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Experiences of Companies in Using Smart City Technologies[*]

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Abstract

Theoretical background: Smart cities rely on advanced technologies such as ICT, IoT, AI, and ML to streamline urban operations and foster sustainable growth. Successful implementation, however, hinges not only on technology but also on how businesses adopt and integrate these innovations. Companies play a critical role in driving technological adoption within smart cities, enhancing urban services, and contributing to economic growth.

Purpose of the article: The objective of this paper is to obtain insights into the experiences of companies in the utilization of smart city technologies. The paper explores companies' active use, challenges in adoption, and potential for increased engagement with these technologies.

Research methods: The authors conducted a pilot survey in 2021, targeting companies in Szczecin and Koszalin, Poland. Using CATI and CAWI techniques, data were collected from 221 companies through a structured questionnaire. The Chi-square test was applied to examine the relationships between variables. The study focused on ten types of smart city technologies and classified company responses into three categories: active use, non-use, and future intent to adopt.

Main findings: The study revealed varying levels of technology adoption across companies. Popular technologies like intelligent payment systems and e-government services saw high adoption rates, while applications for environmental protection and security-related technologies were less utilized. The findings indicate that local business strategies, stakeholder engagement, and investment levels significantly influence adoption rates. Companies in both cities expressed a growing interest in future adoption, especially in smart infrastructure technologies, suggesting potential growth in their usage.

Introduction

The successful implementation of smart city projects not only depends on the technological infrastructure but also on how effectively companies can integrate and benefit from these innovations. Smart cities leverage a variety of advanced technologies such as Information and Communications Technology (ICT), Internet of Things (IoT), Artificial Intelligence (AI), and Machine Learning (ML) to offer enhanced urban services and streamline operations for businesses (Fatewar & Vaishali, 2021; Sulich et al., 2023). These technologies aim to improve efficiency, foster sustainable development, and boost economic growth by optimizing urban systems, including transport, energy, and resource management (Štofková & Janoskova, 2021). However, successfully employing these technologies requires that companies possess a strong understanding of their potential and practical applications (Shin et al., 2021).

Moreover, the involvement of companies in smart city initiatives is critical to ensuring these projects' long-term success. Active participation from the business sector helps drive the adoption of new technologies, promoting innovation and ensuring that urban services cater to both the needs of residents and enterprises (Turgel et al., 2019). Smart city projects aim to create an environment where businesses can flourish by improving mobility, enhancing service delivery, and fostering economic development (Kim et al., 2021). These initiatives align with the broader goals of achieving sustainable urban growth and improving overall quality of life (Huang et al., 2021).

The objective of this paper is to obtain significant insights into the experiences of companies in the utilisation of smart city technologies.The authors explore three key aspects: active use of these technologies by businesses, challenges companies face in adopting them, and the potential for increased engagement in the future. The analysis covers the ways companies utilize tools such as IoT-enabled devices, smart logistics systems, and urban data platforms to enhance their operations and decision-making processes. The challenges discussed include a lack of technical expertise and potential barriers to technology adoption, while future prospects focus on companies' willingness to engage with smart technologies.

The structure of the paper is aligned with the objective formulated above. Therefore, the next section is dedicated to the experiences of companies in utilizing smart city technologies. Various types of smart city technologies are presented, along with an analysis of companies' usage patterns and preferences, which constitutes the authors' original contribution. In the third part, a case study of the cities of Szczecin and Koszalin is conducted. Following that, the results of a pilot survey and feedback from companies are discussed, accompanied by practical recommendations to enhance business engagement with these technologies. The practical contribution of the paper is the conclusion that smart city initiatives must focus on the sustainable development of practical solutions and enable companies to actively participate in the decision-making process. The recommendations formulated integrate insights from ICT and urban management to better understand the deployment of smart city technologies by businesses.

Literature review

The increasing adoption of smart city technologies by businesses is becoming more common as cities globally seek to improve efficiency, sustainability, and the quality of life for their residents. Smart cities utilize advanced technologies like the IoT, big data, AI, and cloud computing to create more efficient and livable urban areas (Prasetyo & Habibie, 2022). These innovations aim to optimize resource use, enhance service delivery, and promote sustainability (Gracias et al., 2023). For companies in smart cities, integrating these smart technologies can lead to greater productivity and innovation (Almeida, 2023). A key element of smart city technologies is their ability to foster innovation and create a smart environment beyond mere technological progress (Almeida, 2023). Incorporating IoT and AI into their operations allows companies to streamline processes and contribute to the development of a smart economy and governance within the city (Almeida, 2023). This comprehensive approach enables companies to improve their operations and support the city's overall advancement.

