditation process within Philippine educational institutions but also to map out the countermeasures employed. The study uniquely delves into the perceptions of diverse stakeholders - administrators, faculty, staff, and students - providing a comprehensive, multi-perspective view of the barriers to accreditation. The objective is to explore these perceptions, assess their alignment, and thereby create a more effective, stakeholder-informed strategy for accreditation processes. This novel approach is designed to optimize institutional performance and bolster educational quality, marking our study's distinctive contribution to the field.

METHODS: A descriptive survey method was employed in this study. The sample comprised administrators, faculty, staff, and students from various schools. A self-constructed questionnaire that was validated and were to gather data on hindrances faced by the schools during the accreditation process, and the measures taken to address them. Descriptive statistics were used to analyze the data, and ANOVA was performed to identify any significant differences in the perceptions of the respondents.

FINDINGS: The results revealed several categories of hindrances, with administration, faculty, instruction, laboratory, library, and physical facilities emerging as the key areas of concern. Financial aspects in administration and faculty development programs in the faculty category were the most significant hindrances. Other notable hindrances included measuring student progress in the instruction category, sufficiency of facilities in the laboratory category, organizational structure of libraries, and room lighting in the physical plant category. No significant differences were found in the perceptions of administrators, faculty, staff, and students regarding accreditation hindrances, indicating a shared understanding of these challenges.

CONCLUSION: This study examines the hindrances to accreditation and the steps educational institutions have taken to overcome them. Prioritizing these challenges is vital for continuous improvement and educational quality. Investment in competent administrators and funding is crucial for problem-solving. Creative service formulation aids in overcoming hindrances and achieving accreditation. The study provides insights into stakeholders' perceptions of accreditation challenges, helping schools enhance performance and reputation, benefiting students and the broader community.

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INTRODUCTION

Accreditation, a process of validation in which educational institutions are evaluated against established standards to ensure a high level of educational quality, plays a pivotal role in the educational landscape. It confers a sense of legitimacy, verifying that an institution meets or exceeds an established set of educational standards. Notwithstanding its relevance, a significant proportion of Higher Education Institutions remain unaccredited, raising concerns about their quality of education. This study aims to delve into the challenges these institutions face in obtaining accreditation and proposes feasible solutions to address them. Previous research on accreditation has explored various facets of this complex phenomenon, yet a comprehensive understanding of the challenges and obstacles to accreditation remains elusive. Prior studies (Hanh, 2019; Alajoutsijärvi, 2018 and Sanyal, 2007) have underscored the significance of accreditation as an indirect measure of educational quality. However, despite these insights, a critical gap persists in the literature, pertaining specifically to the barriers to accreditation in the context of the Philippines. Different educational institutions must go through one type of accreditation in order to be “recognized by the government.” An educational institution has the chance to achieve standards above those set as minimal requirements by the government through private, voluntary certification by a recognized accrediting agency. Programs and institutions can be distinguished based on their quality using accreditation as an indirect measure of quality (Min-Allah and Saeed, 2020; Tayag, 2005). It also serves as a means of motivating schools that have been determined to have met the desired standards to continue to improve. Large number of the Higher Education Institutions now is not accredited and the question is what about the assurance whether those schools are capable in catering and meeting the needs of their clients which is quality and competitive education which they pay for (Harvey and Williams, 2010). Accreditation, as an evaluation process based on the criteria of an accrediting body, is aimed at guaranteeing and enhancing educational quality (Corpus, 2003; Blouin *et al.*, 2018). Notably, it is a status reflecting a public declaration that a program or institution aligns with the quality standards set by an accrediting body Ching (2013). According to

research, addressing these barriers requires the university to articulate its philosophy and vision-mission statements more clearly (Margareth *et al.*, 2016; Bueno, 2019). The objectives of this study align with this approach, aiming to cohesively represent the institution’s philosophy and mission while also portraying and contributing to national development objectives (Abelman *et al.*, 2007). As suggested by Harrington (2020), it could be beneficial for universities to regularly introduce new faculty members and students to their institutional philosophy, vision, mission, and program objectives upon appointment and admission. These should be periodically reviewed, considering input from various school departments (Compelio *et al.*, 2015). Inclusive development of these foundational elements involves representation from parents, alumni, business partners, industry stakeholders, and professionals from various fields. The result is a comprehensive program for the student’s intellectual, moral, social, emotional, spiritual, and physical development, reflecting the school’s aims (Heikkinen 2018 and Barton and Coley, 2011). To ensure the consistency of operations towards achieving these objectives, an open line of communication between all stakeholders is necessary. All information published by the school, as per Schönwetter *et al.*, (2002), should be factual and verifiable. The lack of financial support from governmental and non-governmental organizations for administrative programs, such as faculty/staff and student development and facility renovation, received high ratings. This could be attributed to the limited funding these schools receive (Malaluan, 2017; Mgaiwa, 2018; Gedeon, 2020). Various issues associated with administrative support included the absence of an Internal Assessment Board (IAB) or Quality Assurance Office, lack of an operational IAB structure to ensure proper accreditation task management, lack of written policies on document submission and filing for accreditation, poor implementation of updating and submission guidelines, irregular monitoring and evaluation of the accreditation process, and limited academic and administrative projects and programs (Malaluan, 2017; Suleiman, 2019; Balas, Chapman, and Romanowski, 2022). Naidoo (2019) and Ancheta (2012), who identified the lack of personnel cooperation in document provision as a common pressing issue for accreditation. The perceived

hindrances in this area might be influenced by previous issues encountered concerning administrative support. According to Lajus *et al.* (2018) and Malaluan, (2017), the problems with administrative support in accreditation were significant but manageable. Dumancas and Prado (2015) and Al-Kassem *et al.* (2022) show a positive attitude from faculty members towards accreditation, underlining its importance for enhancing institutional resources (Soliven *et al.*, 2012). In the study conducted by Dumancas and Prado (2015), their respondents have positive attitude towards accreditation because they believe that accreditation will improve the quality of education in their institution. Prominently, measuring student progress through tests and examinations emerged as the most crucial challenge. This suggests that accreditation can be hindered by difficulties in aligning assessments with the requirements of accrediting bodies. It further implies that schools may struggle to accurately track and enhance student learning, which is a critical element in fostering an effective learning environment. By addressing these hindrances, schools can better measure and enhance student learning, which is crucial for improving educational outcomes and supporting community development. Dela Cruz and Mendoza (2018); Chowdhury (2019), stated that the large number of instructors and students that use these facilities made maintenance and management of laboratory equipment difficult. Santos (2023) pointed out, specific HRM practices can enhance organizational success by improving performance. This applies directly to libraries, where staff roles, particularly those of head and assistant librarians, are essential. Their duties extend beyond maintaining the existing collection to continually updating and expanding resources to match recent advancements and publications. Accomplishing these tasks requires competence, dedication, and up-to-date knowledge, all traits nurtured by effective HRM practices. Pila *et al.* (2016) supported this perception, identifying improvements needed in their library, such as catering to a growing number of students, increasing seating capacity, and addressing insufficient library budgets. Additionally, Adetunla and Familusi (2017) found that positive perceptions of accreditation led to better library resources and improvements. However, without accreditation, they noted that libraries received insufficient support and funding,

resulting in subpar services and a lack of acquisitions. Trigueiro (2021); Patel and Brown (2021); Agboola and Bassey (2021); Lunenberg (2010). These researchers pointed out that schools often have outdated physical facilities, such as plumbing, sewer, electrical, roofing, masonry, and carpentry systems. This ageing infrastructure naturally contributes to perceptions of physical obstacles to accreditation. A significant budget must be allocated for the student programs and extracurricular activities for the office organization with qualified staff to provide student services as required by accrediting agencies (Nguyen *et al.*, 2018). There are a number of things that contribute to the perceived barriers to student services in the school, including a lack of skilled staff, a lack of facilities and equipment, and a lack of cooperation amongst partner agencies (Alamri and Almazan, 2018; Singhavi *et al.*, 2019). By putting students and various staff members who deal with student matters through various seminars and training on personality development programs and proper handling of student services, the issues with student services in accreditation concerns can be resolved. Hire licensed, academically prepared librarians and guidance counselors, expand the staff in the registrar's office, guidance office, and medical-dental clinic, provide a separate area for group counseling sessions, and upgrade the facilities and equipment (Calamayo *et al.*, 2022). Tapscott's (2010) findings, attributing the failure of certain activities to poor coordination and logistical issues. Furthermore, Tapscott observed that these organizational flaws often lead to problems with community service or outreach activities in schools. There is also an underlying issue of recipients' lack of appreciation, which may cause protest or discourtesy towards those helping them. The recommendation extends to attending community development seminars and workshops, as suggested by Fagan *et al.*, (2022) and Locke *et al.*, (2019). Based on the model of the Community Extension Office, community programs should focus on sustainability, self-sufficiency, and self-reliance (Sunarti *et al.*, 2023). Previous studies have highlighted the role of faculty members' opinions in enhancing the quality assurance process (Aamodt *et al.*, 2018; Nguyen and Ta, 2018; Absor, 2022). They hold valuable insights into the on-ground realities and challenges of the education system that can inform strategic plans for accreditation.

Furthermore, the studies of Alsete (2004), Hendrick *et al.*, (2010), and Jackson *et al.*, (2010) underscore the significant impact accreditation has on institutional and program reputation, as well as its connection to program review. Santos (2023) highlights the pivotal role of coordination between government and stakeholders in fostering smart cities and how robust economies propel the adoption of safer city programs. In parallel, a similar relationship can be seen in the education sector where accreditation bolsters the quality of education in a school, stimulating trust and confidence among its stakeholders including students, parents, faculty, and the larger community. Much like how coordination serves as a conduit for the success of smart city programs, accreditation operates as a key performance indicator in the education field. Both drive continuous improvement and commitment to excellence, emphasizing the interconnected nature of trust-building measures in different sectors, from urban development to education. Despite its recognized importance, it remains an uphill battle for many institutions, particularly in urban areas, to achieve this status. Addressing this identified gap in research, the present study seeks to explore and elucidate the obstacles that prevent educational institutions in the Philippines from attaining accreditation. Through a meticulous examination of pertinent literature and a rigorous analysis of existing accreditation protocols, this study endeavors to uncover the inherent barriers that inhibit these institutions from fulfilling accreditation prerequisites. To gain a deeper understanding of these impediments, the current study adopts a mixed-method approach, integrating qualitative and quantitative data collection methods. It focuses on the exploration of respondents' perceptions concerning the obstacles that prevent private schools from obtaining accreditation across a spectrum of operational aspects including administration, faculty, instruction, labs, libraries, physical facilities, school-community relations, and student services. The structure of this study is as follows: The following section offers an overview of the study's theoretical framework, following which the methodology adopted is detailed. This is succeeded by a discussion of the study's findings, their implications, and proposed recommendations. The study culminates with a conclusion summarizing the key findings and potential

avenues for future research. By dissecting the hindrances to accreditation and suggesting actionable solutions, this study aspires to contribute significantly to the educational discourse, particularly in the context of accreditation. The current study has been carried out in Nueva Ecija in 2022.

MATERIALS AND METHODS

Research design and Instrument

Employing a descriptive research approach, this study utilized a specially developed survey instrument designed to gauge the impediments that hinder schools from undergoing accreditation. The instrument was informed by insights from both local and international literature on accreditation, Accreditation Primers, and the researcher's own expertise in this field. The questionnaire was segmented into three sections:

1. Identification of areas that obstruct schools from seeking accreditation, including philosophy and objectives, administration, faculty, instruction, laboratories, library, physical plant, school-community relations, and student services.
2. Measures that schools have adopted to mitigate identified obstacles.
3. Perceived benefits of achieving accredited status.

To assure the instrument's validity and reliability, a test-retest method was employed, with the questionnaire administered to 5 administrators, 20 teachers, 10 staff, 30 students, and 10 parents who were not part of the primary study sample. The instrument demonstrated high reliability, with a value of 0.89.

Sample

Participants were the administrators; faculty; staff; the Parents who are involve in the school and community affairs; and student leaders of the Nueva Ecija University of Science and Technology Table 1. Purposive sampling was used to ensure the sample adequately represented the key demographic groups involved in the accreditation process.

Data Gathering

The researcher addresses a letter of request to the President of the University. After the necessary permit is already secured, the researcher sought the help of the administrators of the schools and

coordinated with them for the administration of the questionnaire. The researcher administered a set of questionnaires to the respondents. The same sets of questionnaires were retrieved after two to three days. This was done in order to give the different respondents enough time to answer the items to the best of their knowledge and ability. The researcher presumed that if the researchers were asked to accomplish the set of questionnaires in a limited span of time/ at once, the validity of the data might suffer. The researcher also conducted an interview to the participants to verify the results from the questionnaire.

Data Analysis

The collected data was meticulously organized, tallied, tabulated, and analyzed to answer the research questions. Descriptive statistics, specifically weighted averages, were used to describe respondents' perceptions regarding the factors that hinder schools from seeking accreditation and the severity of these hindrances. Furthermore, the researcher employed Friedman's Two-Way Analysis of Variance (ANOVA) by Rank to detect significant differences in perceptions across the five respondent categories. In this model, the dependent variable was 'perception of the hindrances to accreditation,' while the two classifying factors were 'type of respondent' and 'type of hindrance.' Both main effects and potential interaction effects were considered in this analysis. Concerning the collective measures or actions taken by schools to counteract the hindrances, a qualitative approach was adopted. Instead of numbers, words were employed to vividly illustrate the responses shared by the respondents. Lastly, percentage distribution was employed to quantify the proportion of respondents aware of the incentives and benefits of accreditation. This method helps understand

the broader awareness and perception about accreditation among the various respondent groups.

RESULTS AND DISCUSSION

Table 2 indicates respondents agree that every aspect under the area of Philosophy and Objectives can be considered potential roadblocks for schools seeking accreditation. The most significant challenge identified is the involvement of faculty in crafting the philosophy and objectives. The least intricate appears to be aligning the philosophy and objectives with regional and national goals. It seems many respondents feel unfamiliar with their institution's mission and objectives, which could hinder the accreditation process.

Table 3 provides an insight into the respondents' perceptions regarding various administrative aspects, which may pose potential barriers to the accreditation of schools in urban areas. Each factor was rated on a scale of 1 to 5, where 1 represents "Strongly Disagree" and 5 represents "Strongly Agree". On average, respondents agreed (with an average weighted mean of 3.79) that aspects such as administrative organization, administrators' qualifications, the school curriculum, school policy consistency, school budget organization, goal record organization, administrative performance, and planning and development effectiveness were hindrances to accreditation. The qualification of administrators to hold office garnered the highest agreement (4.97), signaling it as a major hindrance. All aspects of the administration were perceived as obstacles to accreditation, with planning and development effectiveness, administrative performance, policy consistency, administrative qualifications, and organization ranked from least to most obstructive. The school budget organization was rated as the least obstructive administrative aspect.

Table 4 shows the respondents' perceptions of

Table 1: Distribution of the respondents

Respondents	Frequency	Percent
School Administrator	11	3.60
Faculty Member	182	59.10
Staff	37	12.00
Supreme Student Government Officer	78	25.30
Total	308	100.00

Table 2: Respondents' perception about philosophy and objectives as hindrance which prevent the school in urban areas from undergoing accreditation

Item Statements	Weighted Mean	Verbal Description
a. Clarity of the principles	3.73	Agree
b. Awareness of the students	3.87	Agree
c. Awareness of the faculty	3.65	Agree
d. Awareness of the staff Agree	3.59	Agree
e. Participation of the faculty members in the formulation of the philosophy and objectives	3.98	Agree
f. Alignment and conformity of the philosophy and objectives with the with the regional and national goals.	3.45	Agree
g. School's mission and vision posted within the conspicuous places within the campus	4.02	Agree
Average Weighted Mean	3.76	Agree

Legend: 1.00 - 1.79 = Strongly Disagree; 1.80 - 2.59 = Disagree; 2.60 - 3.39 = Neither Agree nor Disagree; 3.40 - 4.19 = Agree; 4.20 - 5.00 = Strongly Agree

Table 3: Respondents' perception about Administration as hindrance which prevent the school from undergoing accreditation

Item Statements	Weighted Mean	Verbal Description
a. Organization of the administration	3.67	Agree
b. Qualifications of the administrators to hold office	4.97	Agree
c. The school curriculum	3.86	Agree
d. Consistency of the school policies	3.72	Agree
e. Organization of the school budget	3.57	Agree
f. Organization of the records goals	3.61	Agree
g. Administrative performance	3.58	Agree
h. Effectiveness of planning and development	3.56	Agree
Average Weighted Mean	3.79	Agree

Legend: 1.00 - 1.79 = Strongly Disagree; 1.80 - 2.59 = Disagree; 2.60 - 3.39 = Neither Agree nor Disagree; 3.40 - 4.19 = Agree; 4.20 - 5.00 = Strongly Agree

Table 4: Respondents' perception about faculty as hindrance which prevent the school in from undergoing accreditation

Item Statements	Weighted Mean	Verbal Description
a. Academic qualification of the faculty members	3.91	Agree
b. Competency of the faculty members	3.94	Agree
c. Load assignment of the faculty members	3.96	Agree
d. Field of expertise on the subjects taught	3.74	Agree
e. Ranking of faculty members	3.86	Agree
f. Benefits and salary of the faculty members	3.85	Agree
g. Faculty development program	4.02	Agree
Average Weighted Mean	3.90	Agree

Legend: 1.00 - 1.79 = Strongly Disagree; 1.80 - 2.59 = Disagree; 2.60 - 3.39 = Neither Agree nor Disagree; 3.40 - 4.19 = Agree; 4.20 - 5.00 = Strongly Agree

faculty-related factors, such as academic qualification, competency, load assignment, field of expertise, ranking, benefits, salary, and faculty development programs, and their role as potential hindrances to the accreditation process. On average, respondents generally agreed (with an average weighted mean of 3.90) that these factors significantly impede accreditation. Among the items, the faculty development program emerged as the most significant barrier, scoring the highest agreement rate (4.02). According to the respondents, the order of obstacles from greatest to least is as follows: faculty development program, load distribution, faculty competency, academic qualifications, faculty member rankings, faculty benefits and salary, and field of expertise in taught subjects.

