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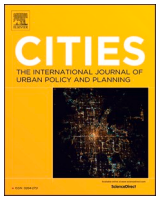

Remote work in cities: Assessing the effectiveness of public utility services

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ABSTRACT

Remote work is such a reengineering of an organization's culture and management system. Public utility sector organizations are in an extraordinary situation because their primary goal, the current and continued satisfaction of social needs, partly determines innovative behavior. The lack of classic market determinants, such as profit orientation and private ownership, slows the adjustment to the new conditions. That's why organizing remote work is challenging for human resource managers and team leaders in the public utility sector. Therefore, the article assesses the effectiveness of the management in the public utility sector during remote work. The most important conclusions are: (1) The full and effective integration of remote work practices remains an ongoing challenge, (2) The dominant form of goal control is task control (not direct control) during remote working, and (3) The organizational structure is flattened and flexible during remote work implementation.

1. Introduction

The COVID-19 pandemic triggered the need for widespread communication, learning, and working remotely. Barriers to remote communication related to awareness, acceptance, technical inadequacies, and hardware and software interoperability gaps, among others, were broken down. However, in doing so, new challenges emerged, including those related to management effectiveness. These changes are accompanied by several global trends that radically change socio-economic reality and human-space relationships. In the context of remote work, research has identified several particularly significant trends: the app-driven economy (Hasselwander, 2024; Morris & Murray, 2018; Nieborg et al., 2020), the sharing economy (Rifkin, 2014; Sundararajan, 2017), and the on-demand economy (Lin et al., 2025; Maselli et al., 2016; Sedkaoui & Khelfaoui, 2020). These interconnected economic paradigms have fundamentally altered how work is organized, delivered, and managed in the digital age, creating both opportunities and challenges for remote work implementation.

One of the transformational forces behind the emergence of a global app economy has been the global spread of mobile media. By the early 1980s, the term "app" had become commonly used (Morris & Murray, 2018, p. 4). In the following years, the global popularity of apps made them great business, quickly becoming one of the most frequent ways users interact with software. "Apps are insinuating themselves further and further into the patterns of our everyday lives and becoming more habitual and second nature in the process" (Morris & Murray, 2018, p. 5). The applications become a habit, and users fluctuate between conscious routine and unconscious action, voluntary and involuntary, and creative and mechanical actions, thus becoming the main place of power and ideology (Chun, 2016, p. 8; Codagnone et al., 2018). As "the latest iteration of the software commodity," mobile applications, or "apps," have become both mundane and ubiquitous (Morris & Murray, 2018, p. 3). In an unusual way, they allow the democratization of life in all areas, from entertainment to work, business, social, or public activities. On the other hand, some researchers believe that we are dealing with hypercapitalism (Nieborg, 2021, p. 1) or App Imperialism (the dominance and control exerted by a few powerful app platforms over the digital ecosystem) (Nieborg et al., 2020). Applications integrate mobile hardware and personal software in a completely different way than desktop computers; they trigger a common understanding of technology, convenience, and the need to use it. All this makes us eager to move a significant part of our lives to the virtual world, e.g., work, education, health, entertainment, sports, shopping, market and non-market services.

The app-driven economy is reinforced by another megatrend, the sharing economy (Sundararajan, 2017). Access to goods and services is as strong a basis for market functioning as ownership. However, the sharing of goods in the virtual space additionally makes it possible to achieve a state of zero marginal cost, completely changing the logic of costs and prices in both the public and private sectors (Rifkin, 2014;

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Sedkaoui & Khelfaoui, 2020). On the other hand, the non-spatial nature of virtual products and the development of online sales channels make warehousing functions independent of transaction sites. The production-warehousing way of "Just in Time" (Inventory management method in which goods are received from suppliers only as needed) management has evolved and spread to various market and non-market good types. As a result, today's on-demand economy is another global trend of providing labor from the place of producing goods and providing services. The evolving dynamics of the economy have given rise to a new type of employee, who we might call the on-demand workforce (Fuller et al., 2020). These processes are also partly justified on the basis of the gig economy.

These processes, on an unprecedented scale, make it possible to implement remote working in all sectors of the economy. Remote working, also known as working from home (WFH) or teleworking, was introduced by Jack Nilles after the international oil crisis in the 1970s (Nilles et al., 1976). At that time, it became a solution for congested and polluted metropolises. The approach evolved with changing global economic demand for competitive and flexible work systems, social responsibility, and ecological awareness. Sustainable development goals view remote work as an innovative solution for environmental health and social well-being (Moglia et al., 2021).

Nowadays, the rapid advancements in modern technology, particularly the proliferation of various mobile applications, have played a pivotal role in intensifying workplace competitiveness. With a vast global communication infrastructure, these technologies have enabled seamless interaction, thereby facilitating the rise of remote work and enhancing workforce efficiency in the corporate sector (Flores, 2019). The widespread availability and functionality of mobile applications have made remote work a viable and attractive option for both employees and organizations.

The feasibility of remote work largely depends on the nature of the job and the specific skills required for its execution. Occupations that are compatible with remote arrangements typically exhibit characteristics associated with office-based, white-collar work (OECD, 2021).

From a technical standpoint, remote work involves performing job responsibilities outside the physical premises of the organization while maintaining active communication with it. This is made possible through mobile applications such as Outlook, Gmail, Zoom, Microsoft Teams, and virtual desktop platforms like Microsoft Remote Desktop and Citrix Workspace (Yu, 2008). These tools empower remote workers to efficiently manage tasks and collaborate with colleagues regardless of geographical location. Consequently, the widespread adoption of remote work also contributes significantly to the growth of the app economy.

The International Labour Organization defines WFH as work:

I. performed at home or another location but not on the employer's premises;
II. for which remuneration is received;
III. the result of which is a product or service following the employer's objectives, regardless of who provides the equipment, or other tangible or intangible resources (Berg et al., 2021).

Remote work is a response to the needs of modern economies, where private and public institutions operate and create networks of connections. Among them is the public utility sector, which refers to an activity, good, or service that brings benefits or collective interests to the residents of a country (Bruijn & Dicke, 2006).

Although remote work is not a new concept in the labor market, its large-scale adoption has introduced new challenges, particularly concerning its effectiveness within various organizations. The public sector is known for its slow-moving and archaic nature regarding technological innovation. With the constantly changing workforce and generational differences of employees, one common request among people is the ability to work remotely, which has become increasingly common in the private sector but is not as popular in the public sector. This is due to assumptions that remote work does not produce the same level of productivity (Buckingham, 2021).