However, security challenges are a significant concern for companies adopting smart city technologies (Ahmad et al., 2024). The widespread use of IoT, a fundamental aspect of smart cities, often faces security vulnerabilities that need addressing to ensure safe and effective operation (Neupane et al., 2021). Companies must invest in strong cybersecurity measures to protect their data and operations from potential cyber threats in the interconnected smart city ecosystem (Demertzi et al., 2023).

In smart city development, companies are crucial in driving innovation and sustainable urban growth (Khalifi et al., 2024). Technology companies like IBM are leading the development of smart city solutions worldwide, transforming traditional cities into interconnected innovation hubs (Khalifi et al., 2024). By partnering with governments and other stakeholders, companies can use their expertise to implement smart city strategies that enhance citizens' quality of life and promote economic growth.

The success of adopting smart city technology depends heavily on technological factors, as various studies indicate (Alkdour et al., 2023). Companies focusing on technological advancements and investing in cutting-edge solutions are more likely to succeed in smart city initiatives that drive efficiency and sustainability (Alkdour et al., 2023). Embracing IoT, AI, and cloud computing not only improves company operations but also contributes to the overall success of smart city projects.

Moreover, integrating smart city technologies offers companies opportunities to create innovative business models that meet the evolving needs of urban populations (Shetty et al., 2019). By embracing technological, policy, and management innovations, companies can develop new ways of delivering services, interacting with customers, and optimizing their operations within the smart city ecosystem (Shetty et al., 2019). This adaptability and innovation are essential for companies to thrive in the dynamic and interconnected environment of smart cities.

The experiences of companies in utilizing smart city technologies are shaped by a complex interplay of governance, sustainability, and innovative business practices. The transition towards inclusive smart cities necessitates a comprehensive understanding of these factors, ensuring that technological advancements contribute positively to urban life and community engagement.

Research methods

In 2021, the authors carried out a pilot survey in Szczecin and Koszalin, the two biggest cities in the West Pomeranian region of Poland. Computer-assisted telephone interview (CATI) and computer-assisted web interview (CAWI) techniques were used to gather responses from a random sample of 221 companies. To interpret the results, the authors applied the Chi-square test to examine the independence of variables. The data collection was based on a structured questionnaire that included both nominal and ordinal scales.

The present study is a pilot study, and therefore inductive reasoning was the primary method employed. This shaped the study's structure and objective, which was to identify patterns and draw conclusions about observed phenomena based on the results of statistical hypothesis testing. To generalise the sample statistics, statistical hypotheses were formulated, which enabled the application of the Chi-square test of independence.

The authors conducted an empirical investigation into the experiences of companies with a range of smart city technologies in two Polish cities: Szczecin (City 1) and Koszalin (City 2). The objective of the study was to evaluate the utilisation and interest in ten specific types of technologies (Table 1).

Table 1. Technologies analysed in the study and the symbolic representation

Technologies	Features
Technologies 1	inteligent payment systems
Technologies 2	e-government and mobile-government
Technologies 3	health applications
Technologies 4	applications for cultural activities
Technologies 5	applications for environmental protection
Technologies 6	security-related applications
Technologies 7	intelligent water and sewage meters
Technologies 8	smart electricity meters
Technologies 9	free Wi-Fi hotspots
Technologies 10	intelligent transport applications

Source: Authors' own study.

Cronbach's alpha was computed to assess the internal consistency of the smart city technologies scale, which comprises ten items (Table 1). The sample, consisting of 120 companies from the Polish city of Szczecin, exhibits acceptable consistency with a Cronbach's alpha of 0.75. Additionally, the sample made up of 101 companies from the Polish city of Koszalin demonstrates good consistency with a Cronbach's alpha of 0.86.

The authors collated data from both cities, classifying the responses into three discrete categories: those who actively utilise the technology (Option 1), those who do not employ the technology (Option 2), and those who have expressed an intention to utilise the technology in the future (Option 3).