Table 5 displays the viewpoints of the respondents regarding how instructional issues act as barriers to the accreditation process for schools. Respondents collectively ranked these instructional factors based on their perceived impact in preventing urban schools from pursuing certification. According to the respondents, the most significant barrier to student progress measurement through tests and exams is classroom management, then student academic performance, alignment and conformity of academic programs with the Department of Education, and the instructional process, with co-curricular activities ranking as the least significant barrier. The findings showed that because tests and examinations must adhere to the requirements specified by the accrediting body, the tests and examinations created by teachers are actually a huge difficulty for the school during accreditation. Poor academic performance of the students might be ascribed to a variety of causes.

Some of this may be due to instructor factors, some may be related to the school environment, some may be related to the family, and some may be due to student factors. But whatever the elements that affect students' academic performance may be, the school must make every effort to improve them. Otherwise, there will always be a problem area that stops the school from taking the first step toward accreditation. Co-curricular activities are pursuits that the school is expected to pursue or participate, both within and outside of the classroom. It can be in a form of competition, be it academic or non-academic like sports, and the like that would broaden the experience of the students. To pursue these co-curricular activities, a school has to spend money and since the school is self-sufficient, they have to follow strictly the budget of the school year.

Table 6 presents the respondents' perceptions on how the school laboratory might hinder the accreditation process. They've identified and ranked specific characteristics of the lab as potential obstacles. The most prominent barrier is the inadequacy of school facilities, followed by lack of necessary equipment and supplies. It's crucial for the accreditation process that the lab is well-equipped and functional, with sufficient resources for various experimental activities. This ensures quality education and meets students' needs. However, the substantial cost associated with acquiring such equipment and maintaining facilities could impede schools, particularly those in urban areas, from seeking accreditation. The respondents ranked the lack of school supplies as one of the biggest obstacles, despite the fact that schools may readily supply them because they are less expensive than facilities and equipment.

Table 5: Respondents' perception about instruction as hindrance which prevent the school in from undergoing accreditation

Item Statements	Weighted Mean	Verbal Description
a. Alignment and conformity of Academic programs with the Department of Education	3.86	Agree
b. Co-curricular activities	3.79	Agree
c. Instructional process	3.81	Agree
d. Classroom management	3.89	Agree
e. Academic performance of the students	3.89	Agree
f. Measuring the progress of the students through tests and examinations	4.12	Agree
Average Weighted Mean	3.90	Agree

Legend: 1.00 - 1.79 = Strongly Disagree; 1.80 - 2.59 = Disagree; 2.60 - 3.39 = Neither Agree nor Disagree; 3.40 - 4.19 = Agree; 4.20 - 5.00 = Strongly Agree

Table 7 indicates the respondents' perception of the library as a potential obstacle for schools in urban areas seeking accreditation. Respondents agreed that the library's organizational structure was the most significant barrier. This was followed by the library collection, staff qualifications, offered services, and the qualifications of the head librarian. The library's atmosphere and its furniture and equipment, with an average score of 3.71, were viewed as the least significant barriers. These results suggest that respondents believe their institution's library organizational structure and resources do not meet the necessary standards for accreditation.

As illustrated in Table 8, the respondents identified physical aspects of the school, particularly classroom lighting, as major hindrances to accreditation, with a weighted mean value of 3.88. Following classroom lighting, respondents listed the state of school buildings, room ventilation, school environment, and restroom conditions as impediments to accreditation. Although factors like campus layout, attractiveness, and water availability were ranked lower, they were still identified as obstacles.

Table 9 shows that the respondents agreed that all aspects from students' services are hindrances. The most important factor that prevents a school from undergoing accreditation is staff qualification, which has a weighted mean value of 3.87. Next on the list are student programs or co-curricular activities, the office organization, and the school's student assistance program, both of which have a weighted mean of 3.72. The qualification of staff members who will give services to students, such as guidance counselors and librarians, in the sense that they are licensed as a primary requirement for accreditation, is crucial. The student services office must take the initiative to tell students about the programs offered by the guidance and other offices for their welfare.

As shown in Table 10, the respondents expressed a belief that all aspects of school community services are hindrances to accreditation for schools in urban areas. According to their views, the most significant component is the school's community service and involvement. This is followed by the school's outreach activities, school-community relations, and finally, school's social awareness and concern.

Table 6: Respondents' perception about Laboratory as hindrance which prevent the school in from undergoing accreditation

Item Statements	Weighted Mean	Verbal Description
a. Sufficiency of school facilities	3.65	Agree
b. Sufficiency of school equipment	3.71	Agree
c. Sufficiency of school supplies	3.81	Agree
d. Maintenance of school supplies	3.76	Agree
Average Weighted Mean	3.73	Agree

Legend: 1.00 - 1.79 = Strongly Disagree; 1.80 - 2.59 = Disagree; 2.60 - 3.39 = Neither Agree nor Disagree; 3.40 - 4.19 = Agree; 4.20 - 5.00 = Strongly Agree

Table 7: Respondents' perception about Library as hindrance which prevent the school in from undergoing accreditation

Item Statements	Weighted Mean	Verbal Description
a. Qualification of the head librarian	3.67	Agree
b. Organizational structure of the library	3.75	Agree
c. Qualification of the library personnel	3.92	Agree
d. Library collections	3.73	Agree
e. Library services	3.86	Agree
f. Library furniture and equipment	3.89	Agree
g. Library ambiance	3.79	Agree
Average Weighted Mean	3.80	Agree

Legend: 1.00 - 1.79 = Strongly Disagree; 1.80 - 2.59 = Disagree; 2.60 - 3.39 = Neither Agree nor Disagree; 3.40 - 4.19 = Agree; 4.20 - 5.00 = Strongly Agree

Table 8: Respondents' perception about Physical Plant as hindrance which prevent the school from undergoing accreditation

Item Statements	Weighted Mean	Verbal Description
a. The school environment	3.66	Agree
b. The campus plan and appearance	3.61	Agree
c. School buildings condition	3.62	Agree
d. Classroom ambience	3.75	Agree
e. Room ventilation	3.69	Agree
f. Room lighting	3.88	Agree
g. Rest room condition	3.72	Agree
h. Sufficiency of water	3.66	
Average Weighted Mean	3.70	Agree

Legend: 1.00 - 1.79 = Strongly Disagree; 1.80 - 2.59 = Disagree; 2.60 - 3.39 = Neither Agree nor Disagree; 3.40 - 4.19 = Agree; 4.20 - 5.00 = Strongly Agree

Table 9: Respondents' perception about Student Services as hindrance which prevent the school in from undergoing accreditation

Item Statements	Weighted Mean	Verbal Description
a. The Office organization	3.72	Agree
b. Qualification of the personnel	3.87	Agree
c. Awareness on Guidance programs	3.78	Agree
d. Student programs or co-curricular activities of the school	3.87	Agree
e. School student assistance program	3.8	Agree
Average Weighted Mean	3.81	Agree

Legend: 1.00 - 1.79 = Strongly Disagree; 1.80 - 2.59 = Disagree; 2.60 - 3.39 = Neither Agree nor Disagree; 3.40 - 4.19 = Agree; 4.20 - 5.00 = Strongly Agree

Table 10: Respondents' perception about School Community Relation as hindrance which prevent the school in from undergoing accreditation

Item Statements	Weighted Mean	Verbal Description
a. School outreach programs	3.77	Agree
b. School community service and involvement	3.82	Agree
c. School social awareness and concern	3.66	Agree
d. School community relations	3.73	Agree
Average Weighted Mean	3.75	Agree

Legend: 1.00 - 1.79 = Strongly Disagree; 1.80 - 2.59 = Disagree; 2.60 - 3.39 = Neither Agree nor Disagree; 3.40 - 4.19 = Agree; 4.20 - 5.00 = Strongly Agree

Measures that were implemented by the school in order to address the identified hindrances Philosophy and Objectives

The groups of administrators, teachers and staff and students complete their observations with regards to the measures as a group taken by the school in order to address the problems within the area of Philosophy and Objectives while parents were

quiet about the said area. The administrators see to it that the philosophy and objectives of the schools are clearly integrated in the curriculum. The faculty members take their share of thinning out the mission and vision of the school through reading it out loud, explaining and discussing it during the orientation at the beginning of the school year. The staff and student leaders also give their share in making the

mission and vision of the school known to all through helping the administrators post the mission, vision, goals and objectives of the schools.

Administration

The administrators advised the department heads pursue graduate studies (Master's Degree and Doctorate Degree) for them to be qualified for the office they occupy and for them to widen their technical skills. Putting the right persons at the right positions is the name of the game for them. They tried hard to be consistent of the school policies. In terms of the school curriculum, the administrators ensure that the school curriculum is in line with the one implemented by the Commission on Higher Education and Department of Education.

Faculty

According to the responses, the administrators and faculty members confirm that the administration supports faculty members in their pursuit of obtaining graduate degrees. For faculty members who wanted to pursue graduate study, the administrators worked to arrange timetables and even urged them to participate in workshops and trainings for professional development. The educators concurred that their managers should push them to attend seminars and seek graduate degrees and they acknowledged that the subject load assignments are split up according to their areas of specialization.

Instruction

According to the respondents, faculty members were encouraged to use varied instructional materials and multimedia for variation. This is to give the students activities that will develop and hone their higher order thinking skills to improve the test and examination scores of the students and to improve further their class standing.

Laboratories

Administrators and the faculty members responded and explained the measures taken by the school to address the hindrances in the area. The administrators used to schedule budget hearing for the allotment of funds for the improvement of laboratories, other facilities and equipment of the schools. According to the faculty members they were consulted by their respective department heads or

chairmen regarding the needs of the department for budget hearing.

Library

The administrators stressed that they tried hard to look for qualified librarian and advised them to attend seminars and trainings in order to be up dated to the current trends in managing the library. The administrators also included the library in the budget hearing through the head librarians. And the administrators tried their best to increase the budget allotted to the library expenses. The staff claimed that they asked the faculty regarding the books that they need for instruction. This is to consider the books needed and the books that are used by the faculty members in teaching their respective subjects. The faculty members on the other hand submits list of books that they need. This is done every end of the school year in order to purchase the books recommended by the faculty members for the next school year.

Physical Plant

The administrators do budget hearing for the allocation of funds to be spent for school's physical development. This is done annually. In this budget include the school repair and renovation, beautification and improvisation of the physical aspects of the school.

Student Services

The administrators, faculty and staff claimed that the school is trying to give fairness to the students by providing different services like guidance, library, clinic, school canteen and stores and the provision of complete facilities for their use. The faculty and the staff also stated the same as what the administrators said.

Community Relations

The administrators the teachers and the staff claimed that school community service is already part of the programs offered by their school. There were very outreach programs like community clean up and the like. They tried hard to establish linkage and involvement with the community. Significant difference among the perceptions of the respondents with regard to the areas that hinder their schools from undergoing accreditation.

Table 11 shows a uniform perception among students, staff, instructors, and school administrators that certain factors act as barriers to their schools' accreditation process. The p-values corresponding to different areas that may hinder schools from undergoing accreditation, according to respondents' perceptions. In hypothesis testing, a p-value less than 0.05 usually indicates a statistically significant difference. However, all the p-values listed here are much greater than 0.05. This means that, statistically, there is no significant difference in the perceptions of respondents regarding how these various areas might prevent their schools from undergoing accreditation. The p-value is quite high in all areas, which suggests that the respondents' views are largely consistent across these areas. These areas include Philosophy and Objectives, Administration, Faculty, Instruction, Laboratories, Library, Physical Plant, Student Services, and School Community Relations.

The implication of the findings to school management Philosophy and objectives

The school's philosophy and goals serve as the school's road map and compass in order to actualize its existence. The mission and vision of their institution are not well known to the respondents who are students. This might be ascribed to another issue, namely the lack of clarity in the school's mission and vision, for which the faculty members were not involved in the creation of the aforementioned elements of the philosophy and aims. Additionally, neither the instructors nor the employees at the institution are familiar with its philosophies or goals. According to this scenario, the school should carefully

undertake a campaign to spread information about its goal, vision, philosophy, and objectives so that even the professors and staff are knowledgeable about it. Even though the respondent institutions' mission and vision statements may be displayed in a variety of high-traffic areas on their campuses, everyone already understands these values.

Administration

The respondents agreed that administration is one factor that prevents schools from getting accreditation, which implies that they hold the administration accountable for its performance and are dissatisfied with the way administrators operate the school. They even thought it might prevent the institutions from applying for accreditation. Parents, students, and other staff members are generally dissatisfied with how the school is run.

Faculty

There is a program for faculty development that is largely regarded as being insufficient in the faculty sector. As a result, there aren't often opportunities for teachers to participate in seminars that would improve their capacity to deliver high-quality instruction. In addition, teachers are so overworked that they are unable to advance their academic credentials. Because of this, the majority of teachers are not academically qualified. They lack the chance to participate in graduate programs and raise their level of education. As a result, teachers lack proficiency and are out of touch with current events and innovative approaches to teaching their particular disciplines.

Table 11: Difference among the perceptions of the respondents with regard to the areas that hinder their schools from undergoing accreditation

Area	Mean Square	P - value
Philosophy and Objectives and Objectives	25.249	0.684
Administration	7.343	0.958
Faculty	2.725	0.976
Instruction	2.273	0.977
Laboratories	0.568	0.984
Library	3.792	0.962
Physical Plant	12.758	0.797
Student Services	4.607	0.908
School Community Relations	1.262	0.981

Instruction

The Faculty's shaky basis can be blamed for the deficiencies. Strong, capable faculty members who are academically qualified and continually work to advance and update both academic qualification and teaching competency have a significant impact on students' academic achievement. Upgrading the method of instruction entails making the teacher aware of the various ways to assess student learning rather than solely relying on one or two methods, such as written quizzes and tests, to gauge the students' intelligence. As the saying goes, "No one can give what he/she does not possess." Holistic measurement is required. The variation between academic and extracurricular activities is unbalanced since pupils don't participate in enough co-curricular activities. This implies that both pupils and teachers may be monotonous and bored. All of these are seen as threats to school accreditation and must be handled by competent administrators in a timely and effective manner.

Laboratories

Along with laboratories, adequate school infrastructure and supplies are seen as a barrier to undergoing accreditation. Although it is stated that a brilliant teacher can instruct even while sitting under a tree, this proverb may have been true decades ago, before technology. Today's students prefer to learn more when they apply concepts taught through visuals, audios, or a combination of the two through motion pictures, usually known as video clips. This is because school facilities and equipment are essential. In addition, the school must have certain facilities and equipment in order to receive accreditation.

Library

Both lecturer and students should have access to a sufficient number of books and periodicals in the library for reference purposes. The results suggested that the respondent schools' libraries don't have enough books and that the environment isn't good for learning. It is also alleged that librarians lack qualifications. These things all keep the schools from receiving accreditation.

Physical Plant

Good administrators who can manage to provide solutions to the recognized physical plant problems are required. There is no denying the fact that adequate

funding must be allocated in order to address these issues. These issues can't be resolved in a flash or with the snap of a finger. It necessitates shrewd spending and budgeting abilities over time.

Student Services

The department of student services is not meeting the needs of the students, according to the weaknesses that have been found there. The office's primary responsibility of informing the students of the services it provides appears to be neglected. It can be linked to underqualified staff members who are unable to engage in co-curricular activities that would provide pupils with variety and balance in their academic and extracurricular pursuits. These unquestionably prevent the schools from receiving accreditation.

School Community Relations

Because all of its facets were found to be barriers to school accreditation, it was asserted that the school community relations of the respondents presented a challenge in the process of accreditation. Since the schools are unable to travel outside their walls to provide programs for the community, there were no outreach initiatives. Due to a lack of resources, they seldom ever participate in communal affairs. However, not all outreach initiatives need to be costly. Services might be provided. To fully fulfill this sector, administrators must be imaginative enough to provide services that the community can use.