Consequently, organizing and evaluating the effectiveness of remote work in public utility services presents unique challenges. Today, flexible work models such as remote work are increasingly prevalent worldwide, offering both opportunities and difficulties within a rapidly changing work environment. Remote work has emerged as a strategic response to the demands of modern economies, where both private and public institutions function within interconnected networks.

In the context of public utility services—where the ability to meet immediate and ongoing social needs is essential—remote work necessitates a reconfiguration of traditional office structures to enhance operational outcomes. As the work environment grows more dynamic, achieving service delivery goals becomes increasingly vital. This underscores the importance of implementing and optimizing remote work within the public utility sector.

The framework that conditions the proper implementation and development of remote work is embedded in the principles of the Knowledge-Based Economy (KBE) (Harris, 2001: Llerena, 2005; Godin, 2006: Kam, 2023), the Flexible-Firm Model (FFM) (Chatterjee et al., 2022; Choudhury et al., 2021; Zhao, 2020), and the Social Exchange Theory (Agbanyo & Shi, 2024; Cropanzano & Mitchell, 2005; Kam, 2024; Mise, 2024). The transition to a KBE began in the early 1970s and has steadily extended across economies, owing to advancements in high technology and the growth of the information and communication service sectors. Reliance on new information technologies, such as remote work, is one of the main characteristics of knowledge-based economies (Schiliro, 2012), which need specialized knowledge, lifelong learning, and innovations.

The FFM was proposed by John Atkinson in 1984. He suggested that organizational structures should be flexible and able to adapt to the turbulent environment and changes that come from the market (Zhao, 2020); it is a technique for managing an organization and a workplace. Its foundation is the use of various forms of flexibility – functional, numerical, and financial (Atkinson, 1984) – to most effectively lead the company's human resources (Procter et al., 1994; Prowse, 1990; Taylor, 2018). The FFM divides employees into core and peripheral groups. Members of the first group are difficult to replace, while peripheral groups are often needed only for certain tasks or peak periods. Employees of public institutions can be almost entirely included in the core group. This means that when changing the form of work to remote, it is vital to maintain the quality of work of all employees.

On the other hand Social Exchange Theory believes that market participants and employees engage in a social network when they have a reason to do so. The motivation to engage in social relations may be, e.g., the need to acquire resources or the desire to achieve a goal (Lambe et al., 2001). The distribution and type of resources in the network explain the relative power of actors (individuals and organizations). Different types of management networks will be distinguished by patterns of resource dependence" (Rhodes, 2017, p.201). The important features of this theory are that:

I. organizations are interdependent;
II. the exchange of resources between participants is a prerequisite for achieving goals;
III. a leading group of partners influences resource exchange.

Public organizations form cooperative ties with other entities. Despite their relative operational independence, they are highly dependent on other market actors to create final services. Their role may be different from the point of view of decision-making or the role they play in the task, depending on the affiliation of a particular network. Implementing remote work in the public sector is a technological, allocative, and managerial challenge. In the context of the cited trends and theories, ensuring remote work effectiveness in public institutions is

particularly relevant. The article assesses management effectiveness in the public utility sector groups during remote work. Defining management effectiveness is complex and requires research using four key approaches: The purposeful approach, the system approach, the multi-criteria approach, and the team management approach.

1.1. Desirability and advantages of remote work – recent developments

Successfully transitioning to working remotely in the public sector depends on the demands of certain professional job tasks. In knowledge-oriented jobs, it is necessary to adjust external and internal rules and procedures. The public sector's ability to adapt to remote workability depends largely on the ability to comply with institutional arrangements, quality and control management, and human resource management (Mousa & Abdelgaffar, 2021, p.3). Public sector entities apply the required organizational arrangements to implement remote working effectively. This will be achieved when: a) employees are equipped with critical information and communication technology devices and solutions, applications, software, and online connectivity to internal and external networks; b) work guidelines are established and adopted, and remote communication and collaboration tools are used; c) the execution of management functions (planning, organizing, and leading, i.e., motivating and controlling) are adapted to remote work (Milasi et al., 2021).

After analyzing research on the use of remote work in public organizations, it can be said that this solution has potential. It can help improve working conditions and outcomes if it is carefully implemented. Research shows the advantages of remote work for individuals, organizations and society. These benefits are categorized below (Baruch, 2000; European Commission, 2021; Felstead & Henseke, 2017; Filardi et al., 2020; Grant, Wallace, & Spurgeon, 2013; Kam, 2023; Ozimek, 2020);

Individual benefits include improved quality of life, higher organizational commitment, job satisfaction, higher productivity levels, more flexibility in duties, less stress, savings in commuting time, fewer unnecessary meetings, reduced interruptions, and geographical and spatial barriers.

Organizational benefits include a more productive workforce, reduced costs (e.g., office space, commuting), increased employee retention, access to a broader pool of talent, improved employee morale, and enhanced employee well-being.

Societal benefits include reduced traffic congestion and pollution, increased economic activity in rural and underserved areas, better job opportunities for people with disabilities, reduced environmental impact from commuting and office space, more sustainable work practices, increased productivity and economic growth.

The unexpected outbreak of the COVID-19 pandemic affected the way public sector organizations operate (Schuster et al., 2020, pp. 792–796), with remote working rapidly increasing in popularity. Many organizations had to quickly transition to the remote work system (Bick et al., 2020; Kwon & Kim-Goh, 2022; Metselaar et al., 2023) to ensure the continuity of public service delivery (Belzunegui-Eraso & Erro-Garcés, 2020, p. 3662). Public institutions (e.g., universities and municipalities) also transitioned to remote working.

Implementing and working remotely also brings several categories of challenges (technical, organizational, individual and societal). The first group includes technical aspects. Barriers noted include access to technology (OECD, 2020), operability of ICT solutions, or insufficient support infrastructure (Schuster et al., 2020). The organizational aspect concerns mainly the costs, which are significant, especially for organizations that have limited adoption of digitization. Entities also lacked funding for this purpose (Choi, 2018). There are also threats related to the lack of experience, organization and work approaches, management resistance, and insufficient competencies (especially technological ones). Despite legislative policies regulating and enabling the full or partial implementation of remote work in public entities, concerns regarding cybersecurity, privacy, and information confidentiality were significant barriers (Berg et al., 2021).