The preceding findings permitted the authors to conduct a comprehensive analysis of the present usage patterns and prospective adoption rates of smart city technologies among companies operating in the Szczecin and Koszalin regions. The objective of this paper is to obtain significant insights into the experiences of companies in the utilisation of smart city technologies. To provide a structured approach to the study, a conceptual framework was developed (Figure 1).

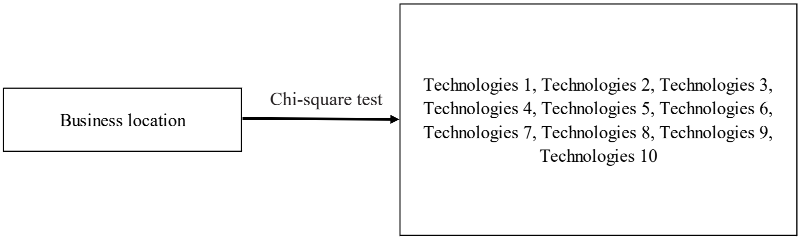

Figure 1. Conceptual framework of the study

Source: Authors' own study.

The conceptual framework indicates the association between the business location and the use of ten different smart city technologies, where H_{0x} relate to null hypotheses and H_{ax} – to alternative hypotheses. Thus, the formulated statistical hypotheses are:

H_{01}: There is no association between the business location and the use of intelligent payment systems.

H_{a1}: There is an association between the business location and the use of intelligent payment systems.

H_{02}: There is no association between the business location and the use of e-office applications.

H_{a2}: There is an association between the business location and the use of e-office applications.

H_{03}: There is no association between the business location and the use of health applications.

H_{a3}: There is an association between the business location and the use of health applications.

H_{04}: There is no association between the business location and the use of applications for cultural activities.

H_{a4}: There is an association between the business location and the use of applications of cultural activities.

H_{05}: There is no association between the business location and the use of applications for environmental protection.

H_{a5}: There is an association between the business location and the use of applications for environmental protection.

H_{06}: There is no association between the business location and the use of applications related to security.

H_{a6}: There is an association between the business location and the use of applications related to security.

H_{07}: There is no association between the business location and the use of intelligent water and sewage meters.

H_{a7}: There is an association between the business location and the use of intelligent water and sewage meters.

H_{08}: There is no association between the business location and the use of smart electricity meters.

H_{a8}: There is an association between the business location and the use of smart electricity meters.

H_{09}: There is no association between the business location and the use of free Wi-Fi hotspots.

H_{a9}: There is an association between the business location and the use of free Wi-Fi hotspots.

H_{010}: There is no association between the business location and the use of intelligent transport applications.

H_{a10}: There is an association between the business location and the use of intelligent transport applications.

The study employed a methodology consistent with that of regional research, and the sample selected is representative of the population of companies in the West Pomeranian Voivodeship. A crucial aspect was to ascertain the representativeness of the sample, ensuring its accuracy in reflecting the analysed elements.

Results

The study involved a randomly selected group of 120 companies from Szczecin and 101 companies from Koszalin. During the study, participants were asked to share their experiences with selected smart city technologies. The findings for Szczecin are shown in Table 2 and for Koszalin – in Table 3.

Table 2. Summary of the City of Szczecin, including frequency of technology used by the company, sample proportion and 95% CI estimation for the population proportion

Technologies	Option	City 1 – Frequency	City 1 – Sample Proportion (n = 120)	95% CI estimation for the population proportion
Technologies 1	1	115	0.96	$0.92 \le p \le 0.99$
	2	4	0.03	$0.00 \le p \le 0.07$
	3	1	0.01	$-0.01 \le p \le 0.02$
Technologies 2	1	112	0.93	$0.89 \le p \le 0.98$
	2	4	0.03	$0.00 \le p \le 0.07$
	3	4	0.03	$0.00 \le p \le 0.07$
Technologies 3	1	78	0.65	$0.56 \le p \le 0.74$
	2	31	0.26	$0.18 \le p \le 0.34$
	3	11	0.09	$0.04 \le p \le 0.14$
Technologies 4	1	58	0.48	$0.39 \le p \le 0.57$
	2	40	0.33	$0.25 \le p \le 0.42$
	3	22	0.18	$0.11 \le p \le 0.25$