Discussion

The outcomes of this research align with existing literature, notably illustrating that the challenges to accreditation are multifaceted, encompassing a range of issues from institutional philosophy and objectives to facilities and community services. In line with [Margareth et al., \(2016\)](#); [Bueno \(2019\)](#), faculty involvement in crafting the institution's philosophy and mission was deemed crucial, reinforcing the idea that clarity in a university's vision-mission can enhance the accreditation process. However, as highlighted in this study, many educational institutions in urban areas struggle with this aspect, suggesting a need for more focused efforts in this direction. Administrative challenges, particularly the qualifications of administrators, echo the concerns raised in the works of [Malaluan \(2017\)](#); [Mgaiwa \(2018\)](#); [Gedeon \(2020\)](#). The problems with administrative support in accreditation

were found to be significant but manageable, much like the findings of [Lajus et al. \(2018\)](#); [Malaluan \(2017\)](#). Schools appear to struggle with the absence of structures like an Internal Assessment Board (IAB) or Quality Assurance Office, underlining the need for better organization and clearer guidelines. Faculty-related challenges align with the insights of [Naidoo \(2019\)](#); [Ancheta \(2012\)](#). Interestingly, despite the positive attitudes from faculty members towards accreditation, as noted by [Dumancas and Prado \(2015\)](#), the faculty development program was identified as a major hurdle, suggesting that perceived barriers could be rooted in broader systemic issues. Measuring student progress through tests and examinations emerged as the most significant challenge, which mirrors the concerns raised by [Dela Cruz and Mendoza \(2018\)](#); [Chowdhury \(2019\)](#). Challenges associated with the management and maintenance of laboratory equipment likely reflect the practical difficulties of serving large numbers of students and instructors. The importance of effective HRM practices in maintaining and upgrading library resources, as highlighted by [Santos \(2023\)](#); [Pila et al., \(2016\)](#); [Adetunla and Familusi \(2017\)](#), also resonates in this study. Concerning physical facilities, this study aligns with the observations of [Trigueiro \(2021\)](#); [Patel and Brown \(2021\)](#); [Agboola and Bassey \(2021\)](#); [Lunenberg \(2010\)](#), demonstrating that outdated infrastructure contributes to perceived physical barriers to accreditation. Student services and community services, as discussed by [Nguyen et al., \(2018\)](#); [Alamri and Almazan \(2018\)](#); [Singhavi et al., \(2019\)](#), appeared as critical areas of concern, echoing the findings of [Tapscott \(2010\)](#). The significant role of faculty members' opinions, as noted by [Aamodt et al., \(2018\)](#), [Nguyen and Ta \(2018\)](#); [Absor \(2022\)](#), underscores the importance of their insights in enhancing the quality assurance process. In light of the findings, this study recommends proactive initiatives in addressing the identified challenges. Institutions should prioritize clear articulation of their philosophy and mission, engaging all stakeholders in their formulation and periodic review. It is crucial to enhance administrative support structures, develop more defined guidelines for accreditation tasks, and ensure regular monitoring and evaluation. Further, faculty development programs should be strengthened, aiming to boost faculty competency and foster a positive attitude towards accreditation. Schools should invest in developing more effective methods

for student progress assessment, aligning these with accreditation standards. Upgrading and maintaining school facilities, including laboratories, libraries, and physical structures, should be a part of the schools' strategic plans. To improve student services, training programs for staff members and expanding personnel in key offices could be instrumental. Community outreach programs need to be better coordinated, and schools should strive for sustainable, self-reliant initiatives. It's critical to foster an open communication culture that ensures transparency and effective information dissemination among stakeholders, as emphasized by [Schönwetter et al., \(2002\)](#). Attention should also be given to enhancing the cooperation and engagement of faculty members in the accreditation process, leveraging their on-ground knowledge and experiences for improvement. Lastly, ongoing research should be conducted to continually identify and address new challenges as they emerge, thus ensuring the persistent relevance and applicability of the accreditation process in improving the quality of education.

CONCLUSION

The core objective of this research was to elucidate the challenges that educational institutions encounter during the accreditation process and to highlight the countermeasures they employ to mitigate these issues. Drawing from our findings, we identified several areas that serve as major roadblocks, spanning administration, faculty, instruction, laboratories, libraries, and physical plant facilities. In the administrative domain, one prominent example of such hindrances is financial constraints, illustrated by instances where institutions struggled to procure necessary resources due to budget limitations. Within the faculty category, inadequacies in faculty development programs surfaced as a considerable impediment, with some faculty members expressing the need for more comprehensive and targeted professional development opportunities. Concerning instruction, a key challenge lay in effectively measuring student progress, with teachers citing difficulties in developing suitable assessment methods to capture student learning accurately. For laboratories and physical plant facilities, issues related to the adequacy and upkeep of infrastructure posed a significant obstacle, as demonstrated by feedback on outdated laboratory equipment and poorly lit classrooms. Within

the library domain, concerns about the organizational structure, such as lack of clear cataloging or digitized resources, emerged as a distinct barrier. Addressing these challenges requires institutions to enhance administrative efficacy, formulate clear objectives, engage stakeholders, allocate resources judiciously, and invest in comprehensive faculty development programs. It also necessitates the alignment of academic programs with instructional methodologies, maintenance and upgrading of physical facilities, and overall enhancement of the campus environment. Interestingly, the research found no significant differences in how administrators, faculty, staff, and students perceive these hindrances, indicating a shared comprehension of the challenges. This finding underscores the importance of fostering collaborative efforts among all stakeholders to devise and implement customized policies, programs, and strategies that effectively tackle these impediments. On the strength of these findings, we recommend that educational institutions place a high priority on addressing these challenges to ensure the quality of education and secure accreditation. Key strategies include investments in competent leadership, securing adequate funding, and developing innovative services to address hindrances effectively. Despite the insights this study offers, it is important to recognize its limitations. The research was primarily confined to urban areas, and as such, the findings may not fully represent the unique challenges of institutions in rural or socio-economically distinct environments. Future research should aim to rectify this by expanding the investigation to more diverse geographical and socio-economic contexts. Moreover, this study prompts a call for further research into other factors that may hinder accreditation, including socio-economic and cultural variables, which could provide additional depth to our understanding and inform the development of policy and programmatic decisions.

AUTHOR CONTRIBUTIONS

E.G. Claudio was responsible for all aspects of the study. This encompassed formulating the research design, collecting and analyzing the data, interpreting the results, and drafting and revising the manuscript.

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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.

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ABBREVIATIONS

<i>Ict</i>	Information and communication technology
<i>Paascu</i>	Philippine accrediting association of schools, colleges, and universities
<i>Sdg</i>	Sustainable development goals
<i>Tesda</i>	Technical education and skills development authority

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ORIGINAL RESEARCH PAPER

Identifying the constituent factors of open governance in public institutions

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ABSTRACT

BACKGROUND AND OBJECTIVES: Open governance is considered an important tool to solve complicated issues in countries, increase efficiency, and build public trust based on indicators like information transparency and public participation using Information and Communication Technologies. Therefore, considering that no research with this title has been conducted in Iran, this research was studied in the municipalities of Tehran Province, Iran, with the aim of identifying the factors that constitute open governance in Iran's public institutions.

METHODS: The present study is mixed-method research. In the qualitative part, interviews and theme analysis were used, while the quantitative part used a descriptive method. The study population in the qualitative section consisted of university experts and specialists who were knowledgeable about the subject of the study. Purposive sampling was used, and after conducting 20 interviews, theoretical saturation was achieved. This study was conducted in the first half of 2023. The study population in the quantitative section consisted of all senior managers of municipalities in Tehran Province, estimated to be around 440 individuals. Using the Cochran formula, 205 individuals were selected as the sample. Data was collected using both library and field methods. A 23-item questionnaire with a Likert scale was constructed, and validity and reliability were checked in all sections. SPSS-24 software was used for the descriptive part, and Smart PLS 3 software was used for analysis, including Pearson's correlation test, one-sample t-test, and structural equation modeling.

FINDINGS: The findings indicated that the dimensions of open data, open service and open process were found for the establishment of open cooperation. By performing the first-order factor analysis, the factor loadings between the indicators and dimensions of the model were in a favorable condition. On the other hand, in the second-order factor analysis, the factors open data, open service, and open process were determined at 0.964, 0.968, and 0.955, respectively, which were considered significant according to Student's t-test.

CONCLUSION: Three key factors are needed to establish open governance. The open process includes policy changes, approval of necessary regulations, modification of organizational structures and activities. Providing open service, including systems and platforms that allow greater participation of civil society and other urban actors. Open data includes publishing public data, reporting on the performance of managers and public institutions in established platforms.

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INTRODUCTION

Governance is one of the most important and controversial concepts in political science, which refers to the methods used by governing institutions in society to manage resources and perform their duties. Governance in public institutions is also referred to as the set of process and mechanisms that they use to make decisions implement and monitor their work (Ferlie, 2017). Municipalities, as one of the public institutions and responsible for various departments of urban management, operate based on government policies to provide services to the citizens of their region and improve the urban situation. Considering that municipalities in Iran, as institutions with a close relationship with citizens, are highly dynamic and changeable and play a very important role in urban management and governance, therefore it is very important to examine governance and management practices in these institutions (Arzam et al. 2020). Nowadays cities face challenges like environmental issues, resource management, urban crises, and similar items (Dagar et al., 2023). In this regard, public institutions, including municipalities in Iran, face numerous challenges that can be categorized into several sections: management and organization, finance and human resources, corruption, monitoring and auditing. In general, the issues mentioned are only a part of the challenges that Iranian municipalities face in providing quality public services and improving urban management. To tackle these issues, policymakers and urban managers should prioritize improving management structures, enhancing the quality of human resources, establishing effective auditing and monitoring systems, and promoting transparency in delivering urban services (Ashnavar et al., 2021). Open governance is used as a management method to create transparency, participation, trust and people's presence in the public decision-making process at the local and international level (Mumladze, 2023). This management approach aims to enhance the connection between individuals and public institutions. To achieve this objective, it operates based on principles such as transparency, participation, trust, and accountability (Nabatchi et al., 2017). Open governance is an integral part of the innovation policy in the public sector based on information technology, which is on the agenda of many governments today (Gao et al., 2023). Hence, the aim of this study is to

identify the dimensions, components, and indicators of open governance in Iran's public institutions, particularly the municipalities in Tehran province, and provide a theoretical framework for analyzing these dimensions and indicators. The findings of this research can be valuable for public sector managers and for the purposes of review and evaluation. The insights gained from assessing the performance of the municipalities in Tehran province can be used to enhance governance practices in Iran.

Research background

Open governance was proposed as one of the newest concepts in the field of governance in the first decade of 2000, and they sought to create a solution to increase transparency and participation in governance process. This concept grew with the advancement of Information and Communication Technology (ICT) and is currently considered as one of the key concepts in the field of governance (Ingrams et al. 2020). In the (Table 1) some studies of recent years about open governance are discussed.

Literature review

While the concept of open government has a lengthy history, it was during the United Nations General Assembly in September 2011 that the significance of this principle was highlighted when the President of the United States, Barack Obama, specifically addressed the need to promote open government practices in other countries. This event is recognized as one of the most significant milestones that contributed to the emergence and advancement of the open government principle (Bouchet, 2013). OECD (2017) defines Open governance as "a governance culture that promotes the principles of transparency, honesty, accountability and stakeholder participation in support of democracy and inclusive growth". The United Nations Economic and Social Commission for Western Asia (UN ESCWA) define open government as "a government that is effective and efficient in carrying out its duties, its work is transparent and accountable, and everyone can access its services. It is also a Government that responds to the needs of its citizens, values their participation, experience and knowledge in decision-making, and relies on modern and emerging technologies to enhance its governance. ESCWA believes that improving participation, transparency and accountability are the primary goals of open

Table 1: A review of related literature on the models of open governance

Title	Researchers	Results
Offering an open data governance model to achieve administrative health by the establishment of e-government in Iran National Tax Administration	Sami et al. (2022)	This study has identified six components for open governance, including fundamental factors, intervening conditions, causal factors, infrastructure, strategies, and consequences. To achieve open governance, attention must be paid to these various factors and their interactions.
A model of assessing policymakers' inclination toward the open government in Iran	Momen Kashani et al. (2020)	This study has found that the inclination towards open government is a multi-dimensional concept, and policymakers' willingness and inclination towards it can be measured by six items: transparency, citizens' participation, collaboration, government responsiveness, support for innovation, and assistance in business development.
A model to detect the drivers of implementing an open government model in Iran's executive bodies: a case study of the Ministry of Interior	Abol-Maali et al. (2020)	This study has classified the network of themes into five main categories, namely the enforcement of laws related to free access to information, open governance data, technology implementation, government data and technology implementation to enforce programs, and gaining access to actual transparency. These categories represent key areas of focus that are critical for achieving open governance.
Open Government Maturity Models: A Global Comparison	Pirannejad and Ingrams (2022)	These researchers developed a model consisting of six stages that need to be taken to achieve open government, including the preliminary stage, transparency and responsiveness stage, open collaboration stage, platform stage, open democratic government stage, and governance stage. Each stage represents a progression towards more advanced and comprehensive open governance
An integrated model of digital open government	Wirtz et al. (2022)	This model offers policymakers a comprehensive framework to guide the implementation of digital open government initiatives. By outlining the key levels of technological infrastructure, development, process, services and business models, governance, and regulations, the model provides a roadmap for policymakers to follow.
Joining the open government partnership initiative: An empirical analysis of diffusion effects	Tavares et al. (2023)	The goal of this study was to investigate the reasons that motivate countries to join the international organization of open governments. The findings, based on data collected from 175 countries, show that open government diffusion is influenced by regional proximity, shared cultural features, governmental systems, and membership in international organizations.
An investigation of the factors influencing the open government from the perspective of a country	Ayinde et al. (2023)	This study was conducted on the secondary data collected from 137 countries to measure the factors influencing the open government on a global scale using multiple regression analysis. The article investigated the technical-social aspects of the open government by taking a look at the following five factors: the development of the e-government, free press, innovation capabilities, digital skills, and legal compatibility.
A model for the maturation of the open government: attracting the participation of civil society through social media	Lee and Kwak (2012)	This study proposes a model for achieving open governance that emphasizes transparent and interactive public participation. The model consists of five main stages: preliminary conditions, information transparency, free participation, open cooperation, and inclusive interaction. Each stage represents a progression towards more comprehensive and effective open governance.

government, regardless of its definition” (Bakleh and Denner, 2021). However, there is no single and universally accepted definition of open government and it generally includes different approaches, definitions and principles and considers different legal, historical or cultural aspects of countries around the world (OECD, 2016). But (almost) all definitions include the same basic concepts of transparency, accountability and participation (Matheus and Janssen, 2020). For example, the European Union has no official definition of open government. However, in its vision on public services European Commission (2015) it stated that open government includes three main aspects: open data, open service and open process. The principle of open data is to provide free access to government data in an open and usable form for all. This data can be provided through public databases, web service sites, government websites and other sources. This principle increases transparency and stability in governments. The principle of open service deals with the provision of government services in an open and accessible manner for all. These services can be provided online and people can use them easily and quickly. This principle increases participation and stability in governments. The principle of open process deals with creating opportunities for participation and transparency in government processes. This includes creating opportunities for citizens to participate in decision-making processes, providing clear and understandable information about government processes, and creating opportunities to handle citizens’ complaints and opinions. This principle increases accountability and stability in governments. Therefore, the principles of open data, open service and open process have been proposed with the aim of increasing transparency, participation and accountability in governments and public institutions in decision-making processes and providing services to people and civil society (Millard, 2018). Open governance and open data: Open Government encompasses the more limited concept of Open Government Data (OGD), which involves the idea that in most government and public entities data should be freely available to everyone to use and republish as they wish, without restrictions from copyright, patents or other mechanisms of control, as they were financed by public money and constitute public good. Open Data Charter (ODC) was created in 2015 by 70 countries and international organizations to promote the openness

of government data and the development of the digital economy and innovation. This charter is based on 6 key principles of government data openness, including: data openness, transparency, usability, provision of technology infrastructure, development of data-oriented programs, and international and government cooperation (Matasick *et al.*, 2020). The conceptualization of Open Government Data also emerged from the concept of Open Data (OD), which developed worldwide in parallel and in response to the development of intellectual property and the rise of their commercial value, especially with the acceleration of the circulation and accumulation of information through the web (the data revolution) (Kitchin, 2014). Open Governance and e-Government: Electronic Government (e-Government) is a strong enabler of open government when it supports the same principles. E-government is mainly related to the use of modern ICT technologies by government and local authorities to provide better public services to citizens (Lytras and Şerban, 2020). However, there is a clear difference between e-government and open government, the latter being a governance issue. In fact, new ICT technologies facilitate open government and allow innovative approaches; but open government can be implemented even with low penetration of ICT technologies (Criado *et al.*, 2018). Many UN agencies use interchangeably the terms “e-government” and “digital government”, as no formal distinction is made between them among academics, policymakers and practitioners. In many countries, the term e-government is embedded and institutionalized in national policies and strategies, though in some cases reference is made to digital government as the next phase of e-government. United Nations Department of Economic and Social Affairs (UN DESA) does not differentiate between e-government and digital government in its worldwide surveys (Janowski, 2015). Janssen and Estevez (2013) used the terms “e-government”, “transformational government”, and “lean government” to illustrate the stages of evolution in an electronic government and argued that a lean government is represented by platform-based governance (Tahmasebi *et al.*, 2020). Open government can be added to the above cycle. The above four stages are not distinct but are involved in a process of evolutionary progress (Millard, 2018). Fig.1 by Millard (2018) explains the process of open governance and its place with other governances.