When discussing the traditional way of working, employees are motivated and monitored while at the workplace, interacting with supervisors and colleagues and coordinating activities together (Felstead and Henseke, 2017). Remote work reduces the possibility of supervising employees, triggering the search for new practices to enable effective staff management (Taskin & Edwards, 2007). Therefore, the inadequate level of essential managerial competencies for individuals operating in a virtual environment and leading remote teams presents a significant challenge (Maher & Bedawy, 2015; Trippner-Hrabi et al., 2023).

Individual remote work challenges include lower job stability, weaker identification with the organization, more intense work, and the blurring of the boundaries between work and private life. Employees who work remotely suffer from increasing work-life clashes. Societal challenges can be identified as reduced community engagement because of social isolation, difficulty in maintaining cultural solid dynamics and dependency on technology (Filardi et al., 2020; Palumbo, 2020, p. 771; Ferreira et al., 2021; Ipsen et al., 2021; Bloom et al., 2022; Kam, 2023).

The more remote workers feel that their e-work contributes to their task performance, the better their self-reported mental health and vitality are, and vice versa (Grant et al., 2019). However, de Vries et al. (2019) show that remote work did not negatively affect employee engagement. Remote work in public institutions is becoming an option since entities must be effective and efficient by adapting the work system to market requirements and customer needs. In addition, they operate based on networking, where they are members of many networks where cooperation and communication are based to a significant extent on remote work.

Methodology for researching the effectiveness of management in remote work the effectiveness of remote work is a multi-dimensional category. Identifying whether and under what conditions remote work is economically effective in the public utility sector requires a holistic approach. Referring to the literature and previously indicated areas of research in the field of remote work, we define the holistic effectiveness of remote work based on the three perspectives most frequently taken into account by researchers (Corrie, 2004; Kam, 2024; Kam et al., 2023; Tsim et al., 2002)

I. Technological effectiveness: It focuses on whether organizations use technology effectively to improve the remote work experience for their employees (Ilag, 2021).
II. Resource allocation effectiveness: It focuses on whether organizations use resources effectively to maximize productivity and minimize costs (Paccagnan et al., 2022).
III. Management effectiveness: It evaluates organizational effectiveness within purposeful, system, multi-criteria, and team management approaches (Belbin, 2004: Sullivan, 2012; Zimmerman, 2000; Delfino & Van Der Kolk, 2021; Principale et al., 2025).

The paper assesses the effectiveness of the management in the public utility sector groups during remote work. The management effectiveness perspective is complex and is examined using four approaches: the purposeful approach, the system approach, the multi-criteria approach, and a team management approach.

Eight research questions (RQ1-RQ8) and four research hypotheses (H1-H4) were formulated in Table 1 to identify each area of remote work effectiveness.

According to the classic definition of the public utility sector, three types of public services can be distinguished:

I. Administrative services (e.g., decision, strategic planning, registrations, local taxes),
II. Civil services (e.g., education, culture, sports, social care),
III. Technical/infrastructural services (e.g., water supply, public transport, maintenance of roads, public spaces).

Table 1
Research questions and hypotheses to identify the effectiveness of remote work from a management perspective.

Perspective of economic effectiveness		Research Questions	Hypotheses
Management effectiveness	*Purposeful approach*	RQ1. How effective has the public utility service been in achieving its remote working goals? RQ2.What strategies and tools are applied to motivate remote employees within the public utility services? RQ3. What strategies and methods do employers in public utility services use to monitor the performance of remote workers?	H1. If public utility service works remotely, the dominant form of goal control is task control (not direct control).
	System approach	RQ4. Do public utility services apply research and development activities to enhance remote work effectiveness? RQ5. What are the attributes defining relational capital within the context of remote work in public institutions?	H2. If a public utility service works remotely, its organizational structure is flat and flexible
	Multi-criteria approach	RQ6. Does remote work implementation in public utility services lead to improved time management efficiency for operational activities? RQ7. What is the impact of remote work on work-life balance?	H3. Regarding generational characteristics, if public utility services work remotely, there are significant differences in the impact of remote work on work-life balance.
	Team management approach	RQ8. What is the level of decision-making of employees who work remotely in public utility services?	H4. If public utility service works remotely, they are not self-management teams

Source: own prepared.

Based on this typology, the study included administrative and civil services. We excluded infrastructure services because they are closely related to the use of technical infrastructure in the physical space. Hence the virtual dimension is limited. In addition, these services are most often outsourced to the private sector. Units that provide civil and administrative services and that met the following conditions were selected for the survey:

I. potentially highly advanced level of remote working,
II. team working,
III. innovation potential in services,
IV. a complex range of tasks.

The criteria allow us to identify those areas of public sector activity that are most demanding in terms of work organization and management system. Administrative service providers include various types of departments, where residents and business entities are clients. The basic types of administrative services that met the criteria defined above include those related to decision issuance, strategic planning, spatial planning, and marketing management. Thus, city hall units with the greatest scope of autonomy were selected for the study. To eliminate potential regional differences in the organization and provision of services, the survey was conducted in all 16 regional capitals in Poland. In each city, the survey was conducted in two selected departments. The total general population was 32 units. Ultimately, 26 units (81 %) participated in the survey. Due to the substantive scope of the survey, the direct respondent was the unit head.

The scope of civil service providers is much broader, as educational, cultural, recreational, civil, and other services can be included. Similar selection criteria were applied to the selection of entities as for administrative services. The criteria adopted allowed the selection of civil services in the higher education sector for the study. It was also assumed that there might be regional differences in their organization and provision. To this end, the best university in each region was selected (using the Perspectives 2021 comparative ranking of higher education institutions). A survey was conducted in the 16 best universities in each region. Unlike clerical and administrative work, academics work primarily with independent research teams. Each university has a specific organizational structure and varied self-governance. Hence, it was decided to conduct the survey at the level of each independent organizational unit, that is, at the level of each faculty (a total of 185 faculties were identified). Faculties have their managers – deans – who are responsible for shaping how work is organized within the unit, including its structure and the tools utilized. Faculties are often divided into smaller organizational units, including departments, institutes, laboratories, and research teams. Nevertheless, the environment for creating working conditions in these units is similar at the level of the entire department. Hence, using simple random sampling in each department, one unit (e.g., department, research team) was selected for the survey. The direct respondent was the head of this unit due to the substantive scope of the survey. Ultimately, the survey was implemented in 139 units, representing 75 % of the general population.