Technologies	Option	City 1 – Frequency	City 1 – Sample Proportion (n = 120)	95% CI estimation for the population proportion
Technologies 5	1	30	0.25	$0.17 \leq p \leq 0.33$
	2	65	0.54	$0.45 \leq p \leq 0.63$
	3	25	0.21	$0.14 \leq p \leq 0.28$
Technologies 6	1	47	0.39	$0.30 \leq p \leq 0.48$
	2	54	0.45	$0.36 \leq p \leq 0.54$
	3	19	0.16	$0.09 \leq p \leq 0.22$
Technologies 7	1	40	0.33	$0.25 \leq p \leq 0.42$
	2	39	0.33	$0.24 \leq p \leq 0.41$
	3	41	0.34	$0.26 \leq p \leq 0.43$
Technologies 8	1	40	0.33	$0.25 \leq p \leq 0.42$
	2	38	0.32	$0.23 \leq p \leq 0.40$
	3	42	0.35	$0.26 \leq p \leq 0.44$
Technologies 9	1	53	0.44	$0.35 \leq p \leq 0.53$
	2	52	0.43	$0.34 \leq p \leq 0.52$
	3	15	0.13	$0.07 \leq p \leq 0.18$
Technologies 10	1	62	0.52	$0.43 \leq p \leq 0.61$
	2	29	0.24	$0.17 \leq p \leq 0.32$
	3	29	0.24	$0.17 \leq p \leq 0.32$

Source: Authors' own study.

The analysis of technology usage across the various technologies reveals key differences and similarities. Technologies 1 (intelligent payment systems) and 2 (e-government and mobile-government) show the highest level of active use among respondents in Szczecin, with 96% and 93%, respectively. This suggests that these technologies are well-adopted, with most of the sample population using them regularly. The confidence intervals also indicate a strong level of reliability for these findings. Technologies 7 (intelligent water and sewage meters) and 8 (smart electricity meters) present an equal distribution among the three options (around 33% each), indicating a balance between active users, non-users, and those with future intent. This balance highlights a more varied response to these technologies, reflecting perhaps less overall familiarity or mixed interest compared to Technologies 1 (intelligent payment systems) and 2 (e-government and mobile-government). Technologies 5 (applications for environmental protection) and 6 (security-related applications) exhibit relatively high non-usage rates, with 54% and 45% of respondents, respectively, indicating they do not currently use these technologies. This is a stark contrast to Technologies 1 (intelligent payment systems) and 2 (e-government and mobile-government), where non-usage is minimal. Technologies 7 (intelligent water and sewage meters), 8 (smart electricity meters), and 10 (intelligent transport applications) show higher proportions of respondents indicating future intent to use (around 34–35% for Technologies 7 and 8, and 24% for Technology 10). This is particularly notable compared to Technologies 1 and 2, where future intent is much lower (1% and 3%). Across most technologies, a clear trend emerges where Technologies 1 and 2 are highly adopted, while Technologies 7 (intelligent water and sewage meters) and 8 (smart electricity meters) show more equal distribution between active use, non-use, and future intent. Technologies 5 (applications for environmental protection) and 6 (security-related applications), however, show a larger segment of non-users, highlighting that not all technologies in the smart city framework have been equally embraced.

Table 3. Summary of the City of Koszalin including frequency of technology used by the company, sample proportion and 95% CI estimation for the population proportion