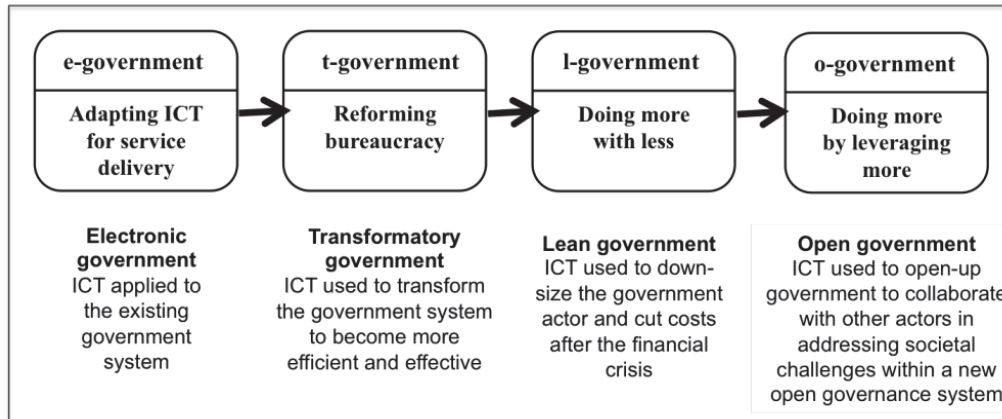


Fig. 1: The evolutionary process of an open government (Millard, 2018)

Challenges of Open Government Adoption: According to Ruijter and Meijer (2020), the difficulty of open government data as an innovation is finding out how to scale the availability of open data. According to Nam (2015), open government is expected to provide social and economic benefits through public use of government information. However, as open government matures, it may face more administrative and technological difficulties. According to Kopec and Sheldrick (2020), the obstacles to the adoption of open government include: Lack of financial resources insufficient time Nonfunctional websites Restrictive regulations and Lack of information available. The data release process is fraught with problems. such as lack of data openness due to organizational capabilities and culture, legal and regulatory issues, especially those related to privacy and security, technical problems such as lack of support infrastructure due to fragmentation, lack of knowledge and skills among public administrators involved in All stages of the data generation process (Gascó-Hernández *et al.*, 2018). Therefore, based on previous studies and literature review, open governance is one of the important concepts in the field of public administration and is considered in different countries as a strategy for sustainable development and improving the quality of public services. In Iran, the establishment of open governance is considered as an important challenge in the field of public administration, which is very important for Iran public institutions due to the benefits it brings. Therefore, knowing the dimensions and components of open governance is necessary for

these managers to better understand the concept of governance. Therefore, the main question of this research is, what are the dimensions and indicators of open governance public institutions of Iran (Municipalities of Tehran Province, Iran)? The present research was conducted in Iran, Iran in 2023.

MATERIALS AND METHODS

The present study employs an applied research approach with the aim of proposing an open governance model for the municipalities in Tehran province, Iran. The study utilizes a mixed-method approach, combining qualitative and quantitative data. The qualitative portion involves interviews and theme analysis, while the quantitative section utilizes a descriptive methodology. The study begins by exploring the research topic qualitatively with a limited number of participants. Based on the qualitative findings, the researcher proceeds to construct the desired tool. The study aims to understand the characteristics, components, and indicators of open governance by examining expert opinions gathered through interviews, followed by quantitative analysis to produce comprehensive findings. Population, Sampling Method, and Sample Size in the Study: The study population in the qualitative section consisted of university experts and specialists who were knowledgeable about the subject of open governance in municipalities, particularly in the areas of local government and municipalities in Iran. These experts possessed the following characteristics: familiarity with the subject of open governance, at least 7 years

Table 2: Demographic statistics of interviewees

Variable	category	Frequency	Variable	category	Frequency	Variable	category	Abundance
Work place	chancellor of Azad Islamic University	5	Education	PhD	13	Age	Below 39 years	2
	The experts of the districts and municipalities of Tehran	8		Master's degree	7		40 to 45 years	10
	Informed professors in the field of this study	7		Female	5		46 to 50 years	4
			Gender	Man	15	Work experience	Over 50 years old	4
							Under 15 years	6
							16 to 20 years	8
							Above 20	6

of experience at the level of senior management, and a doctoral degree for academic experts or a master's degree for experts with managerial experience in the relevant field. A purposive sampling method was used in this study to select the participants. In this method, the selection of sample cases is based on the researcher's study objectives and the nature of the research. The study reached theoretical saturation after conducting 20 interviews (Table 2). It is worth noting that the interview process was conducted in the first half of 2023.

The study population in the quantitative section consists of all senior managers of municipalities in Tehran province, Iran, which is estimated to be around 440 individuals. In this study, the Cochran formula was used to determine the sample size, and based on this, 205 individuals were selected as the sample (Cochran, 1977), (Eqs. 1 and 2). In addition, a stratified random sampling method was used to select the statistical samples in this study.

$$n = \frac{z^2 pq}{1 + \frac{1}{n} \left(\frac{z^2 pq}{d^2 - 1} \right)} \quad (1)$$

$$205 = \frac{3.8416^2 * 0.5 * 0.5}{1 + \frac{1}{440} \left(\frac{3.8416^2 * 0.5 * 0.5}{0.05^2 - 1} \right)} \quad (2)$$

Data Collection Method and Tools: Two methods were used to collect data in this study: the library

method and the field method. In the library method, information was collected by studying books, journals, online sources, and databases. After selecting the sources, the texts were extracted, translated, and analyzed to identify the primary components and indicators of the research based on theoretical and practical foundations. The field method was carried out in two ways. First, for exploratory interviews, a number of university experts were purposefully selected, and after necessary coordination, interviews were conducted with them at their workplace. Then, for collecting the required data in the quantitative section, questionnaires were distributed among the statistical samples after necessary coordination. The collected data were entered into the system and analyzed. The interview questions included demographic information, a questionnaire based on the literature, and interviews with experts. The interview questions included demographic information and a questionnaire derived from the literature and interviews with experts. The questionnaire consisted of 23 items with a five-point Likert scale, which was developed by reviewing the theoretical and practical foundations and the results of exploratory interviews (With the primary and secondary coding of the exploratory interview texts, the theme analysis of the Braun and Clarke method has been done) (Table 3). According to Braun and Clarke, theme analysis is a method to recognize, analyse and report the patterns in qualitative data and a method for analysing textual data that turns scattered and diverse data

into rich data, and when viewing the text, a proper understanding of Irrelevant information, qualitative information analysis, systematic observation of person, group, situation, and converting qualitative data into quantitative data are used. The concept of theme shows important information about data and research questions and to some extent shows the meaning and concept of the pattern in the collection. The results of data analysis are presented using the qualitative approach of theme analysis in the form of main themes, sub-themes and concepts. Based on Braun and Clarke's approach, in this research, for theme analysis, six phases of getting to know the data, creating initial codes, searching for themes, revising themes, defining and naming themes, and finally a report have been prepared (Braun and Clarke, 2006).

To describe the demographic characteristics, whose data was obtained from the questionnaire, Spss-24 software was used. In the inferential part, to answer the research questions, Pearson's correlation test, one-sample t-test, structural equation modelling (confirmatory factor analysis) was used using Smart PLS 3 software.

The reliability and validity of the measurement instrument: In the qualitative section, the validity

of the research tool was confirmed by 5 professors familiar with the field of study. To calculate the reliability of the test-retest method, a sample is selected from among the conducted interviews, each of which is repeated in a short time interval. Then, the specified codes were compared in two-time intervals for each of the interviews. The retesting method is used to evaluate the stability of the researcher's coding. In each of the interviews, the codes that are similar in two-time intervals are marked as "agreement" and the codes that are not similar are marked as "disagreement" (Mohammad Beigi et al., 2015). The method of calculating the reliability between the coding done by the researcher in two-time intervals is shown through Eq. 3 in Table 4:

$$\text{Percent reliability} = \frac{2(\text{Number of agreements})}{\text{Total number of codes}} \times 100 \quad (3)$$

In Table 4, the reliability coefficient between the done coding was 78.65%, which indicates its acceptability.

Calculation of reliability between two coders: In order to calculate the reliability of the interview with the

Table 3: Information relevant to the implemented questionnaire

Concept	Dimensions	Indicator	Item number
Open governance	Open data	6 indicators	21-26
	Open service	6 indicators	27-32
	Open process	11 indicators	33-43

Table 4: Reliability coefficient between coding

Row	Interview code	Total number of codes	Number of agreements	Number of disagreements	Reliability of the test
1	8	16	6	1	75
2	17	17	7	2	82.3
Total		33	11	3	78.65

Table 5: Calculation of reliability between two coders

Row	Interview code	Total number of codes	Number of agreements	Number of disagreements	Reliability of the test
1	5	18	7	2	78
2	12	17	7	2	82.3
3	18	15	5	3	66.7
Total		33	11	3	75.7

intra-theme agreement method of three coders, one of the professors in the relevant field who is familiar with coding was requested to participate in the research as a secondary coder. Further, the researcher coded the number of two interviews with this research colleague and the percentage of agreement within the subject that is used as the reliability index of the analysis has been calculated using the (Eq 3), (Mohammad Beigi *et al.*, 2015). In this research, the reliability coefficient between the two codes was 75.7%, which indicates its acceptability (Table 5).

In the quantitative part, to check the validity of the main variables, the convergent validity of AVE and the divergent validity of the Fornell-Larcker matrix were used, as well as Cronbach's alpha and the Composite Reliability (CR) were used to check the reliability (Table 6).

- Cronbach's alpha value higher than 0.7 is an acceptable reliability indicator.
- If the value of Composite Reliability (CR) for any structure is above 0.7, it shows the internal stability suitable for the measurement model.

Table 6: Validity coefficients of the main variables of the model

Component	alpha Cronbach's	reliability Shared	AVE	Fornell-Larcker Matrix		
open data	0.744	0.787	0.552	0.743		
open service	0.753	0.844	0.644	0.342	0.803	
Open process	0.798	0.918	0.651	0.331	0.47	0.807

Table 7: Modifying primary codes, extracting secondary codes and defining and labeling themes

Interviewee code	Index (extraction of themes)	Dimensions (definition of themes)	Concept (renaming themes)
Open governance	Open data	Reporting on the performance of managers and institutions	I15.I17. I18.I20.
		The activity of mass media to broadcast news	I19.I16.
		Establishing the infrastructure for monitoring and control and feedback on this	I16.I19. I15.I13.
		Using the information channels of global organizations and organizational networks	I5. I4.
		Strengthening communication systems	I4. I6. I11.I13. I14.
		Making all actions of the government accessible to the public	I15.I17. I18.
	Open service	Distributing services and conveniences in a fair manner	I18.I17. I12.I7.
		Establishing the infrastructure necessary to maximize citizens' participation	I6. I4. I9.
		Relaying people's demands	I10.I11. I16.
		Network relationships among all stakeholders and civil society activists	I17.I18. I20.I15.
		The participation of the government, citizens, and private institutions	I16.I12. I9.
		Freedom of expression	I6. I3. I5. I8. I10.I12.
	Open process	Training leadership skills	I13.I14. I16.I18.
		Revising and modifying activities	I19.I17. I12.I9.
		Integrating policies	I8. I6. I5.
		Offering full-scale support to people	I3. I6. I8. I10.
		Reducing organizational hierarchies	I9. I8. I3.
		Introducing independent institutions	I4
		Public policies	I5. I7.
		Inter-sectoral collaboration	I8. I10.I11.
		Establishing required communication and equilibrium	I11.I13. I16.I17.
		Employing people with expertise in urban matters	I17.
		Training future managers	I17.I19. I14.I7. I6

- Also, should values $CR > AVE$
- AVE value above 0.5 indicates acceptable convergent validity (Habibi and kolahi, 2017)
- In the analysis of Structural Equation Models using the Partial Least Squares (SEM-PLS) method, which is usually analyzed with Smart PLS software, for a reliable diagnosis that indicates the existence of partial correlations between the indicators of a structure and the indicators of other structures from the Fornell-Larcker criterion is used. The Larcker-Fornell criterion refers to the fact that the square root of the explained variance values (AVE) of each construct is greater than the correlation values of that construct with other constructs. The values on the main diameter of the matrix must be greater than all the values in the column (Azar et al., 2011) Therefore, divergent validity is also confirmed.

Findings

As explained in the materials and methods section, in the qualitative section, Brown and Clark's theme analysis method was used, the steps of which

are shown together in (Table 7).

Validity check of dimensions and indices of the model was done from structural equations and factor analysis of the first and second type using smartpls3 software. (Fig. 3 and Fig. 4) show the output of the software.

The strength of the relationship between the Dimensions and Index is shown by the factor loading. Factor load is a value between zero and one. If the factor load is less than 0.3, the relationship is considered weak and it is ignored. A factor loading between 0.3 and 0.6 is acceptable, and if it is greater than 0.6, it is very desirable. Therefore, according to Figs. 3 and 4 and the values of Table 8, the first-order factor analysis for the model indicators is confirmed.

Table 9 shows the coefficients of the path and the values of the t-student test. If the t-student test values are greater than 2.58, the path coefficient is significant at the 0.05 level, so the dimensions of open governance are also confirmed. the establishment of open governance requires factors to bring about transparency, participation, and the responsibility of the government or administration.

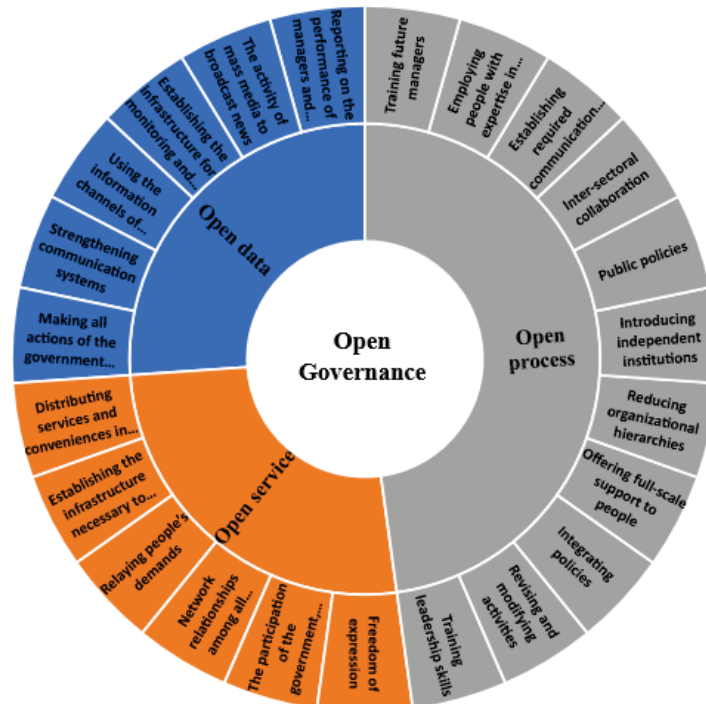


Fig. 2: Display dimensions and indicators of open governance

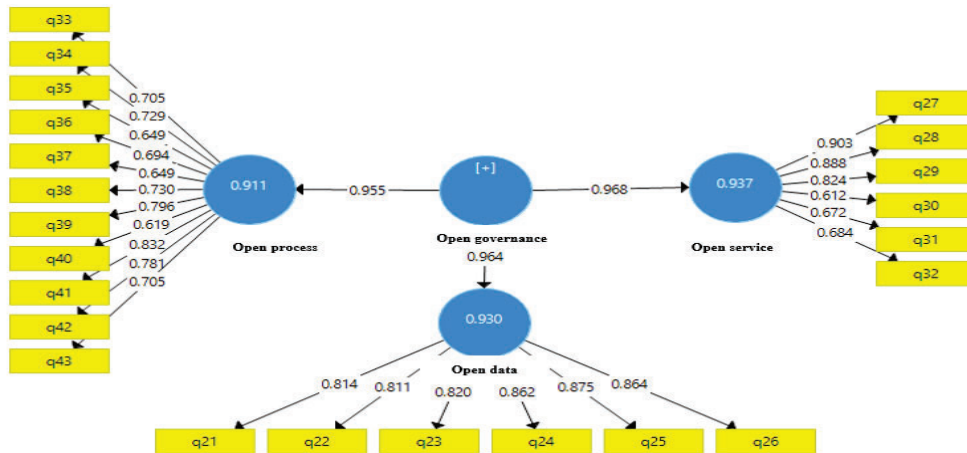


Fig. 3: Significance of the main research model based on path coefficients and factor loadings

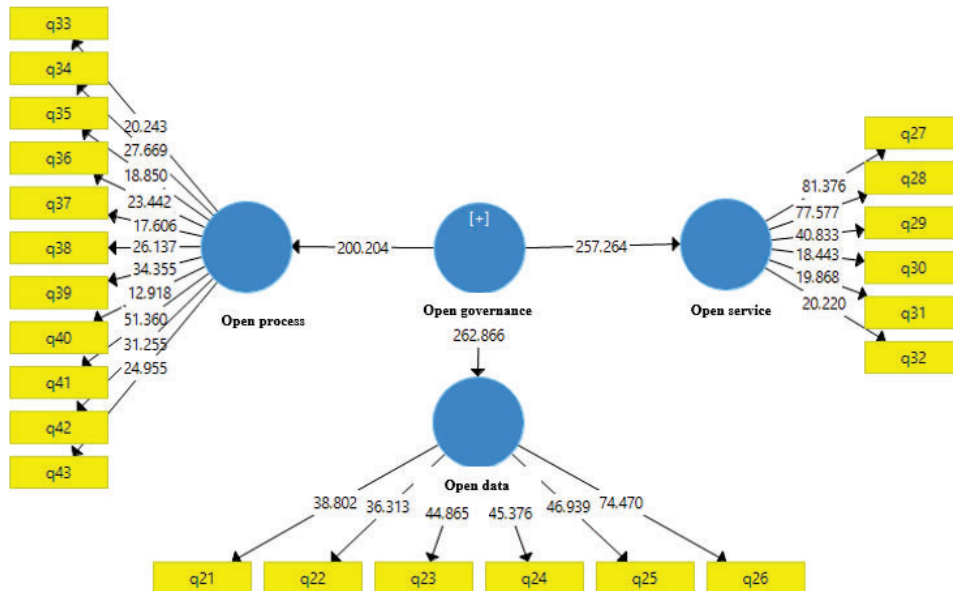


Fig. 4: Significance of the main research model based on T-Student

Discussion

The present study was carried out to designate a practical model for the establishment of open governance in Iran's public institutions by conducting a case study in Tehran Province's municipalities. Thus, after reviewing the related literature and various models offered by researchers in the field of open government/governance and interviewing the elite using thematic analysis, three dimensions were detected as the variables of the present study. The three dimensions included open service,

open data, and open process. The reliability and validity of both qualitative and quantitative sections were corroborated in the study. The dimensions are investigated in more detail below. Open data included reporting on the performance of managers and institutions, the activity of mass media to broadcast news, establishing infrastructure for monitoring and control and the feedback to this, using the information channels of global networks and organizational networks, strengthening communication systems, and making a government's