This study adopted desk research as a qualitative research method involving literature review and critical text analysis. The survey was also adopted as a primary quantitative research method. The use of quantitative research in this study helped minimize the risk of drawing erroneous conclusions about the entire population. This risk arises from regional and urban differences, which may influence how work is organized and its effectiveness—both in offices and academic institutions. Quantitative methods help account for this variability, reducing the likelihood of overgeneralizing from unique or exceptional cases. Data were collected via an online survey designed to address the research questions and hypotheses.

When constructing the survey, in addition to the author's methodologies, the following concepts were used: Personality types (according to Jung, 1921), Team roles (according to Belbin, 2012), the PDCA (Plan-Do-Check-Act) cycle (according to Deming, 1986), the process approach (according to ISO 9000), Decision level concept: Empowerment and delegation stage (according to Conger, 1989), Work-Life Spill-Over (according to Felstead & Henseke, 2017). A Likert-type 0 to 5 scale was used for the survey questions, with the percentage calculated as follows: 0 = 0 %, 1 = 20 %, 2 = 40 %, 3 = 60 %, 4 = 80 %, and 5 = 100 %.

Fig. 1 displays the number of leaders in administrative and civil services by age group. Research was conducted on 165 heads of department in civil services and administrative services in Poland. One hundred thirty-nine department leaders work in civil services, and twenty-six in administrative services. Among the 139 civil services leaders that constitute the first sample group of the study, 66 are in the 58–76 age range (Baby Boomers), 70 are in the 42–57 age range (Generation X), and 3 are in the 27–41 age range (Generation Y). Among the 26 administrative services leaders that constitute the second sample group, 9 are in the 58–76 age range (Baby Boomers), 15 leaders are in the 42–57 age range (Generation X), and 2 are in the 27–41 age range (Generation Y).

The average time worked by the civil services leaders in their department is ten years, and six years for administrative services department leaders. The marital status of the leaders is married 124 (89.2 %) and single 15 (10.8 %) for heads of departments in civil services, married 22 (84.6 %) and single 4 (15.4 %) for administrative services.

When department member profiles are examined (i.e., leaders and workers), civil services (139) on average comprised 18.86 % Baby

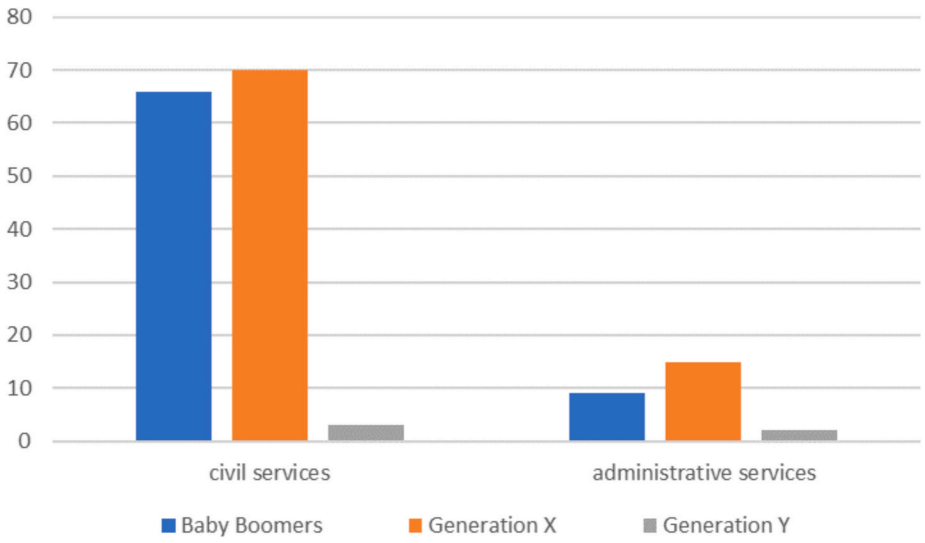

Fig. 1. The number of leaders in administrative and civil services by age group. Source: own prepared.

Boomers, 47.62 % Generation X, 31.58 % Generation Y, and 1.94 % Generation Z. On the other hand, administrative services (26) on average comprised 14.56 % Baby Boomers, 44.25 % Generation X, 38.66 % Generation Y, and 2.53 % Generation Z. The national characteristics were 95.51 % Polish and 4.49 % foreigners for civil services, and 97.69 % Polish and 2.31 % foreigners for administrative services. Gender characteristics were 48.62 % women and 51.38 % men for civil services, and 72.18 % women and 27.82 % men for administrative services. The gathered data were analyzed in two ways. Fig. 2 displays adopted data analyzis methods: factor analysis using the Principal Component Analysis method and a statistical and descriptive analysis.

2. Results

2.1. Exploratory factor analysis

The term "Factor Analysis" serves as a comprehensive descriptor for a range of multivariate statistical methods designed to elucidate the inherent structure of a data matrix. It is pivotal in extending its applicability beyond fundamental functions and can be instrumental in employing diverse statistical techniques (Alpar, 2011). In this study, the Principal Component Analysis method (Pearson, 1901) was employed as an estimation technique, and the Varimax Rotation Method (Kaiser, 1958) was selected.

2.1.1. Purposeful approach

The appropriateness of the data for factor analysis was assessed by examining the Kaiser-Meyer-Olkin (KMO) coefficient and the Bartlett Sphericity test. The obtained KMO value is 0.862, signifying a favourable indication. Furthermore, the Bartlett Sphericity test results are statistically significant ($\chi 2 = 814.917$, $p < 0.001$), supporting the suitability of the data for factor analysis. Given the positive outcomes from both tests, it was deemed appropriate to conduct factor analysis on the data related to Purposeful Approach.

Table 2 shows that the Plan-Do-Check-Act (PDCA) Deming cycle consists of Decision-Making in Team, Team Activity Proportion, Execution of Strategic and Ongoing Activities, Task and Project Control, Team Communication, and Goal Achievement. In addition, monitoring remote work performance consists of using the primary remote control method and task control frequency.