Technologies	Option	City 2 – Frequency	City 2 – Sample Proportion (n = 101)	95% CI estimation for the population proportion
Technologies 1	1	90	0.89	$0.83 \leq p \leq 0.95$
	2	8	0.08	$0.03 \leq p \leq 0.13$
	3	3	0.03	$0.00 \leq p \leq 0.06$
Technologies 2	1	83	0.82	$0.75 \leq p \leq 0.90$
	2	9	0.09	$0.03 \leq p \leq 0.14$
	3	9	0.09	$0.03 \leq p \leq 0.14$
Technologies 3	1	54	0.53	$0.44 \leq p \leq 0.63$
	2	31	0.31	$0.22 \leq p \leq 0.40$
	3	16	0.16	$0.09 \leq p \leq 0.23$
Technologies 4	1	43	0.43	$0.33 \leq p \leq 0.52$
	2	36	0.36	$0.26 \leq p \leq 0.45$
	3	22	0.22	$0.14 \leq p \leq 0.30$
Technologies 5	1	18	0.18	$0.10 \leq p \leq 0.25$
	2	61	0.60	$0.51 \leq p \leq 0.70$
	3	22	0.22	$0.14 \leq p \leq 0.30$
Technologies 6	1	37	0.37	$0.27 \leq p \leq 0.46$
	2	37	0.37	$0.27 \leq p \leq 0.46$
	3	27	0.27	$0.18 \leq p \leq 0.35$
Technologies 7	1	39	0.39	$0.29 \leq p \leq 0.48$
	2	27	0.27	$0.18 \leq p \leq 0.35$
	3	35	0.35	$0.25 \leq p \leq 0.44$
Technologies 8	1	42	0.42	$0.32 \leq p \leq 0.51$
	2	22	0.22	$0.14 \leq p \leq 0.30$
	3	37	0.37	$0.27 \leq p \leq 0.46$
Technologies 9	1	33	0.33	$0.24 \leq p \leq 0.42$
	2	42	0.42	$0.32 \leq p \leq 0.51$
	3	26	0.26	$0.17 \leq p \leq 0.34$
Technologies 10	1	30	0.30	$0.21 \leq p \leq 0.39$
	2	43	0.43	$0.33 \leq p \leq 0.52$
	3	28	0.28	$0.19 \leq p \leq 0.36$

Source: Authors' own study.

The data from Koszalin reveals varying patterns of technology use, highlighting some key differences and similarities between the technologies. For Technologies 1 (intelligent payment systems), active use was reported by 89% of respondents (95% CI [0.83, 0.95]), making it the most widely adopted technology, with only 8% non-use and 3% future intent. Technologies 2 (e-government and mobile-government) also showed high adoption (82%), but a slightly higher proportion of respondents indicated either non-use (9%) or future intent (9%), making this technology slightly less dominant in comparison. Moving to Technologies 3 (health applications), a more balanced distribution is observed, with 53% active users, 31% non-users, and 16% indicating future intent. This suggests a more mixed reception to this technology. Similar patterns are seen with Technologies 4 (applications for cultural activities), where only 43% of respondents use the technology, 36% do not, and 22% express interest in future use, highlighting more cautious adoption. Technologies 5 (applications for environmental protection) stands out for its high non-usage rate, with 60% of respondents not using it, while only 18% actively use it and 22% are open to future use. This contrasts with Technologies 6 (security-related applications), which shows equal distribution between active use (37%), non-use (37%), and future intent (27%), reflecting uncertainty or ambivalence among respondents. In summary, Technologies like 1 (intelligent payment systems) and 2 (e-government and mobile-government) have high adoption, while Technologies 5 (applications for environmental protection) and 6 (security-related applications) display more reluctance, with a significant portion of respondents either not using or undecided about future use. Technologies 7 through 10 (intelligent water and sewage meters; smart electricity meters; free Wi-Fi hotspots and intelligent transport applications) show similar balanced patterns, with roughly a third of respondents in each category, suggesting that these technologies may have growth potential as more people consider future use.

The comparison between Szczecin and Koszalin shows strong similarities in the adoption of Technologies 1 (intelligent payment systems) and 2 (government and mobile-government) with high usage rates in both cities (Szczecin: 96% and 93%, Koszalin: 89% and 82%, respectively). However, there are notable differences in the adoption of less popular technologies. For example, Technologies 5 (applications for environmental protection) shows low usage in both cities but is slightly more adopted in Szczecin (25% vs. 18% in Koszalin). Technologies 6 (security-related applications) exhibits a balanced split between users and non-users in both cities, while Technologies 9 (free Wi-Fi hotspots) has higher adoption in Szczecin (44% vs. 33% in Koszalin), with Koszalin showing more future intent. These patterns indicate similar trends for widely used technologies but greater variability in less adopted ones. Further, Chi-square analysis was performed, and the outcomes are shown in Table 4.

A Chi-square test of independence showed that there was no significant association between the business location and the Technologies 1 (intelligent payment systems), $\chi2$ (2, N = 221) = 3.777, $p > .05$; there was no significant association between the business location and the use of Technologies 3 (health applications), $\chi2$ (2, N = 221) = 3.683, $p > .05$; there was no significant association between the business location and the use of Technologies 4 (applications for cultural activities), $\chi2$ (2, N = 221) = 0.811, $p > .05$; there was no significant association between the business location and the use of Technologies 5 (applications for environmental protection), $\chi2$ (2, N = 221) = 1.698, $p > .05$; there was no significant association between the business location and the use of Technologies 6 (security-related applications) $\chi2$ (2, N = 221) = 4.155,

$p > .05$; there was no significant association between the business location and the use of Technologies 7 (intelligent water and sewage meters), $\chi 2$ (2, $N = 221$) = 1.042, $p > .05$; and there was no significant association between the business location and the use of Technologies 8 (smart electricity meters), $\chi 2$ (2, $N = 221$) = 3.021, $p > .05$.