Table 8: Factor analysis of the first type between indicators and dimensions of the model

Concept (renaming themes)	Dimensions (definition of themes)	Index (extraction of themes)	Factor load values
Open governance	Open data	Reporting on the performance of managers and institutions	0.814
		The activity of mass media to broadcast news	0.811
		Establishing the infrastructure for monitoring and control and feedback on this	0.82
		Using the information channels of global organizations and organizational networks	0.862
		Strengthening communication systems	0.875
		Making all actions of the government accessible to the public	0.864
	Open service	Distributing services and conveniences in a fair manner	0.903
		Establishing the infrastructure necessary to maximize citizens' participation	0.888
		Relaying people's demands	0.824
		Network relationships among all stakeholders and civil society activists	0.614
		The participation of the government, citizens, and private institutions	0.672
		Freedom of expression	0.684
	Open process	Training leadership skills	0.705
		Revising and modifying activities	0.729
		Integrating policies	0.649
		Offering full-scale support to people	0.694
		Reducing organizational hierarchies	0.649
		Introducing independent institutions	0.73
		Public policies	0.796
		Inter-sectoral collaboration	0.619
		Establishing required communication and equilibrium	0.832
		Employing people with expertise in urban matters	0.781
		Training future managers	0.705

Table 9: path coefficients and values t-student dimensions of open governance

Concept	Dimensions	Factor loadings between open governance and its dimensions	The value of t Student between open governance and its dimensions
Open governance	open data	0.964	262.866
	open service	0.968	257.264
	Open process	0.955	200.204

actions and undertakings accessible to the public. As indicated in the review of the related literature, one solution to increase transparency and responsiveness is to freely offer public information on matters like accidents and illnesses, information on municipalities' comprehensive plans, tenders, fiscal contracts, and the performance of public organizations and their employees. This was corroborated by the majority of the researcher, including [Sami et al. \(2022\)](#), [Abolmaali et al. \(2020\)](#); [Lee and Kwak \(2012\)](#), [Momen](#)

[Kashani et al. \(2020\)](#), and [Pirannejad and Ingrams \(2022\)](#). Open service included the fair distribution of services and conveniences, establishing infrastructure to maximize citizens' participation, relaying people's demands, establishing a network relationship among all stakeholders and activists in civil society, the participation of the government, citizens, and private institutions, and the freedom of expression. Establishing the required infrastructure, including platforms, IT systems to offer public information,

and exchange information for the participation and collaboration of civil society and other stakeholders in society with the governments, are among the most basic dimensions of governance, corroborated by Sami *et al.* (2022); Momen Kashani *et al.* (2020); Abolmaali *et al.* (2020); Pirannejad and Ingrams (2022); Wirtz *et al.* (2022); Ayinde *et al.* (2023). Open process included training people in leadership skills, revising and modifying activities, integrating policies, offering full-scale support for people, reducing organizational hierarchy, introducing independent institutions, public policies, inert-sectoral collaboration, establishing required communication and equilibrium, employing people specializing in urban matters, and training future managers. Any change needs a process. Thus, the establishment of open governance requires governments to pass through stages dealing with technical, legal, cultural, and structural aspects, as well as any other consideration needed for each type of government. This has been corroborated by researchers like Momen Kashani *et al.* (2020); Abolmaali *et al.* (2020); Pirannejad and Ingrams (2022); Ayinde *et al.* (2023).

CONCLUSION

The present study aimed to develop a practical model for the establishment of open governance in Iran's public institutions through a case study of Tehran Province's municipalities of Iran. The study found three dimensions of open governance: open data, open service, and open process. These dimensions were validated through qualitative and quantitative methods, including literature review and interviews with experts. The review of related literature and the majority of researchers' opinions suggested that open governance requires the free flow of public information, fair distribution of services, and infrastructure to promote citizens' participation. Additionally, open governance requires training people in leadership skills, integrating policies, and reducing organizational hierarchy. The study's findings suggest that open governance can be established by addressing technical, legal, cultural, and structural aspects. The study's theoretical implication is that it provides a practical model for the establishment of open governance in Iran's public institutions, which can be generalized to other sectors of Iran and other countries. The practical implications are that the model can be used to guide

policymakers and public managers in implementing open governance practices. However, there were some limitations to the study. The case study was conducted only in Tehran Province's municipalities, and the generalizability of the findings to other provinces and sectors may be limited. Future research can replicate the study in other provinces and sectors of Iran to test the model's validity and generalizability.

Suggestions

According to the findings, the following suggestions are presented to managers and employees of public institutions in Iran:

- In order to increase the awareness of managers and officials of public institutions about open governance, appropriate training courses should be held for them.
- To create policy integration, different policies should be coordinated and inspired by the model presented in this research.
- Public institutions should provide the basis for more activity of civil society by facilitating the conditions for creating organizations and establishing legal protections for them. Also, public institutions should take action regarding delegating responsibilities, holdings and providing the necessary conditions for people's trust in this sector.

AUTHOR CONTRIBUTIONS

S. Tootian did the literature review, experimental design, manuscript text and manuscript preparation. M. Mirzapour helped with the literature review, data collection and analysis and interpretation, and manuscript preparation. G.R. Memarzadeh and G.R. Hashemzadeh helped in reviewing the literature and preparing the manuscript.

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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.

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ABBREVIATIONS

<i>AVE</i>	Average Variance Extracted
<i>CR</i>	Composite Reliability
<i>ICT</i>	Information and Communication Technologies
<i>OD</i>	Open Data
<i>ODC</i>	Open Data Charter
<i>OECD</i>	Organization for Economic Co-operation and Development
<i>OGD</i>	Open Government Data
<i>SDG</i>	Sustainable Development Goals
<i>SEM</i>	Structural Equation Modeling
<i>SEM-PLS</i>	Structural Equation Models using the Partial Least Squares
<i>UN</i>	United Nations
<i>UN DESA</i>	United Nations Department of Economic and Social Affairs

UN
ESCSA

The United Nations Economic and Social Commission for Western Asia

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ORIGINAL RESEARCH PAPER

Human resource management practices and employee engagement

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ABSTRACT

BACKGROUND AND OBJECTIVES: Employee engagement has emerged as a critical factor for organizations seeking to enhance productivity, foster employee well-being, and gain a competitive advantage. Human resource management practices are vital to driving employee engagement. Therefore, based on the social exchange theory, the current study explores the interaction between human resource management practices and employee engagement. and evaluates the level of engagement (i.e., High, medium, low) of employees. Also, finds an association between engagement levels and the age group of employees.

METHODS: The study administered the standardized questionnaire to employees (n= 187) working in information technology companies. A purposive random sampling research design was adopted for data collection. Confirmatory factor analysis was performed to ensure the validity of the adapted questionnaire, then simple linear regression was run in AMOS v24 software for finding the variance between human resource management practices and employee engagement. Further, chi-square and analysis of variance tests were also used in SPSS v22.

FINDINGS: Human Resource Management practices such as recruiting and selection, continuous training and development opportunities, competitive rewards, career advancement, and employee involvement together explained 33 percent variance based on the coefficient of determination (R²) value, where (Beta= 0.57, p<0.001). Also found 30 employees fell in the low engaged category, 96 were in moderately engaged, 61 lay in the high engaged category, where 75 employees out of 96 (moderately engaged employee category) lay in the 20-30 age group and 31 out of 61 (high engaged employee's category) belonged to the 30-40 age group. The novelty of this study is to examine the influence of human resource management practices by taking factors such as rigorous hiring, continuous training, career advancement, competitive rewards, and employee involvement on employee engagement, particularly in the information technology industry.

CONCLUSION: This study highlights the necessity for Human resource management practices to take a proactive, holistic approach to ensure congruence with corporate objectives and emphasize engagement. It also underlines the vitality of ongoing human resource management practice monitoring and growth to maintain and boost employee engagement. The study further discusses the strategies which must be adopted for enhancing the engagement level of low-engaged employees.

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INTRODUCTION

Human Resource Management (HRM) has been engrossed in the last two decades, but the phenomenon has changed. Initially, workers were considered a commodity but are now regarded as the organization's valued assets (Marescaux et al., 2013; Subramanian and Suresh, 2022; Herdiansyah, 2023). HRM practices are related to managing the manpower of the organization, including recruiting, selecting, developing, and rewarding them (Collins and Clark, 2003; Tabiu et al., 2020; Cao and Nguyen, 2022; Aldhaferi et al., 2023). The best talent could be engaged by providing them with flexible approaches toward policies, practices, work design, pay, and benefits. Today's workplaces are much more complex and uncertain than they were in the past. Since the economic policy in 1991, the competition in the global business environment has increased considerably. And since then, Indian Information Technology (IT) companies are growing and have attracted enormous interest from both academia and industry in the last twenty years (Kundu and Mor, 2017). These companies have established themselves as "India's philosopher's stone and have been able to achieve prominence at the international level, making the Indian IT companies a name to be reckoned with in the worldwide scenario (Kundu and Mor, 2017). This industry earned US\$ 227 billion in sales in the Financial Year, 2022 (FY-22), reflecting a 15.5% Year of Year (YoY) growth, and contributing 7.4% of India's Gross Domestic Product (GDP) and its predicted 10% of India's GDP by 2025, confirmed by the report by the India Brand Equity Foundation (IBEF) in February 2023. Due to the rapid expansion of this sector, confronts formidable obstacles including constant technical improvements, and increasing competition, and the real challenge is to maintain and engage its qualified workforce. Also, these industries are essentially dynamic and people-centered and rely on the intellectual growth, knowledge, competence, proficiency, and cognitive ability of their employees to maintain a competitive advantage and to engage employees by implementing effective HRM practices has become crucial (Murthy and Abeysekera 2007; Nair and Vohra 2010; Sekhar, 2022; Sharma, 2022; Subramanian and Suresh, 2022). The dynamics of IT companies are changing at a rapid pace, so skills have to be modified quickly as per market trends and restructured for attaining

competitive advantage and positive work-related outcomes (Bakker et al., 2003; Minbaeva, 2005; Fiorito et al., 2007; Yadav et al., 2022). The higher employee turnover is forcing firms to have more innovative HRM practices to retain the talent, who possess the necessary skills and competencies, and experience to maintain organizational performance. Therefore, engaging the best talent in this sector has become crucial, and Human Resource (HR) managers in this industry need to be strategic and concentrate on developing talent relationships by providing various practices (Gellatly et al., 2009; Sarenko, 2023; Rahman et al., 2022; Saif et al., 2023). There may be soft and hard HRM, former can be treated as a modern approach to treat an individual as a human with a personal touch, which defines that there must have a friendly work environment, participative management style, a challenging task to create initiative, and many more while later including authoritarian management style, pessimistic view of people, unmotivated and dislike work. Innovative HR practices directly related to the Soft HRM, resulting in positive employee behavior but the quality of implementation of these practices has the greatest effect (Weisberg and Kirschenbaum, 1991; Paul and Anantharaman, 2004; Benson, 2006; Marescaux et al., 2013). Employees who feel aligned with their organization are pushing longer, staying longer, and inspiring others to do the same known as employee engagement. Engaged workers are those who have or reflected positiveness, are gratifying, and are associated with work in the particular organization. It is categorized by vigor, dedication, and absorption. Vigor refers to a high degree of zest and cognitive agility, while dedication defines a commitment to work, excitement, creativity, challenges, and pride. Absorption means that it is consumed to fulfil the aims of an organization (Schaufeli et al., 2002). Engaged workers through the provision of work services or by providing job resources, including freedom of choice, opinions, and supervisor assistance (Macey and Schneider, 2008; Albrecht et al., 2015). These resources play an active role in the drivers of employee engagement and job satisfaction and decreased burnout and also define the extrinsic and intrinsic motivational role (Tims et al., 2013). Extrinsic motivation is reward-driven behaviour. Giving recognition and other incentives can motivate the employee towards goal attainment whereas,

intrinsic motivation occurs when inner forces such as growth in oneself or an urge to promote success (Van den Broeck *et al.*, 2008; Zhao *et al.*, 2023). HRM practices have a positive influence on desired behaviour such as employee creative performance (Yang and Yang, 2020), job satisfaction, and organization commitment (Meyer and Smith, 2000; Loi *et al.*, 2006; Marescaux *et al.*, 2013; Li *et al.*, 2019; Aboramadan *et al.*, 2020), employee engagement (Bakker *et al.*, 2003; Xanthopoulou *et al.*, 2009; Van Wingerden *et al.*, 2017; Nehra, 2023) and lower turnover rates (Li *et al.*, 2019). Engaged people can create a positive environment that gives results like; a hike in sales, financial returns, and enhanced productivity (Maryati *et al.*, 2022). A quantitative study based on 227 samples of 24 small medium enterprises of the eastern and western mainland in China indicated that employee perception of HRM practices such as development and continuous learning, compensation, and performance feedback positively related to commitment and inversely related to employee turnover (Li *et al.*, 2019). Social Exchange Theory (SET) is a sociological and psychological theory that involves an economic relationship between two parties i.e., an employer-employee relationship where they take responsibility for one another and depend on each other (Cropanzano and Mitchell, 2005). Employees put efforts into accomplishing particular goals in consideration to get rewards from an employer. For implementing effective HRM practices, an organization must have strong employer-employee relations. The link between engagement and the HRM domain offers the potential to both broaden the study of engagement in the body of current literature as an emotional state and to take engagement into account within a societal framework (Truss *et al.*, 2013). Conway *et al.* (2016) used employee voice, and performance management activities as distinct HR practices that can be utilized to increase engagement while also balancing the requirements of a system for managing performance and decreasing the adverse consequences of emotional fatigue. While, Saks (2022) explained that caring HRM practices which include flexibility, work-life balance, job design, safety, a healthy environment, and providing career development opportunities should lead to engagement level up of employees. In other words, the employer should develop an organizational

care environment that will not enhance the engagement level but will also help to attain the organization's goals efficiently. Xiayan *et al.* (2021) found that hiring procedure, compensation, and performance feedback practices have a significant effect on the staying of young employees, whereas, training and development do not. Akter *et al.* (2022) revealed that except for the training and development practices, all other talent practices (career development and reward and recognition) have a positive influence on employee engagement through psychological empowerment. Whereas, a longitudinal time-lagged survey revealed that the perception of organization politics has a partial mediator between high-involvement work practices and employee outcomes such as trust in employer and engagement (Mehmood *et al.*, 2022). Prior studies defined different HRM practices as per their context and outcomes. A few HRM practices (rigorous hiring, continuous training, competitive rewards, career advancement, employee involvement) are defined in this study in the context of Indian IT companies that may have an impact on the individual level outcome (employee engagement) have not been studied so far. Prior studies (Gitanjali *et al.*, 2010; Aktar and Pangil, 2018) focussed on the role of individual HRM practices on employee engagement but this study focused on the bundle of HRM practices on employee engagement rather than the individual. Hiring the right people for the right job has become crucial for HR managers in IT companies. These companies require young talent who can boost their energy for creativity and update themselves towards new adaptation. Hiring the best talent not only systematically leads the organization's objective but also facilitates the transfer of knowledge from an individual to a company (Gope *et al.*, 2018). Matching the right talent with the right job may create organizational commitment and ultimately achieves the objectives (Lauver and Kristof-Brown, 2001; Chew and Chan, 2008). This also ensures a sense of accomplishment and gives job happiness and encourages positive behaviour (Si and Li, 2012; Aboramadan, *et al.*, 2020). Studies showed that positive relationship between selection procedure based on person's ability fit and employee engagement in the higher education sector (Aboramadan, *et al.*, 2020). Previous scholars (Lauver and Kristof-Brown, 2001; Kristof-Brown *et al.*, 2005;

Chew and Chan, 2008; Aladwan *et al.*, 2015) demonstrated that the selection of an employee based on his/her ability leads to organizational commitment and committed employees may create engagement for the organization. An inverse relationship has been found between turnover intentions by giving two HRM practices: rewards and training. Employees, who feel more committed at their workplace, are less likely to quit (Guchait and Cho, 2010). *Continuous training opportunities* are the most common and widely used practice for updating manpower according to trends, especially in high-tech firms, and have a positive link with employee engagement (Paul and Anantharaman, 2004; Aktar and Pangil, 2018; Pinskaya *et al.*, 2021; Sunarti *et al.*, 2023). Prior literature also defines that training has a positive influence on organizational commitment (Meyer and Smith, 2000, Aboramadan *et al.*, 2020), firm productivity (Guthrie, 2001), and organizational effectiveness (Otoo, 2020). perceived efficacy and engagement (Tomar and Dhiman, 2013; Sivapragasam and Raya, 2018; Tahir, 2023). *Rewards* (Venkataramanan, 2023) are defined as financial and non-financial benefits paid to employees in consideration of their services to the organization. Employees might leave the organization when they offer rewards more than their existing workplace. Competitive rewards can motivate employees to engage with the organization (Li *et al.*, 2019; Aboramadan *et al.*, 2020, Venkataramanan, 2023). *Career enhancement* defines growth or upward progression in one's career by providing continuous training and overall development and it indicates that employers are interested in building long-term relationships with their existing talent. Studies demonstrated that development opportunities have a positive link with employee engagement and a negative link with burnout (Chuang and Liao, 2010; Albrecht, 2012; Van De Voorde and Beijer, 2015). Studies found that career advancement is the salient antecedent of employee engagement (Bal *et al.*, 2013; Sarti, 2014; Aktar and Pangil 2017; Huang *et al.*, 2018). *Employee involvement*, as per SET assumptions when an employee feels valued at their workplace, is likely to be motivated, obligated, and reciprocate by giving a positive attitude in the organization which by default creates engagement and employee well-being (Tremblay *et al.*, 2010; VDe Voorde and Beijer, 2015). Strive for clarity, transparency, and honesty

must be there between the organization's goal and employees' goals. Based on the particular employee's talent, skills, and ability corresponding set the goal and give a time frame also (Sivapragasam and Raya, 2018). Selection of employees based on person-job fit, competitive rewards, continuous training opportunities, flexibility in career advancement, and ensuring their involvement in decision-making are broadly termed as HRM practices. Based on prior literature, the following hypothesis is proposed:

H1: HRM practices have a positive influence on employee engagement

To attain these objectives, a survey was conducted between January 2022 to October 2022 northern region of Indian software companies.