Factor analysis was applied to 8 expressions associated with the two constructions under investigation in this study. The analysis unveiled

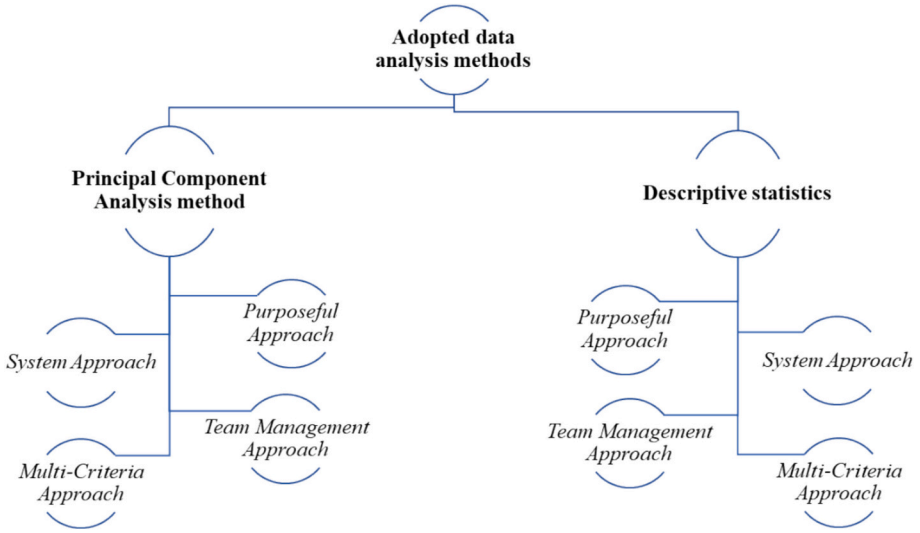

Fig. 2. Adopted methods for analyzing data obtained from surveys. Source: own prepared.

Table 2
Results of the exploratory factor analysis related to purposeful approach.

Corresponding Items	*Plan-Do-Check-Act (PDCA) Deming cycle*	*Monitoring Remote Work Performance*
Decision-Making in Team	0.889	0.044
Team Activity Proportion	0.889	0.012
Execution of Strategic and Ongoing Activities	0.875	0.091
Task and Project Control	0.834	0.034
Team Communication	0.817	0.075
Goal Achievement	0.699	0.140
Primary Remote Control Method	−0.015	0.883
Task Control Frequency	0.160	0.862
Total Variance Explained	*53.72 %*	*18.59 %*

Source: own prepared.

the presence of two dimensions, each with eigenvalues surpassing 1. Together, these dimensions elucidate a cumulative variance of 72.31 %; the first dimension accounts for 53.72 % of the variance, and the second dimension contributes 18.59 %.

2.1.2. System approach

The adequacy of the data for factor analysis was assessed by examining the Kaiser-Meyer-Olkin (KMO) coefficient and the Bartlett Sphericity test. The KMO value, at 0.583, indicates a discernible level of suitability. Additionally, the results from the Bartlett Sphericity test proved to be statistically significant ($\chi 2 = 256.453$, $p < 0.001$). After a comprehensive review of the outcomes from both tests, it was concluded that it is fitting to proceed with factor analysis on the dataset about the system approach.

Table 3 shows that Research and Development Activities consist of Customer Satisfaction Measurement and Research on Customer Needs. In addition, Relational Capital consists of Dominant Employee-Management Relationships, Predominant Cross-Team Employee Relationships, and Formal Remote Work Procedures: Existence.

Factor analysis was conducted on five expressions associated with the two constructions under examination in this study. The analysis brought to light the presence of two dimensions, each characterized by eigenvalues surpassing 1. These dimensions collectively contribute to a total variance of 71.18 %, with the first dimension explaining 43.80 % and the second dimension elucidating 27.38 %.

2.1.3. Multi-criteria approach

The suitability of the data for factor analysis was examined using the Kaiser-Meyer-Olkin (KMO) coefficient and the Bartlett Sphericity test. The KMO value is 0.634. The results of the Bartlett Sphericity test are also significant ($\chi 2 = 209.711$, $p < 0.001$). Upon reviewing the outcomes of both tests, it was deemed appropriate to conduct factor analysis on the data related to the multi-criteria approach.

Table 4 shows that the Multi-Criteria Approach consists of Work-Life Balance Achievement, Personal Time, and Time Management Efficiency.

Table 3
Results of the exploratory factor analysis related to system approach.

Corresponding Items	*Research and Development Activities*	*Relational Capital*
Customer Satisfaction Measurement	0.937	0.041
Research on Customer Needs	0.923	0.141
Dominant Employee-Management Relationship	0.230	0.811
Predominant Cross-Team Employee Relationships	0.125	0.796
Formal Remote Work Procedures: Existence	−0.067	0.666
Total Variance Explained	*43.80 %*	*27.38 %*

Source: own prepared.

Table 4
Results of the exploratory factor analysis related to multi-criteria approach.

Corresponding Items	*Multi-Criteria Approach*
Work-Life Balance Achievement	0.914
Personal Time	0.877
Time Management Efficiency	0.742
Total Variance Explained	*71.83 %*

Source: own prepared.

Three expressions linked to the one-dimensional construction under investigation in this study underwent factor analysis. The analysis disclosed the presence of a singular dimension characterized by an eigenvalue surpassing 1. This dimension contributes to a total variance of 71.83 %.

2.1.4. Team management approach

The adequacy of the data for factor analysis was assessed by examining the Kaiser-Meyer-Olkin (KMO) coefficient and the Bartlett Sphericity test. The KMO value, at 0.769, indicates a discernible level of suitability. Additionally, the results from the Bartlett Sphericity test proved to be statistically significant ($\chi 2 = 203.024$, $p < 0.001$). After a comprehensive review of the outcomes from both tests, it was concluded that it is fitting to proceed with factor analysis on the dataset about the team management approach.

Table 5 shows that the Team Management Approach consists of Remote Work Commitment Level, Remote Decision-Making Capacity, Task Modification Autonomy, Assessing Employee Competence, Power-Sharing in the Team, and Final Task Executor.

Six expressions linked to the one-dimensional construction under investigation in this study underwent factor analysis. The analysis disclosed the presence of a singular dimension characterized by an eigenvalue surpassing 1. This dimension contributes to a total variance of 43.14 %.

2.2. Descriptive statistics

In the following, the management effectiveness of remote work in public utility sector organizations is evaluated from four approaches: the purposeful approach, the system approach, the multi-criteria approach, and the team management approach.

2.2.1. Purposeful approach

The purposeful approach examines whether organizations achieve their operational goals during remote work. It also examines managers' motivational tools and monitoring methods during remote work. The assessment of whether organizations achieve their operational objectives (RQ1) involves examining the implementation of the Plan-Do-Check-Act (PDCA) Deming cycle in remote work. The PDCA Deming cycle factor encompasses six components: *Decision-Making in Team, Team Activity Proportion, Execution of Strategic and Ongoing Activities, Task and Project Control, Team Communication, and Goal Achievement*. Table 6 shows that the Plan-Do-Check-Act (PDCA) Deming Cycle's mean value is 1.91, the median value is 1.83, and the standard deviation is

Table 5
Results of the exploratory factor analysis related to team management approach.