MATERIAL AND METHODS

Procedure and sample

For data collection, a survey link was created through Google form and spread among middle-level employees of software companies. Overall, 53.9 percent of the sample was male 46.1 were female. 64.2 percent of respondents were 20-30 age group and 28.8 percent were in the 30-40 age group and 4.67 percent were above 40-50 and a very small proportion was above 50 age. 45.6 percent of respondents had a post-graduate degree and 50.3 had an undergraduate degree. The majority of respondents (59.1) had fallen 0-5 experience category.

Measures

The top five IT companies namely TCS, Infosys, HCL, Wipro, and Tech Mahindra, were targeted based on the market capitalization above 1000 billion and where the number of employees approx. 25000 million hired to tame high attrition FY-22. Using Cochran's formula, the statistical sample was estimated at 384 with a 5% error, therefore a questionnaire was sent to 400 middle-level employees and finally, 215 were received but the analysis was done on 187 responses as were completed (Moradi *et al.*, 2022). The adequacy of the study's sample size was derived using a priori statistical power analysis utilizing the G* power (Faul *et al.*, 2007), assuming a mean effect size of f square 0.15 and a maximum of 4 factors, yielding an adequate sample size of 74. A combination of a random and purposive sampling approach was adopted to administer the survey and collect the data. Random sampling was applied to

select service providers in the IT companies while the purposive sampling approach was used to select respondents who are operating at the middle level with service responsibilities in this industry. Content validity was carried out to determine if the contents of the questionnaire were appropriate, relevant, and necessary for research. Experts from the HR, marketing, and IT sector managers have (as the study research design is purposive sampling) verified the content of the scale. Face validity assesses the feasibility, readability, presentation of the questionnaires, consistency of style, and format (Devon *et al.*, 2007). All measures were scored using a 7-point Likert scale from 1 (strongly disagree) to 7 (strongly agree). Reverse statements are also used in a questionnaire to ensure the reliability and concentration of the respondents. Confirmatory factor analysis was used to check the validity of each construct. For measuring HRM practices, a five-item HRM practices scale is used which is originally developed by Sivapragasam and Raya (2018). Sample Items include: "selection of new hires is based on one's competencies and person-organization fit". And for measuring employee engagement, the study used the most common scale developed by Schaufeli *et al.* (2002) with 11 items, 4 items for measuring vigor (e.g., "At my work, I feel bursting with energy"), 4 for dedication (e.g., "My job inspires me"), and 3 for absorption (e.g., "When I am working, I forget everything else around me").

RESULTS AND DISCUSSION

Scholars (Sposito *et al.*, 1983; Al-Ajlouni, 2021;

Tajpour and Razavi, 2023), checked normality by skewness and kurtosis values that should be at the desired threshold (± 2.7). Table 1 shows descriptive statistics which ensure data is normal, and can do further analysis in Covariance-Based Structural Equation Modelling (CB-SEM), AMOS software. Therefore, the present study evaluated first the measurement model using confirmatory factor analysis in AMOS v24 software (Shek and Yu, 2014). HRM practices, and sub-factors (vigor, dedication, absorption) were taken individually for measuring construct and discriminate validity. Reliability was assessed using Cronbach alpha in SPSS v22. All values lay between .953 to .911 which is above the minimum threshold limit (Cronbach alpha > 0.7), recommended by (Hair *et al.*, 2019) shown in Table 1

To ensure discriminating validity, the Average Variance Extracted (AVE) of each construct, used in the model must be greater than the squared correlation of that construct. The AVE of each construct should be larger than the Maximum Shared Squared Variance (MSV) for each pair, shown in Table 2 which states that there is no problem with discriminatory validity. Hence, all variables defined to be unique and distinct from other constructs.

Table 3 represents the correlation at $p < 0.01$ which signifies that all correlated values (HRM practices) were more than 50 percent with employee engagement. Continuous training opportunities have a high correlation with employee engagement among all HRM practices. Table 4 indicates the model fit results recommended by Collier, (2020), where the goodness of fit indicators are: Normed Fit Index (NFI)

Table 1: Descriptive statistics and Cronbach alpha values

Constructs	Items	Mean (S.D)	Skewness (Kurtosis)	Cronbach alpha
HRM practices	5	5.898 (1.08)	-1.701 (3.782)	.919
Vigor	4	5.576 (1.15)	-.861 (.186)	.938
Dedication	4	5.811(1.168)	-1.482 (2.481)	0.953
Absorption	3	5.56(1.158)	-.822(.227)	0.911

Note: S.D = Standard Deviation, HRM = Human Resource Management

Table 2: Reliability and validity using AMOS

Factors	CR	AVE	MSV	MaxR(H)	DED	HRM	VIG	ABS
DED	0.954	0.840	0.401	0.966	0.917			
HRM	0.924	0.708	0.356	0.928	0.567	0.841		
VIG	0.940	0.797	0.468	0.942	0.586	0.398	0.893	
ABS	0.913	0.778	0.468	0.914	0.633	0.597	0.684	0.882

Note: CR= Composite Reliability, AVE= Average Variance Extracted, MSV= Maximum Shared Squared Variance, VIG= Vigor, DED= Dedication, ABS= Absorption. Bold values represent the square root of AVE

Table 3: Correlation of each HRM practices with employee engagement

HRM practices	Correlation
Selection of new hires is based on person-job fit	.545
Competitive rewards	.621
Continuous training opportunities	.625
Flexibility in career advancement	.587
Employee involvement	.621
Employee engagement	1.00

Table 4: Measurement Model (Model Fit Indices)

Fit indices	Cut of point	Measurement model
Absolute measure		
CMIN/DF	≤ 3.000	3.00
PCLOSE (RMSEA)	≤ 0.08	0.02
GFI	$\geq 90\%$.835
Incremental measure		
NFI	$\geq 90\%$.906
CFI	$\geq 90\%$.935
IFI	$\geq 90\%$.935
Parsimony fit measure		
PNFI	$\geq 50\%$.740
PCFI	$\geq 50\%$.763
AGFI	$\geq 80\%$.772

(.906), Comparative Fit Index (CFI) (.935), Incremental Fit Index (IFI) (.945), Parsimony Normed Fit Index (PNFI) (.740), Parsimony Comparative Fit Index (PCFI) (.763), Adjusted Goodness of Fit Index (AGFI) (.772) and badness of fit indicators are as: PCLOSE is used with conjunction of Root Mean Square Error Of Approximation (RMSEA) is (0.02), all values were lying in its threshold range indicating good model fit (Bentler, 1990; Byrne, 2001).

Fig. 1 has shown the cross-loadings of various constructs with each other and also regression weights which help the researcher to find out reliability and validity.

Fig. 2. shows the structural model that demonstrated HRM practices are positively and significantly related to employee engagement (path coefficients =0.57, $p < 0.001$). The study used five variables towards the HRM practices and took the average of it, a new variable termed "HRMavg" and then did an average of all eleven statements of employee engagement (4 items in vigor, 4 items in dedication, and 3 items in absorption) and named as "eeavg". Then run the simple linear regression and found that thirty-three percent is explained by HRM practices.

As data were gathered from different top IT companies, analysed inconsistencies between samples of measures used in the study. Analysis of variances (ANOVA) is a statistical way used by the ANOVA for measures of discrepancies between information. The ANOVA test uses both the F ratio and the significance statistic since the average difference between samples of more than two samples is very difficult to estimate. Table 5 shows that there is a substantial difference in the average score in the perception by demographic variables such as age and job experience of the factors of employee engagement. As the p-value is less than a one percent level of significance, which indicates the age group of the respondents and their work experience both have a significant effect on factors of employee engagement. Table 6 indicates that the gender group has no variation. There is no impact of gender on employee engagement as all p values are greater than at one percent level of significance hence concluded that there is no variation between gender group and employee engagement factors. Levene's test is used for finding equality of variances.

Based on employee engagement scores, the study found the engagement level of employees.

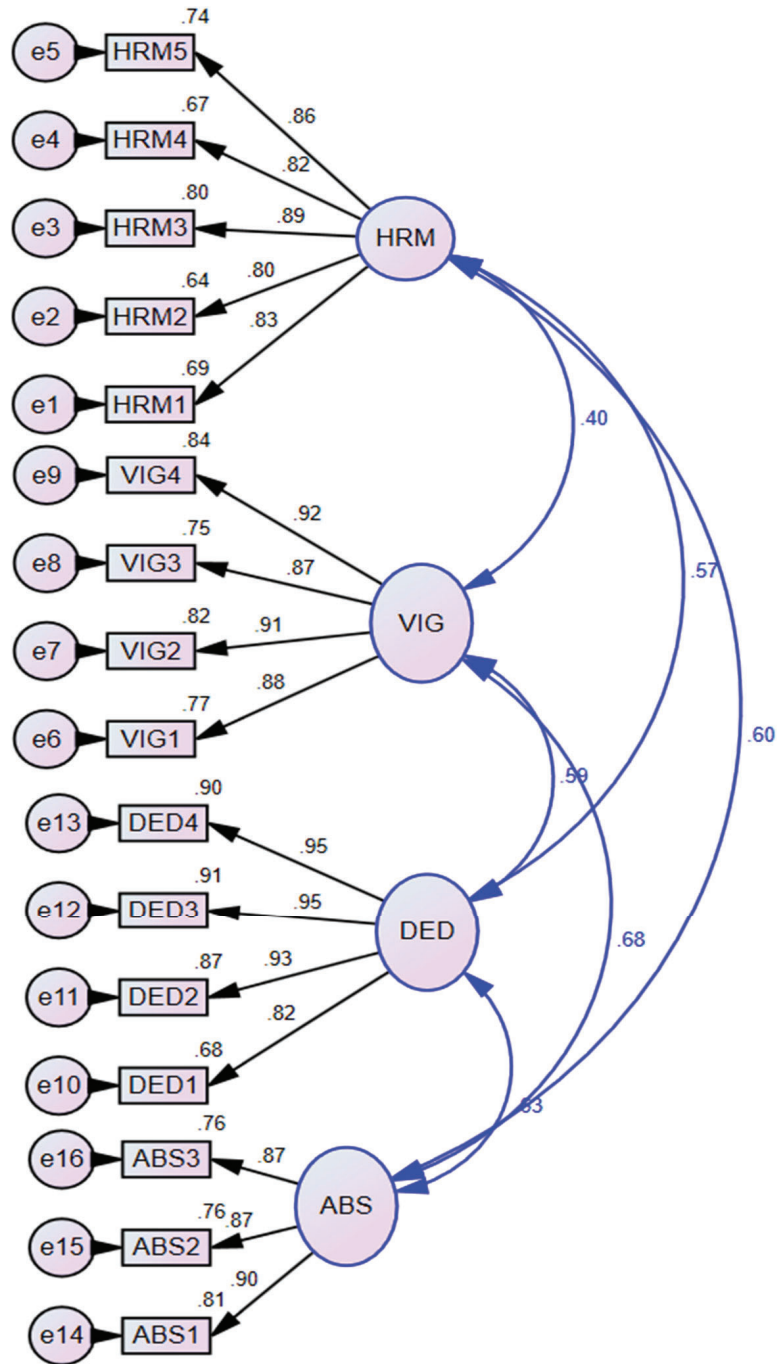


Fig. 1: Confirmatory factor analysis using AMOS software

Table 7 indicated, 30 employees were lying in the low engaged category, 96 employees fell in the moderate category, and 61 lay in the high engaged category.

Mean +S.D. = High engaged = 61.94 + 14 = >75.94

Mean -S.D. = Low engaged = 61.94 - 14 = < 47.94

Mean +S.D. or Mean -S.D. = medium or moderately engaged lies between 47.94 to 75.94.

To check the association between age group and

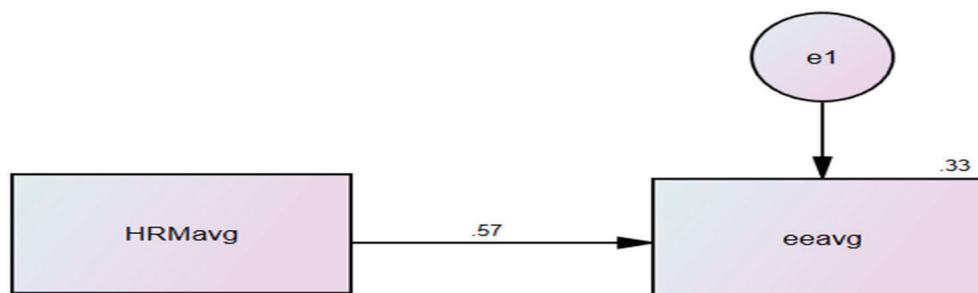


Fig. 2: Simple linear regression results

Table 5: ANOVA results

Variable	Factors	Details	Sum of squares	Df	Mean square	F	sig
The age group of the respondents	Vigor	Between groups	67.24	3	22.41	9.83	.000
		Within groups	417.08	183	2.279		
		Total	484.33	186			
	Dedication	Between groups	44.01	3	14.67	10.19	.000
		Within groups	263.28	183	1.44		
		Total	307.296	186	29.51		
	absorption	Between groups	88.539	3	2.018	14.63	.000
		Within groups	369.21	183			
		Total	457.75	186			
Total work Experience	Vigor	Between groups	70.008	3	23.336	10.307	.000
		Within groups	414.321	183	2.26		
		Total	484.330	186			
	Dedication	Between groups	23.136	3	7.71	4.967	.002
		Within groups	284.16	183	1.55		
		Total	307.296	186			
	Absorption	Between groups	67.324	3	22.44	10.519	.000
		Within groups	390.429	183	2.13		
		Total	457.753	186			

Table 6: Independent sample t-test results

Factors of employee engagement	Gender		T value	F value	P value
	Female	male			
Vigor	5.63 (1.51)	5.21 (1.68)	1.77 1.78	3.37	Vigor
Dedication	6.16 (1.14)	5.84 (1.39)	1.727 1.751		Dedication
Absorption	5.75 (1.40)	5.18 (1.66)	2.52 2.54	4.822	Absorption

level of engagement, a chi-square test is applied. Table 8 indicated that the p-value is less than at a five percent significant level concluding that there is an association between age group and level of employee engagement. For employees who belong to the 30-

40 age group, the number of employees is highly engaged in this group. And 20-30 age group people are moderately engaged.

A significant positive relationship (Beta = 0.57, p = 0.001) has been found between HRM practices and

Table 7: Level of employee engagement

Level of employee engagement	frequency	Percentages
Low	30	16
Moderate	96	51.3
High	61	32.6
Total	187	100

Table 8: Association between age group and engagement level

Level of employee engagement	Age group				Chi square value	p value
	20-30	30-40	40-50	Above 50		
Low	28	2	0	0	59.863	0.00
Moderate	75	21	0	0		
High	18	31	8	4		

employee engagement, and results were consistent with the previous studies, which found when workers are provided with supportive practices, they tend to report a high level of employee engagement (Edgar and Geare, 2005; Kinnie *et al.*, 2005; Kuvaas, 2008; Snape and Redman, 2010; Tremblay *et al.*, 2010; Alfes *et al.*, 2013; Yu *et al.*, 2022). Based on SET properties, employees who receive monetary or social benefits via HRM practices feel obligated to show gratitude to the organization considering their reciprocal bond regarding their employer and to pay back their organization by displaying a greater level of engagement (Karatepe 2013; Song *et al.*, 2014; Van De Voorde and Beijer, 2015; Huang *et al.*, 2018). In this study, demographic variables (age, gender, work experience) were also studied. Table 5 showed that three employee engagement factors, are statistically important at the 5% level and that these three factors are significantly affected by the variables 'age group of the respondents' and 'work experience' of the employees, which concludes that different age group people have different perception towards the factors of employee engagement. Table 6 described that the variance is equal for males and females for measuring the three-factor of employee engagement. Employee engagement is independent of gender. Table 8 indicated elderly expertise employees of higher age are identified to report a high level of engagement. The reason for such relationships may be that most of the benefits associated with employment, such as money, status, and power, accrue with tenure. Employees who belong to the 30-40 age group and

above that, are highly engaged in their organization. Literature highlights how HR practices help the organization to address organizations uncertainties. The selection of employees as per the abilities required in the firm and time to time provide career opportunities are highlighted. In the HRM practice, employees prefer to report positive behaviour like happiness at the work, commitment, and engagement in their jobs when employees see their social exchange relationship that is an employer is providing various benefits in the form of HRM practices to the employees. This would in turn boost productive workforce synergies and contribute to higher results. When workers are conscious that they are supportive, draw resources, and are happy with these activities, they will meet the demands of their job well.

Theoretical and Practical Implication

This study helps the HR practitioner to design an environment that optimizes employee development and engagement towards the organization. Implementing a rigorous hiring procedure aids in the selection of suitable candidates for the job. Organizations may boost their engagement by selecting individuals with the appropriate expertise, endorsements, and personality traits. Recruiting staff that is a good fit for their tasks and their workplace tends to likely elevates work happiness and commitment (Karatepe and Karadas, 2015). Offering regular training sessions for workers highlights the organization's commitment to their development as professionals. Indian IT organizations can strengthen the talent's

competencies, expertise, and capacities by establishing education and training programs that can result in broadened happiness at work, inspiration, and an overwhelming feeling of advancement in oneself, ultimately enhancing engagement (Saks, 2022). Employees in these firms can benefit from established rules for professional upward mobility, such as advancements, and lateral transfers. Also, firms should create reward schemes that are aligned with employee performance, contribution, and market standards. Equitable and attractive awards not only encourage employees but also build a sense of gratitude, pleasure, and tenacity, resulting in improved engagement. This study indicates that when these practices are being provided according to the staff needs then it brought the engagement level up. However, findings also indicate that while creative HR practices are structured to handle workers as persons with their characteristics, employees are not often viewed as individuals in action. As a consequence, adopting flexible HR procedures is inadequate. To achieve a higher degree of commitment, managers should also “walk the talk” and devote attention to considering the individual skills, desires, and aspirations of employees when implementing HR activities.

CONCLUSION

Building and maintaining their talent pool is the main challenge facing IT companies today. High-tech companies should pay attention to employee engagement, especially in competitive and rapidly evolving times. Engagement can be improved by executing effective hiring tactics that seek out and choose competent workers who embrace the organization’s principles and objectives. Effective hiring adheres to ensure that employees and the organization are a good fit, strengthening their dedication and drive. Companies that prioritize learning, upgrading, reskilling, and career growth programs turn an engagement through letting employees feel appreciated and offering them chances to hone their expertise and flourish in their respective fields. and empowering workers to make a greater contribution to their jobs and organization. And employees should be paid competitive salaries as the similar organization is providing.

This study also identified level of engagement that is high, moderate, and low. Transforming the low-engaged people to highly engaged, a firm should adopt strategies. Like, the firm should provide flexible

working hours, rather than having a rigid time policy to stay in the office, people tend to be more efficient, happier, and more engaged in the workplace when they have flexible work hours’ autonomy. It is vital to know that trust is inspired by a genuine partnership between staff and management and fosters teamwork. As an employer, try the best not to distort relationships and develop a trusting working environment. Employers should take regular feedback on their job styles, work environment, job stress, and other aspects. Taking feedback from workers makes them feel as though their opinion is respected and plays an important role in the business. Establish a people-focused community, promote teamwork, and participate in daily interaction activities.

Limitation and future scope

Due to cross-sectional data, this study’s results cannot be generalized, also the sample size was very low to broaden the results. The survey was restricted to Indian IT companies. Rather future scholars either could go on longitudinal study or Multiple cross-sectional designs or experimental should use, with data collection from two distinct groups of participants (supervisors and subordinates) at the same time to establish the causal order of the relationships and also future scholar should explore more on HRM practices and correlate with positive work behaviour such as organization citizenship behaviour, proactive work behaviour.

AUTHOR CONTRIBUTION

K. Goyal carried out the idea development, performed literature review, data collection, worked on software. A. Nigam helped in editing and date interpretation and N. Goyal corrected data, edited and validated it.

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CONFLICT OF INTEREST

The author declares 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 falsifi-

cation, double publication and, or submission, and redundancy have been completely witnessed by the authors.

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ABBREVIATION

AGFI	Adjusted goodness of fit index
AMOS	Analysis of moment structures
CMIN/DF	Minimum discrepancy function by degrees of freedom divided
CFI	Comparative fit index
CR	Composite reliability
FY-22	Financial year 2022
GDP	Gross Domestic Product
GFI	Goodness of fit indices
HRM	Human resource management
IBEF	India Brand Equity Foundation
IFI	Incremental fit index
IT	Information technology
MSV	Maximum shared squared variance
NFI	Normed fit index

PCFI	Parsimony comparative fit index
PNFI	Parsimony- normed fit index
RMSEA	Root mean square error of approximation

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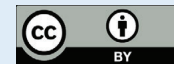
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ORIGINAL RESEARCH PAPER

Prioritizing factors affecting green human resources management, using fuzzy network analysis in the organization

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ABSTRACT

BACKGROUND AND OBJECTIVES: As of present, Green Human Resource Management holds a paramount standing as a crucial business strategy among noteworthy organizations and enterprises, in which Human Resource Department play a vital role. Taking an affirmative role in adopting sustainable practices within the workplace is paramount towards promoting an eco-friendly Environment. As the most prominent entities within societies, organizations possess the capacity to diminish environmental degradation through their undertakings, thereby constituting one of the avenues towards effecting environmentally conscious human resource management within organizational settings. To enact green human resources management within an enterprise, it is essential to identify and establish the key necessities for realizing such a program in the organization. Aligned with the social obligation that rests with organizational executives, they ought to proffer their aspirations, objectives and obligations towards cultivating an environmentally conscious entity. Such stewardship can ameliorate the potential constraints on future demands for ecological resources. In Iran, the field of green human resource management has received limited attention in the extant literature. Thus, the present investigation aimed to identify and rank the critical prerequisites for effectively implementing green human resources management within an organization. Green human resource management involves the utilization of human resource management principles and practices to facilitate more sustainable and eco-friendly use of organizational resources, as well as the promotion and encouragement of environmentally responsible initiatives. The aim of this study is to enhance the environmental quality through the enhancement of the ecological practices of organizations. This can be achieved by identifying and incorporating environmentally sustainable human resource management strategies in organizational operations. The study has successfully identified and prioritized determinants of effective green human resource management within organizational contexts, through utilization of the Fuzzy Network Analysis Process method.

METHODS: The study method is mixed exploratory. The statistical population of this study included 30 experts in the Municipality of Tehran. In this study, the targeted sampling method was used. In this study, based on the research background and expert opinions from the two categories of organizational culture and skills, the influencing factors of green personnel management based on sustainable development were identified and a total of 11 sub-criteria for the main categories were defined. The data collection tool was a questionnaire designed based on the Delphi technique and finally analyzed using the fuzzy method.

FINDINGS: The results showed that organizational culture is the main factor in creating green human resources management with an average of 4.58, followed by skills with an average of 4.49.

CONCLUSION: Green human resource management refers to activities that involve the development, implementation and ongoing maintenance of a system that leads to the greening of the company's employees. In this context, regular employees should become green employees; So that they can reach the organization's environmental donation and ultimately make a significant contribution to environmental sustainability. By promoting the organizational culture and identified skills, employee participation, aligning environmental programs with the organization's environmental goals, supporting senior management and providing sufficient budgets and resources, it is possible to improve green human resource management in Tehran municipal organization.

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INTRODUCTION

Human Resource Management (HRM) is the process of working with people to enable those people and their organizations to reach their full potential, even when changes require the acquisition of new skills, new responsibilities and a new form of relationships. In fact, HRM is the use of human resources for the goals of the organization and includes activities such as recruitment, training, salaries, and organizational relationships (Aibaghi Esfehiani et al., 2017). In other words, HRM is a function in the organization that maximizes employee performance by fulfilling the employer's strategic goals. HRM tries to find out how people can be managed in organizations, with a focus on policies and systems. HRM units and departments are specifically responsible for some activities, including hiring, training and development, performance appraisal, and reward and punishment (e.g., administering the payroll and benefits system) (Babajanzadeh and Navaei, 2014). In recent decades, due to the changes and developments in environmental conditions in the field of increasing and unreliable competition, large organizations pay more attention to issues such as creativity and innovation at the organizational level (Tajpour et al., 2018; Vasudevan and Iqbal, 2018). Environmental conditions in green organizations, one of the most important roles in creating green thinking among the employees of the organizations is the role of managers and human resource professionals to transform employees into people who care about the environment. In order to achieve environmental goals, environmental issues must be defined and implemented in various Human Resource (HR) management policies, such as recruitment, training, performance evaluation, and reward (Farrokhi, 2019). Green Recruitment and Selection (RS) is an important part of environmentally friendly HRM practices. Organizations attract and select people who are committed to environmental issues (Ercantan and Eyupoglu, 2022). Increasing environmental concerns and the consequent emergence of international environmental standards have compelled organizations to adopt green strategies and continue to apply green management in all organizational matters and concerns (Aggarwal and Sharma, 2015). HRM, by focusing on greening of human resources, contributes to the organization's strategic goals towards greening of the organization. One of the most important tasks of Green Human

Resources Management (GHRM) is to help the organization to create and implement green thinking among the employees (Opatha and Arulrajah, 2014). Green management is required to become a green organization (Loknath and Azeem, 2017). In this respect, green management includes the effective and efficient use of all human and material resources to guide and monitor organizations in the achievement of environmental goals with the aim of creating social acceptance and preserving the environment (Lee, 2009; Arredondo-Trapero et al., 2023). In the area of green management, Human resource management measures have been developed under the title of Green Human Resource Management (GHRM). Greening the functional dimensions of HRM such as job description, recruitment, selection, training, performance evaluation and rewards has been defined as green human resource management (Sudin, 2011). In the era of increasing awareness in the field of environmental management and sustainable development of resources, green human resources management focuses on the environmental management practices of companies, in which HRM acts as a platform for connecting human resource management activities with the company's environmental management activities; therefore, Green Human Resources Management (GHRM) is an important area of corporate management (Jabbour and De Sousa Jabbour, 2016). The term green human resource management refers to all activities related to the development, implementation and maintenance of a system with the aim of forming employees of a green organization. This role of human resources management is done through the transformation of regular employees into green employees and relates to the policies, practices and systems that guide the employees of the green organization to work for the benefit of the individual, society, the natural environment and the company (Behnejad, 2018). Considering the importance of the category and the theme of GHRM, organizations are also moving towards greening their devices (Kim et al., 2019). For example, greening the organization creates new jobs and employment opportunities, provides opportunities for innovation, and ultimately leads to increased comfort and well-being (Aibaghi Esfehiani et al., 2017). In general, organizations that have adopted GHRM, have benefited from its implementation and their employees have improved morale. The sustainability

of the organization is the ability to maintain or develop performance over the long term and therefore the satisfaction of the organization's stakeholders over time (Mishra, 2017). Broadly, approaches to GHRM can be grouped into four perspectives: cross-functional (delegated and cross-functional), business (based on instrumental thinking), strategic and operational (mission and function). Realizing the values of peaceful coexistence between the organization and the environment is the goal of the trans-role perspective. In studies of green human resource management, the strategic view places the concept of green in a strategic position in the organization's strategies and human resource management. The commercial view is based on justifying the organization's missions by adopting a concrete green approach in addition tries to reflect green concepts in the roles, responsibilities, and functions of human resources (Tavakoli *et al.*, 2017). Developing an employee's environmental competency involves embedding a positive environmental attitude in the organization through human resource activities such as recruitment, selection, training, and leadership development (Awazkhah, 2019). Generally speaking, green employee behavior can be increased to voluntarily enhance a company's performance through green human resource management practices in the areas of organizational culture and organizational skills. Achieving sustainability in all activities that use resources, as well as their quick and seamless replacement, is the goal of sustainable development. Pervasive global problems such as loss of natural resources (Peñaranda Barba *et al.*, 2022), environmental degradation (Samimi and Shahriari Moghadam, 2018), recurring financial crises, and ultimately natural resource proliferation are leading to a shift in development paradigm from consumption towards sustainable development and the recognition of green economic growth (Zaid *et al.*, 2018; Brotosusilo *et al.*, 2022; Salvaraji *et al.*, 2023). According to the World Commission on Environment and Development, sustainable development meets the needs of the present generation without compromising the ability future generations to meet their own needs. Such development is smart, Eco-friendly and based on effective use of resources, knowledge and innovation (Kramer, 2014; Samimi and Shahriari Moghadam, 2020; Candrianto *et al.*, 2023). The green management approach is based on the concern for sustainability and, therefore, the sustainability of the organization,

as well as social approaches and economic incentives, organizational culture, organizational capacity, health and safety of the company, employees and publishing to the desired audience image of the organization over a long period of time (Mansour, 2023; Sivakumar *et al.*, 2022; Gryshchenko *et al.*, 2022; Barforoush *et al.*, 2020). For this reason, organizations must incorporate many considerations into their environmental performance and management in order to fulfill the public belief in green ideologies and green values (Haddock *et al.*, 2016). In this regard, the results of research by Sabbet and Azizi (2019) showed that among the dimensions of human resource strategies, the reward strategy has the largest impact and the performance management strategy has the least impact on green human resource management. Municipalities are one of the organizations that deal with environmental management issues on a large scale. A municipality is a local organization established on the principle of administrative decentralization and for the purpose of managing local affairs such as construction and settlement, city health and the well-being of city dwellers. The municipality is a non-governmental public body with separate legal personality, which on the basis of the system of local decentralization carries out the tasks and tasks assigned by the legislature within the city limits and within the approved budget and program in accordance with the relevant laws and regulations. Municipalities in Iran provide some city services and manage some local city affairs under the supervision of the city's Islamic Council and with the coordination of the Ministry of Interior (Shirzadi Kandi and Bayat, 2018). In a study, Sheikh (2010) confirms that green human resources play an essential role in the organization to support environmental concerns, leading to higher efficiency, lower costs and employee participation and retention. Green HR management depends on identifiable and unique patterns of green decision-making and human resource manager behavior (Jackson *et al.*, 2011). In a study, Sinagh *et al.* (2020) showed that green human resource management policies have a positive and significant effect on green innovation and then on the environmental performance of organizations by influencing green transformation leadership. Lee (2020) also concluded that paying attention to green human resources management practices increases employees' organizational engagement, pro-environmental behavior, and sustainable performance.

On the other hand, [Musa and Osman \(2020\)](#) acknowledged that the components of green employment, green development and education, and green innovation have an impact on managing sustainable performance in all economic, social, cultural, and environmental dimensions of organizational sustainability. [Asadolahi Dehkordi, et al. \(2019\)](#) found that green resource management has a positive and significant effect on the sustainable performance of downstream petrochemical industries, both directly and through mediation of the organization's environmental actions. In another study, [Pejman et al. \(2019\)](#) identified 51 basic terms and 16 core topics, including structural framework conditions (software, hardware), attitude towards health, health-oriented politics, social responsibility, culture of togetherness, to be the most important. The limitations of this research were the lack of standard measurement tools to measure the dependent variable, little research in the field of green human resource management, the lack of goals and serious determination towards green human resource management by the studied organization and the respondent's lack of interest in completing the questionnaire. Considering the novelty of the subject, conducting this research can be effective in the direction of green human resource management in organizations, including Tehran Municipality. Finally, according to the content indicated, it is clear that the presentation of the green human resources management model as a tool for sustainable development in the municipalities and the creation of new employment opportunities, the generation of income and the creation of cooperation between municipal employees; Because the greening of the environment creates new jobs and leads to the emergence of innovations and creates a basis for sustainable organizational development. Also, one of the fundamental steps to reduce crises and solve environmental problems is to pay special attention to organizations and human resources and to manage them properly. Green human resources management is a new term that leads organizations to improve their environmental performance by aligning their actions with environmental management objectives. Therefore, the main concern and purpose of this research is to present the factors that influence the green management of human resources in line with sustainable development and the tries to find out what factors influence the green management of human

resources in line with the sustainable development. The current study has been carried out in Tehran in 2023.

MATERIALS AND METHODS

Due to the mixed exploratory nature of the research method, both quantitative and qualitative methods have been used in its execution. In the qualitative part, the statistical population of the study includes the experts from the Municipality of Tehran (N=30) who were selected as intentional sample and continued until theoretical saturation (N=11) using the snowball interview method. These experts met requirements like having a doctorate degree in management and urban planning with published scientific articles, at least 15 years of managerial experience in Tehran Municipality's human resources and planning departments. A semi-structured interview with experts (professors and experts with knowledge of management and development) were organized. The interviews with the experts were conducted with two objectives: in order to define all the components of green human resource management and organizational sustainability, all the extracted components from library research, were provided to the experts. Also, other elements, not covered through library research, were identified and finalized by conducting an expert survey using the Delphi method. A special questionnaire with open and closed questions was used to interview the experts. Then the designed model was tested in the target population for validation and applicability of the model in the statistical population. In the two aforementioned stages, a list of factors affecting green human resource management based on sustainable development standards was made, and at the end of this step, a conceptual model of green human resource management was created. In the third stage, a Delphi questionnaire was designed and carried out among experts. After the refinement of the Delphi results, the conceptual model was checked again. Then a random sample of employees was selected for the experimental test of the measurement model and the necessary data was collected. In the third stage, a Delphi questionnaire was designed and implemented among experts ([Table 1](#)). After the refinement of the Delphi results, the conceptual model was checked again. Then, a random sample of employees was selected for the experimental test of the measurement model and the necessary data was collected.

To summarize the methodology, it can be said that in this study, the conceptual model of the study was prepared and compiled with the help of experts for the analysis of the qualitative data using the consensus method (fuzzy) in the Delphi group panels (Oliver Paul Nayagam and Prasanna, 2023). After this phase, to confirm the developed model with quantitative research methods, a questionnaire based on the data from the qualitative phase was developed on the basis of the conceptual model of research and evaluated in the municipal organization.

RESULTS AND DISCUSSION

Based on expert opinion, the fuzzy mean of each component was calculated. In addition, the fuzzy numbers obtained were converted into unambiguous numbers (De-fuzzified average) by Minkowski's formula the results of which can be seen in Table 2.