Corresponding Items	*Team Management Approach*
Remote Work Commitment Level	0.770
Remote Decision-Making Capacity	0.738
Task Modification Autonomy	0.680
Assessing Employee Competence	0.637
Power-Sharing in the Team	0.562
Final Task Executor	0.516
Total Variance Explained	*43.14 %*

Source: own prepared.

Table 6
Evaluation of Plan-Do-Check-Act (PDCA) deming cycle.

Corresponding Item	Mean	Median	Std Dev.
Decision-Making in Team	1.58	1.00	1.43
Team Activity Proportion	1.67	1.00	1.17
Execution of Strategic and Ongoing Activities	1.73	1.00	1.34
Task and Project Control	1.65	1.00	1.41
Team Communication	2.29	2.00	1.55
Goal Achievement	2.51	3.00	1.65
Plan-Do-Check-Act (PDCA) Deming Cycle	1.91	1.83	1.12

Source: own prepared, $n = 165$.

1.12.

The findings suggest that the individual assessments of each component within the Plan-Do-Check-Act (PDCA) Deming cycle indicate a notable lack of effectiveness. Team communication and goal achievement notably exhibit significant differences, although falling short of optimal effectiveness. Nevertheless, these components display overall inefficacy, pointing towards areas that require improvement. The data reveals that approximately 50 % of all team decisions are communicated to employees remotely. Furthermore, achieving goals in public utility services exceeds 50 % slightly. Public utility services face challenges in successfully executing all planned goals during remote work periods.

In summary, implementing the Plan-Do-Check-Act (PDCA) Deming cycle proves ineffective within the context of public utility services, underscoring the need for improvements in operational processes. These findings negatively assess the research question RQ1, indicating that public utility services have not effectively achieved their operational goals during remote work. The following assesses the effectiveness of groups of motivational tools concerning leaders' application (RQ2), ranking them from the most effective to the least effective. The corresponding scores are provided in the Table 7.

The findings reveal that leaders in public utility services consider flexible working time and independence as the most effective motivational tools during remote work. *Motivational interviews and advice* rank second in effectiveness, followed by *material rewards (including money)* in the third position. These results contribute to the assessment of research question RQ2, shedding light on the various strategies and tools employed by leaders/managers in public utility services to motivate remote employees. The findings underscore the importance of providing employees with autonomy and a flexible work schedule, recognizing the role of personalized guidance and support in fostering motivation and highlighting the significance of acknowledging and rewarding employees for their efforts. Table 8 displays the Monitoring Remote Work Performance (RQ3) factor, which comprises two components: *Primary Remote Control Method and Task Control Frequency*.

To assess the Primary Remote Control Method in public utility services, a specific scale was employed with the following ratings: 0 (no control), 1 (informal interview), 2 (scheduled meetings and reporting), 3 (unannounced on-the-job controls), 4 (remote access of the manager to employees' computers), and 5 (written reports). The Primary Remote Control Method scores indicate a mean of 1.93 and a median of 2.00. Notably, 21 public utility services (12.70 %) do not implement any control, 52 (31.50 %) employ informal interviews, 62 (37.60 %) utilize scheduled meetings and reporting, only 2 (1.20 %) resort to unannounced on-the-job controls, 3 (1.80 %) apply remote access of the manager to employees' computers, and 25 (15.20 %) use written reports. The research findings emphasize that the primary remote control method involves either scheduled meetings and reporting or informal interviews conducted by leaders.

Table 7
Evaluation of the groups of motivational tools, from the most effective (1) to the least effective (8), for remote workers.

Groups of Motivational Tools	*1 - Most Effective 8 - Least Effective*
Flexible working time and independence	1
Motivational interviews, advice	2
Material rewards, including money	3
Assessment systems, opinion polls	4
Regulations, instructions, penalties	5
Praise, distinctions	6
Good rapport at work; strong, positive, informal relationships	7
Other	8

Source: own prepared, $n = 165$.

Table 8
Evaluation of monitoring remote work performance.

Corresponding Item	Mean	Median	Std Dev.
Primary Remote Control Method	1.93	2.00	1.51
Task Control Frequency	2.38	2.00	1.65
Monitoring Remote Work Performance	2.16	2.00	1.38

Source: own prepared, n = 165.

In the context of Task Control Frequency within public utility services, a specific scale was implemented with the following ratings: 0 (no task audits), 1 (annual or less frequent reports), 2 (semi-annual), 3 (quarterly), 4 (weekly), and 5 (daily). Task Control Frequency scores reveal a mean of 2.38 and a median of 2.00. The analysis indicates that 30 public utility services (18.20 %) lack any task control system, 26 (15.80 %) employ annual or less frequent reports, 29 (17.60 %) adopt semi-annual reporting, 31 (18.80 %) implement quarterly reporting, 29 (17.60 %) use weekly reporting, and only 20 (12.10 %) employ daily reporting. The findings suggest that the dominant task control frequency is semi-annual or quarterly, facilitated by leaders.

In summary, the research outcomes address research question RQ3, indicating that the prevailing primary remote control method, conducted semi-annually or quarterly, involves either scheduled meetings and reporting or informal interviews facilitated by leaders. In light of these findings, research hypothesis 1, 'If a public utility service works remotely, the dominant form of goal control is task control (not direct control),' has been verified.

2.2.2. System approach

The system approach assesses whether organizations apply research and development activities to enhance remote work effectiveness. It also examines the characteristics of relational capital in organizations during remote working. *The following assess the primary research questions and hypothesis about the System Approach in the context of public utility services. The System Approach factor comprises Research and Development Activities and Relational Capital is provided in* Table 9.

The study's findings indicate that, during remote working, approximately 60 % of public utility services incorporate customer satisfaction measurement into their operational activities. On the other hand, it is deduced that over 40 % of public utility services research their customer needs/preferences during remote work. These results prompt an evaluation of the implementation of Research and Development Activities, revealing that public utility services only partially undertake such activities. In essence, research question RQ4 is addressed, signifying that public utility services employ Research and Development Activities to a limited extent in enhancing remote work effectiveness. There exists room for improvement in bolstering remote work effectiveness,

Table 9
Evaluation of research and development activities.

Corresponding Item	Mean	Median	Std Dev.
Customer Satisfaction Measurement	2.87	3.00	2.14
Research on Customer Needs	2.36	2.00	2.11
Research and Development Activities	2.61	2.50	1.99

Source: own prepared, n = 165.

necessitating a more proactive management perspective. The following Table 10 assesses Relational Capital (RQ5) using Dominant Employee-Management Relationship, Predominant Cross-Team Employee Relationships, and Formal Remote Work Procedures: Existence.

A specific scale was employed to assess the Dominant Employee-Management Relationship within public utility services, with specific descriptors as follows: *0 (No relations between employees), 1 (Individual relations between employees and manager dominate), 2 (Individual relations between employees dominate), 3 (Relationships during formal online team meetings dominate), 4 (Relationships during formal team meetings in the office dominate) and 5 (We usually work together in a team using common communication platforms)*. The scores for the Dominant Employee-Management Relationship reveal a mean of 2.78 and a median of 2.00. Notably, only 4 public utility services (2.40 %) reported no dominant relations between employees, while 43 (26.10 %) indicated dominance of individual relations between employees and managers, 37 (22.40 %) emphasized individual relations between employees, 22 (13.30 %) cited dominance during formal online team meetings, 20 (12.10 %) highlighted dominance during formal team meetings in the office, and 30 (23.60 %) emphasized working together in a team using common communication platforms. The research findings underscore that individual relations are the most prevalent Dominant Employee-Management Relationship.

A specific scale was adopted to evaluate Predominant Cross-Team Employee Relationships in public utility services, ranging from 0 (No relations between employees) to 5 (We most often work in interdisciplinary teams on common communication platforms). The analysis concludes that 94 public utility services (57.00 %) reported individual relations between employees as the predominant cross-team relationship.

Lastly, the Existence of Formal Remote Work Procedures was assessed, revealing that 60 public utility services (41.20 %) lack any procedures or instructions for remote workers. The scores for Formal Remote Work Procedures: Existence show a mean of 1.65 and a median of 1.00, indicating the absence of strict procedures for remote workers. Consequently, the research outcomes address research question RQ5, suggesting that public utility services predominantly foster individual relationships among employees and between employees and managers in remote work scenarios. This aligns with the verification of hypothesis 2, indicating that *if a public utility service works remotely, its organizational structure tends to be flat and flexible*.

2.2.3. Multi-criteria approach

The multi-criteria approach examines whether organizations improve time management efficiency for operational activities during remote work. In addition, it examines how remote work impacts work-life balance. Table 11 displays the Multi-Criteria Approach factor, which consists of *Work-Life Balance Achievement, Personal Time, and Time Management Efficiency*.

Based on the findings, it is evident that remote work does not yield a positive influence on the achievement of work-life balance, personal time, or time management efficiency. These results effectively address research question RQ6, indicating that implementing remote work in public utility services does not improve operational activities' time management efficiency. Furthermore, the outcomes demonstrate that remote work neither adversely nor positively contributes to the work-life balance of leaders in public utility services. In other words, considering the mean and median values assessment, research question RQ7 is addressed, affirming that remote work does not contribute positively to work-life balance in public utility services.

Table 10
Evaluation of relational capital.

Corresponding Item	Mean	Median	Std Dev.
Dominant Employee-Management Relationship	2.78	2.00	1.58
Predominant Cross-Team Employee Relationships	2.57	2.00	1.17
Formal Remote Work Procedures: Existence	1.65	1.00	1.81
Relational Capital	2.33	2.33	1.10

Source: own prepared, n = 165.

Table 11
Evaluation of multi-criteria approach.

Corresponding Item	Mean	Median	Std Dev.
Work-Life Balance Achievement	2.38	2.00	1.71
Personal Time	2.50	2.00	1.79
Time Management Efficiency	1.93	2.00	1.66
Work-Life Balance	2.27	2.33	1.43

Source: own prepared, $n = 165$.

Table 12 displays that upon scrutiny of the acquired data, the analysis concluded that there is no noteworthy difference in Work-Life Balance levels based on the characteristics of Generations Y, X, and Baby Boomers ($F = 0.80$, $p > 0.05$). Consequently, research hypothesis 3, positing that *significant differences exist in the impact of remote work on work-life balance concerning generational characteristics in public utility services*, has been rejected.

2.2.4. Team management approach

The team management approach examines whether managers empower their employees during remote working. The following focuses on the main research question and hypothesis regarding the Team Management Approach that evaluates *Empowerment* for public utility services. Table 13 displays the team Management Approach factor consists of *Remote Work Commitment Level, Remote Decision-Making Capacity, Task Modification Autonomy, Assessing Employee Competence, Power-Sharing in the Team and Final Task Executor*.

The evaluation of employees' decision-making within the organization involved assessments in empowerment (scoring 5 and 4) and delegation stages (scoring 0–3). The scores reveal a delegation stage between employees and department leaders across public utility services. Research question RQ8 is addressed, affirming that leaders allocate tasks and responsibilities to individuals or teams within organizations, giving them the authority to make decisions and act within their work scope. However, it is clarified that despite this delegation, leaders remain the ultimate decision-making authority, thus precluding the characterization of these structures as self-management teams. Consequently, hypothesis 4, which suggests that *if public utility services work remotely, they are not self-management teams*, has been verified.

3. Conclusions and discussions

The research evaluated management effectiveness by using purposeful, system, multi-criteria, and team management approaches. As a result, remote work has yet to be effectively implemented in public utility services. Goal achievement is exceeds 50 % slightly. In other words, remote work slows their operations and increases obstacles to achieving their operational goals. On the other hand, the Plan-Do-Check-Act (PDCA) Deming Cycle evaluation shows that utility services have not effectively deployed the PDCA cycle for remote work. They must improve their procedures and methods to improve remote work outcomes. In this regard, PDCA cycle implementation may contribute significantly to achieving goals. By consistently applying the PDCA cycle, they can effectively address the challenges and optimize the opportunities presented by remote work, improving service delivery and customer satisfaction. The literature review by Isniah et al. (2020) shows that the PDCA method can eliminate workplace waste (reducing waiting time, energy consumption, loss, and defects) and increase productivity and improvement.

Another important subject is the control mechanism for operational activities during remote work. The remote work control mechanism

Table 12
The relationships between *work-life balance* and generations Y, X and baby boomers characteristics-one way anova test analysis results.