In the next step, the average expert opinion was sent to experts again together with the first questionnaire one (second round). Based on this approach, each of the experts can compare their opinions with the average opinions and change their previous opinions if they wish. Table 3 shows the results of the first questionnaire (second round).

In the third step, the level of the expert opinion (difference between the fuzzy mean value of the first and second round) was calculated. If the calculated difference is less than 0.2, the fuzzy Delphi process stops, otherwise the process continues. Table 4 shows the average difference in expert opinions

Considering that the average difference of all components is less than 0.2, it can be concluded that

there is a good consensus among experts and a re-reading of the questionnaire is not necessary. Finally, to extract the components, a limit to accept or not to accept, must be considered. In this study, according to the 80-20 rule (Porvazan *et al.*, 2018), the acceptable limit of the components is about 0.8. According to experts, if the phase-shifted value of the triangle fuzzy number is close to 0.8 or higher, then it is accepted as a component, otherwise it is not accepted. In this way, all the cases have been confirmed by experts as effective factors for green human resource management. Table 5 shows the fuzzy matrix of the direct relationship of factors affecting green human resource management.

After creating the fuzzy matrix of the direct relationship of factors affecting green human resources management, this matrix is transformed into the normalized matrix of the direct relationship. Table 6 shows the normal matrix of direct relationship of factors affecting green human resources management.

According to the results in Table 7, the collective relationship matrix of organizational culture factors and Skills affecting green human resource management is as follows.

Using the mass correlation matrix of factors affecting green human resource management, the values of R_i, \tilde{D}_i were calculated equal to the sum of the rows and columns of the mass correlation of the factors. Considering that the value of each factor was positive, the factor belongs to the group of causes and is definitely an influencing element (Table 8):

The binary comparison of the four factors was performed based on the scale of 9 quantities (Saaty 1990) according to the fuzzy hierarchical analysis

Table 1: Criteria and sub-criteria identified through interviews with experts

Main criteria	Sub- criteria
Organizational Culture	Creating a reward system with an emphasis on creativity and innovation
	Supporting working groups within the company to improve team morale
	Lack of focus on decision making and increasing employee participation
	Delivering training to empower employees
Skills	Revision of corporate governance models (mission/mission of the organization) based on the principles of sustainable development
	Establishment of educational centers for continuous education
	Documentation of changes in the company to learn and change future behavior in the company
	Development of skills of local employees and use of capacities of local groups
	Foundation of market research groups to collect information
	Delegation and acceleration of value chain flow
	Use of available technologies and creation of dedicated channels

Table 2: Average of expert opinions (first round)

Row	Main criteria	Sub-criteria	Average	Fuzzy average	De-fuzzified average
1	Organizational Culture	Creating a reward system with an emphasis on creativity and innovation	4.42	(0.60, 0.85, 0.96)	0.818
2		Supporting working groups within the company to improve team morale	4.50	(0.63, 0.88, 0.98)	0.839
3		Lack of focus on decision making and increasing employee participation	4.33	(0.58, 0.88, 0.98)	0.807
4		Delivering training to empower employees	4.42	(0.60, 0.85, 1.00)	0.828
5		Revision of corporate governance models (mission/mission of the organization) based on the principles of sustainable development	4.42	(0.60, 0.85, 1.00)	0.828
6	Skills	Establishment of educational centers for continuous education	4.42	(0.60, 0.85, 1.00)	0.828
7		Documentation of changes in the company to learn and change future behavior in the company	4.42	(0.60, 0.85, 1.00)	0.828
8		Development of skills of local employees and use of capacities of local groups	4.58	(0.6, 0.90, 1.00)	0.859
9		Foundation of market research groups to collect information	4.42	(0.60, 0.85, 1.00)	0.828
10		Delegation and acceleration of value chain flow	4.42	(0.60, 0.85, 1.00)	0.828
11		Use of available technologies and creation of dedicated channels	4.50	(0.60, 0.85, 1.00)	0.855

Table 3: Average of expert opinions (2nd round)

Row	Main criteria	Sub-criteria	Total average	Average	Fuzzy average	De-fuzzified average
1	Organizational Culture	Creating a reward system with an emphasis on creativity and innovation	4.58	4.58	(0.65, 0.90, 1.00)	0.859
2		Supporting working groups within the company to improve team morale		4.50	(0.63, 0.88, 1.00)	0.8844
3		Lack of focus on decision making and increasing employee participation		4.58	(0.65, 0.90, 1.00)	0.859
4		Delivering training to empower employees		4.67	(0.67, 0.92, 1.00)	0.875
5		Revision of corporate governance models (mission/mission of the organization) based on the principles of sustainable development		4.58	(0.60, 0.85, 1.00)	0.859
6	Skills	Establishment of educational centers for continuous education	4.49	4.75	(0.65, 0.90, 1.00)	0.891
7		Documentation of changes in the company to learn and change future behavior in the company		4.58	(0.69, 0.94, 1.00)	0.859
8		Development of skills of local employees and use of capacities of local groups		4.58	(0.65, 0.90, 1.00)	0.859
9		Foundation of market research groups to collect information		4.67	(0.67, 0.92, 1.00)	0.875
10		Delegation and acceleration of value chain flow		4.58	(0.65, 0.90, 1.00)	0.859
11		Use of available technologies and creation of dedicated channels		4.50	(0.63, 0.88, 1.00)	0.844

Table 4: The difference in the average expert opinions in the first questionnaire

Row	Main criteria	Sub-criteria	De-fuzzified mean (1)	De-fuzzified mean (2)	Disagreement
1	Organizational Culture	Creating a reward system with an emphasis on creativity and innovation	0.818	0.859	0.042
2		Supporting working groups within the company to improve team morale	0.839	0.844	0.005
3		Lack of focus on decision making and increasing employee participation	0.807	0.859	0.052
4		Delivering training to empower employees	0.859	0.891	0.031
5		Revision of corporate governance models (mission/mission of the organization) based on the principles of sustainable development	0.828	0.859	0.031
6	Skills	Establishment of educational centers for continuous education	0.828	0.875	0.047
7		Documentation of changes in the company to learn and change future behavior in the company	0.828	(0.859	0.031
8		Development of skills of local employees and use of capacities of local groups	0.828	0.875	0.047
9		Foundation of market research groups to collect information	0.859	0.891	0.031
10		Delegation and acceleration of value chain flow	0.875	0.859	0.016
11		Use of available technologies and creation of dedicated channels	0.828	0.87559	0.031

Table 5: Fuzzy matrix of the direct relationship of factors influencing GHRM

DM	Main criteria	C1	C2	C3
C1	Organizational Culture	0.00, 0.00, 0.25	(0.23, 0.48, 0.73)	0.25, 0.50, 0.75)
C2	Skills	0.00, 0.21, 0.48)	(0.00, 0.00, 0.25)	0.10, 0.35, 0.60)

Table 6: Normal matrix of direct relationship of factors affecting GHRM

DM	Main criteria	C1	C2	C3
C1	Organizational Culture	0.00, 0.00, 0.10	(0.09, 0.19, 0.29)	0.10, 0.20, 0.30)
C2	Skills	0.00, 0.09, 0.19)	(0.00, 0.00, 0.10)	0.04, 0.14, 0.24)

Table 7: Collective relationship matrix of factors influencing green human resource management

DM	Main Criteria	C1	C2	C3	Ri
C1	Organizational Culture	(0.00, 0.00, 0.10)	(0.09, 0.19, 0.29)	(0.10, 0.20, 0.30)	(0.12, 0.21, 0.31)
C2	Skills	(0.00, 0.09, 0.19)	(0.000, 0.00, 0.10)	(0.04, 0.14, 0.24)	(0.12, 0.21, 0.31)
Di		(0.06, 0.16, 0.26)	(0.06, 0.16, 0.26)	(0.06, 0.16, 0.26)	(0.06, 0.16, 0.26)

method. The result of the prioritization (fuzzy and definite weight) of the factors, the inconsistency rate according to the method of [Gogus and Boucher \(1998\)](#) (less than 0.1) and the resulting weighted vector,

which is W21 (weight), are shown in [Table 9](#). As can be seen, organizational culture (weight 0.289) was more important than other factors. The second priority is skills (weight 0.273).

The current study was conducted with the aim of identifying and prioritizing the effective factors on green human resources management using the Analytical Network Process (ANP) method in Tehran Municipality. After reviewing the texts and the research background, criteria and sub-criteria in the form of organizational culture and skills were calculated. By analyzing the criteria identified by the ANP method, it was found that among the criteria, the highest priority is given to the organizational culture dimension. The results also showed that the average of all indicators of the organizational culture factor exceeded the grade 3 (average). In general, the overall average of all indicators is 4.58 on the border of 4, indicating that experts recognize the organizational culture factor as an important factor for the green human resource management model as a tool for the sustainable development of communities. In this context, according to the results of this research, it can be stated that things like creating a reward system with an emphasis on creativity and innovation, supporting working groups within the company to improve team morale, not focusing on decision-making and increasing employee participation, implementation of courses on empowerment of employees and revision of corporate governance models (the mission/mission of the organization) based on the principles of sustainable development, design and implementation of special events on environmental and cultural

occasions, training of communication skills for targeted managers interactive culture and creating a think tank and supporting new ideas can be beneficial in the area of implementing a corporate culture to influence green human resource management. This finding is consistent with the research results of [Pejman et al. \(2019\)](#) and [Musa and Osman \(2020\)](#). On the other hand, the research results of [Yu et al. \(2020\)](#) showed that green human resources management is significantly and positively associated with environmental collaborations with customers and suppliers, and these relationships are moderated by internal green supply chain management. In addition, [Darvishi et al. \(2019\)](#) state that social aspects and public beliefs influence sustainable urban development. Skills as another identified factor comes second, so it is clear that things like setting up training centers to provide continuous training, documenting changes to learn and change future behavior in the organization, developing the skills of local employees and leveraging employees' capacities and skills, setting up market research groups to gather information, delegating authority and accelerating the flow of the value chain, as well as using available technologies and creating dedicated channels can all have an impact on green human resource management. The finding is consistent with research by [Sabbet and Azizi \(2019\)](#) and [Musa and Osman \(2020\)](#). The ever-growing governmental pressure necessitates the implementation of green

Table 8: Mass correlation matrix values

Components	Organizational Culture	Skills
\tilde{R}	(0.35, 2.12, 8.71)	(0.15, 0.70, 6.09)
\tilde{D}	(0.15, 1.82, 7.63)	(0.32, 1.05, 7.78)
$\tilde{R} + \tilde{D}$	(0.50, 3.94, 16.34)	(0.47, 1.75, 13.88)
$\tilde{R} - \tilde{D}$	(0.00, 0.09, 0.19)	(0.47, 1.75, 0.26)
$(\tilde{R} + \tilde{D})^{def}$	6.93	5.37
$(\tilde{R} - \tilde{D})^{def}$	0.53	-0.74

Table 9: Prioritization (weighting) of factors, compatibility coefficient and weighted vector (W21)

Factors affecting green human resource management	Fuzzy weight	Definitive weight	Inconsistency rate
C1 Organizational Culture	0.158, 0.265, 0.444	0.289	CR ^m =0.05
C2 Skills	0.148, 0.250, 0.420	0.273	

human resource management practices which can strategically support organizations in their pursuit of sustainable approaches and facilitate designing of an effective human resources framework. This framework must empower and motivate the workforce, and establish a culture that aligns with desired behavioral outcomes, as suggested by [Bahuguna and colleagues \(2023\)](#). In the context of digital startups, particularly in Iran where sanctions and economic difficulties present notable obstacles, managerial emphasis is needed on entrepreneurship to cultivate innovative and creative thinking among employees through the suggestion system. As employees gain confidence in the ethical conduct of their leaders, they generate novel ideas to enhance the competitiveness of digital service and urban tech startups on the global stage, while offering prompt feedback to colleagues for improvement and enabling leaders to address crucial organizational issues and challenges ([Tajpour and Razavi, 2023](#)). In order to foster the development of green entrepreneurship processes, it is crucial to establish an appropriate platform. Additionally, it is recommended to define career trajectories based upon a green merit system and cultivate an ethos of participation and teamwork amongst personnel. Furthermore, it is advisable to incorporate educational materials in written form, using successful organizations as models, as a means to promote the adoption of sustainable business practices. Implementing these approaches may prove beneficial in advancing environmentally-friendly commercial initiatives. Measures aimed at promoting sustainable practices within municipal organizations may involve the establishment of green enterprises, fostering positive attitudes towards environmentally conscious behavior among employees, procurement of services that align with sustainable operations, inclusive engagement of employees in the pursuit of sustainable development goals, provision of incentives and opportunities for competitive empowerment towards conventional work tasks. The dimension of Green Empowerment assumes responsibility for leadership platforms aimed at empowering employees throughout the process of driving environmental improvement within the organization. These platforms encompass various aspects, such as developing green skills, fostering environmentally responsible behaviors, enhancing personal growth towards sustainable practices, promoting knowledge acquisition regarding sustainable concepts, and stimulating cognitive

development in the context of sustainable practices.

CONCLUSION

Increasing concerns about the environment and the consequent emergence of international environmental standards have forced organizations to adopt green strategies and continue to apply green management in all organizational matters and concerns, and in this regard human resources management with a focus on greening human resources. The organization's strategic goals help in the greening of the organization, and municipalities are one of the most important organizations that need to take on the role of green HR management to create and implement green thinking among employees. The purpose of this research was to identify and prioritize factors affecting green human resources management using fuzzy network analysis process method in Tehran city government conducted with mixed exploratory method. In this study, the effective factors for green human resources management based on sustainable development were identified based on the research background and expert opinion from the two categories of organizational culture and skills analyzed by fuzzy Delphi method. The results of the research showed that organizational culture is the main factor in creating green human resources management, and skills are second. The results also indicate that leadership strategies (constructive dealing with the environment and teamwork) currently play the most important role in the results of the Green Human Resource Management (GHRM) model as a tool for the sustainable development of communities. Based on the results obtained, the development of green competencies in oneself and the promotion of behaviors that show green creativity and innovation in the organization should be considered, as well as a management that relies on transformative leadership strategies can be the reason for be a change in attitudes and thoughts among them the human resources and the organization. On the other hand, create opportunities to receive feedback from colleagues, customers and other key stakeholders on the organization's performance so that better and more innovative services can be provided based on the process of generating creative ideas and implementing ideas when possible. Finally, the use of external consultants and the outsourcing of some non-specialized services to create the necessary time

and space for expansion, expansion and attention to the dimensions of green entrepreneurship among employees. Influencing factors in the current study in the dimension of organizational agreements are the monitoring of the set of measures that align the actions of the senior elements of the organization towards green human resource management based on social responsibility. In general, the measures include a series of developments such as the development of guidelines, green HR policies, legislation related to the company's social capital, organizational controllers and the development of a vision in the area of implementing the green approach. The dimension of culture formation and discourse formation relates to the development of the human resources approach in relation to the green approach and participation in its implementation; including the guidance and leadership of green human resources, the institutionalization of the green approach and rationale. The management factors dimension is leadership style in administering and supporting green principles; these include managers' approach to green principles, managers' green support, and managers' commitment to green principles. The design dimension of green processes oversees the design of the main processes in the implementation of environmentally friendly human resources management based on social capital; Of course, due to the novelty of the topic, future researchers have plenty of room to create new foundations in this field, such as studying the impact of technical and managerial skills of employees on the implementation of green human resources management and studying the impact of information sharing in the organization at the implementation of resource management. Green Human Resources will examine the impact of collaboration between different departments of the organization in the implementation of green human resources management, examine solutions and methods for executives' understanding of environmental programs, and expand the topics and their practical application.

AUTHOR CONTRIBUTION

H. Gandomkari performed background literature collection, expert interviews, data collection and research methodology, N. Mohammadi performed qualitative and quantitative data analysis, and A.R. Razaghi Rostami was involved in interpreting the results and proofreading the manuscript.

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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.

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ABBREVIATION

ANP	Analytical network process
C	Composition
DM	Diphase matrix
\tilde{D}	Line
GHRM	Green human resource management

HR	Human resource
\tilde{R}	Column
R	Random index
W	Weight

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CONTENT

Volume 8, Number 4, Autumn 2023

(Serial # 32)

443 - 459

Leadership styles and their associated outcomes: A bibliometric review using VOS viewer

U, Udin (Indonesia)

457 - 468

Optimization of energy consumption of ozone generator and plasma generator in decolorization and disinfecting of water system in urban residence

M.H. Mosstafavi; A.R. Karbassi; M. Pazoki (IRAN)

469 - 484

Human capital development in university teaching environment: the role of workplace and innovation culture

T.L.S. Mangahas (Philippines)

485 - 498

The impact of human capital, institutional quality, and innovation on the regional gross domestic product: panel data approach

H. Izadkhasti (IRAN)

499 - 514

The mediating effect of climate change on the relationship between energy resources and cost-saving sustainability and energy security in urban context

J.S. Dionysius; H.L. Vasudevan (Malaysia)

515 - 528

Identifying the antecedents and consequences of phubbing

A. Jamadi; A.R. RajabipourMeybodi; E. Hosseini; Z.S. Doaei (IRAN)

529 - 544

Addressing the barriers and difficulties in achieving educational institutions accreditation

E.G Claudio (Philippines)

545 - 558

Identifying the constituent factors of open governance in public institutions

M. Mirzapour; S. Tootian; G.R. Memarzadeh; G.R. Hashemzadeh Khorasgani (IRAN)

559 - 572

Human resource management practices and employee engagement

K. Goyal; A. Nigam; N. Goyal (India)

573 - 584

Prioritizing factors affecting green human resources management, using fuzzy network analysis in the organization

H. Gandomkari; N. Mohamadi; A. Rezghirostami (IRAN)