Generation Type	N	Mean	SD	Source of Variance	Sum of Squares	df	Mean Square	F	p	Sig
Generation Y	5	2.06	2.01	Between Groups	3.27	2	1.63			
Generation X	85	2.14	1.40	Within Groups	332.04	162	2.05			
Baby Boomers	75	2.42	1.42	Total	335.31	164				
Total	165	2.27	1.43					0.80	0.45	

Source: own prepared.

Table 13
Evaluation of empowerment.

Corresponding Item	Mean	Median	Std Dev.
Remote Work Commitment Level	3.32	4.00	1.55
Remote Decision-Making Capacity	2.92	3.00	1.61
Task Modification Autonomy	3.48	4.00	1.55
Assessing Employee Competence	4.38	5.00	0.91
Power-Sharing in the Team	2.95	3.00	1.89
Final Task Executor	2.42	3.00	1.95
Empowerment	3.25	3.50	1.03

Source: own prepared, n = 165.

includes a variety of strategies and tools for monitoring and managing remote employees' activities, as well as ensuring productivity and accountability. The study conducted on civil servants by Dos Santos et al. (2022) demonstrates that heightened levels of employee control in remote work settings diminish the alignment of individual objectives with those of the organization. Our research findings emphasize that the primary remote control method involves either scheduled meetings and reporting or informal interviews conducted by leaders. On the other hand, dominant task control frequency is semi-annual or quarterly, facilitated by leaders. Thus, public utility services have a task-control mechanism to track whether their employees fulfil their duties.

As motivation levels relate to both the productivity and well-being of individuals, organizations must know how motivation can be facilitated in a remote working context to keep the productivity and well-being of their employees safe (Dryselius & Pettersson, 2021). In this regard, the study assessed the strategies and tools applied to motivate remote employees. Our research findings reveal that leaders in public utility services consider flexible working time and independence as the most effective motivational tools during remote work. Motivational interviews and advice rank second in effectiveness, followed by material rewards (including money) in the third position. In summary, findings underscore the importance of providing employees with autonomy and a flexible work schedule, recognizing the role of personalized guidance and support in fostering motivation and highlighting the significance of acknowledging and rewarding employees for their efforts.

In the era of remote work, it is more important than ever to thoroughly understand relational capital and how it plays a crucial role in promoting organizational performance and successful virtual cooperation. Relational capital pertains to cultivating interconnected associations among enterprises, institutions, and individuals, resulting in a robust sense of affiliation and interdependence for all participating entities (Johnston & Lane, 2018). According to Ramírez-Solis et al. (2022), relational capital strongly impacts organizational technology orientation. Hence, our study focuses on the characteristics of relational capital during remote work. Based on the research outcomes, the distinctive nature of relational capital in remote work within public utility services is characterized by relationships that transcend the conventional hierarchical structure and encompass informal connections. In other words, the organizational structure of public utility services is flat and flexible during remote work.

Work-life balance is another critical component to achieving remote work effectiveness. Ensuring work-life balance contributes to improving the physical health, mental health, and productivity of remote workers (Como et al., 2021). Our finding reveals that remote work neither adversely nor positively contributes to the work-life balance of leaders in public utility services. In other words, remote work does not contribute positively to work-life balance in public utility services. The reason for this finding can be reduced socialization during remote working.

Our research reveals that regarding generational characteristics, there are no statistically significant differences in the impact of remote work on work-life balance in public utility services. According to the generational theory, people who were born and grew up in different times and periods and were influenced by historical, social, cultural, and political events have different values, beliefs, attitudes, and expectations. All these differences are claimed to impact employee behavior (Kam, 2019; Kam & Trippner-Hrabi, 2021). In this regard, our finding provides an unexpected result in light of the generational theory perspective. The following list includes potential explanations for the related findings (Kam, 2019; Kam & Trippner-Hrabi, 2021);

I. The theory goes that because people of a generation might view the relatives they grew up with as role models, their attitudes and ways of thinking might be similar.
II. Despite the fact that department directors come from diverse generations, it is possible that the research was done in settings with similar organizational cultures and beliefs.
III. The age ranges and characteristics of Baby Boomers (1946–1964) and Generation X (1965–1980) employees, which were developed considering the cultural, economic, and political features of the USA, were used in the research. Poland might not fit into this categorization.

A literature review shows empowerment makes employees happier and more productive by giving them resources, authority, opportunities, and motivation to do the job and holding them accountable for their actions (Staniulienė & Zaveckis, 2022). An examination was conducted to assess the extent of employee autonomy in decision-making while engaged in remote work. The results illuminate a distinct delegation framework operating within public utility services, where employees primarily manage tasks entrusted to them by their department heads. In public utility services, empowerment is contingent upon obtaining prior approval from their superiors, reflecting the enduring bureaucratic nature inherent. This finding underscores that, during remote work, organizations do not function as self-managing teams.

In conclusion, the findings reveal that remote work effectiveness is not at the desired level. In other words, remote work has yet to integrate effectively into public utility services. Therefore, utility services need to strengthen their management strategies to optimize outcomes when operating remotely.

It is essential to acknowledge that public utility services were compelled to rapidly transition to remote working due to COVID-19 restrictions, which is why remote work was not yet implemented effectively. The need for swift implementation posed challenges in achieving the most effective application of remote work practices. However, considering the enhanced implementation experience gained since the onset of the COVID-19 pandemic in public utility services, it is probable that remote work will be utilized more effectively nowadays. Future research should evaluate whether there has been any improvement in the utilization of remote work in the public utility sector. Public

utility services have faced challenges in effectively implementing remote work and must reassess their strategies and procedures to enhance overall effectiveness. To support this effort, benchmarking against successful remote work practices in other public and private sector organizations could offer valuable insights and guidance. Additionally, future research should explore the specific challenges of remote work within the public utility sector. It is also recommended that similar studies, using comparable research methodologies, be applied across both public and private sector organizations to enable broader comparative analysis and practical recommendations.

CRediT authorship contribution statement

Aygun Kam: Writing – review & editing, Writing – original draft, Visualization, Validation, Methodology, Formal analysis, Data curation, Conceptualization. **Justyna Trippner-Hrabi:** Writing – review & editing, Writing – original draft, Validation, Methodology, Conceptualization. **Zbigniew Przygodzki:** Writing – review & editing, Writing – original draft, Validation, Supervision, Methodology, Data curation, Conceptualization. **Oya Aytemiz Seymen:** Writing – original draft.

Declaration of competing interest

The authors report there are no competing interests to declare.

Data availability

Data will be made available on request.

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