Table 4. Chi-square analysis

Hypotheses	Chi-square test statistic	df	α	*p*-value	Observation	Decision
H_{01} / H_{a1}	3.777	2	0.05	0.151	*p*-value > *α*	Fail to reject the null hypothesis
H_{02} / H_{a2}	6.574	2	0.05	0.037	*p*-value < *α*	Reject the null hypothesis
H_{03} / H_{a3}	3.683	2	0.05	0.159	*p*-value < *α*	Fail to reject the null hypothesis
H_{04} / H_{a4}	0.811	2	0.05	0.667	*p*-value < *α*	Fail to reject the null hypothesis
H_{05} / H_{a5}	1.698	2	0.05	0.428	*p*-value > *α*	Fail to reject the null hypothesis
H_{06} / H_{a6}	4.155	2	0.05	0.125	*p*-value < *α*	Fail to reject the null hypothesis
H_{07} / H_{a7}	1.042	2	0.05	0.5938	*p*-value > *α*	Fail to reject the null hypothesis
H_{08} / H_{a8}	3.021	2	0.05	0.221	*p*-value > *α*	Fail to reject the null hypothesis
H_{09} / H_{a9}	7.085	2	0.05	0.029	*p*-value < *α*	Reject the null hypothesis
H_{010} / H_{a10}	12.328	2	0.05	0.002	*p*-value < *α*	Reject the null hypothesis

Source: Authors' own study.

However, there was a significant association between the business location and the use of use of Technologies 2 (e-government and mobile-government), $\chi 2$ (2, $N = 221$) = 0.05, $p < .05$; there was a significant association between the business location and the use of Technologies 9 (free Wi-Fi hotspots), $\chi 2$ (2, $N = 221$) = 7.085, $p > .05$; and there was a significant association between the business location and the use of Technologies 10 (intelligent transport applications), $\chi 2$ (2, $N = 221$) = 12.328, $p < .05$.

Based on the results of the statistical hypothesis testing, the researchers are able to conclude that among the ten observed smart city applications, the companies' usage of e-government and mobile-government, free Wi-Fi hotspots, and intelligent transport applications differs between Szczecin and Koszalin. Although Technology 2 (e-government and mobile-government) is one of the most used in both analyzed cities, the difference in its usage is significant, with it being used more frequently in Szczecin than in Koszalin.

Discussions

The comparative analysis of technology adoption between Szczecin and Koszalin highlights usage trends among residents and underscores the critical role of stakeholders, particularly companies, in shaping these trends (Misiak-Kwit & Wiścicka-Fernando, 2024). The high adoption rates of Technologies 1 (intelligent payment systems) and 2 (e-government and mobile-government) in both cities (Szczecin: 96% and 93%, Koszalin: 89% and 82%) suggest that local businesses are likely leveraging these technologies to enhance operational efficiency and customer engagement. This is consistent with findings from Baio and Carrer (2022), which indicate that companies adopting advanced technologies often engage in partnerships with universities and research institutions, thereby fostering innovation and technology diffusion. Such collaborations can be pivotal in driving the adoption of popular technologies as they provide companies with the necessary resources and expertise to implement these innovations effectively. This trend also aligns with findings from Wnuk and Oleksy (2021), who noted that active attachment to a city correlates with a favourable attitude towards enabling technologies, suggesting that stakeholders' engagement levels may influence adoption rates. The high use of these technologies in both cities can be attributed to a shared urban identity and the perceived benefits of these technologies in improving urban life and functioning in the city, such as in Helsinki. By actively involving residents in the development process, a city can successfully integrate smart technologies that are in line with the values and needs of the community, leading to increased use and acceptance (Hämäläinen, 2021).

However, the differences observed in the adoption of less popular technologies, such as Technology 5 (applications for environmental protection), which shows a slight edge in Szczecin (25% vs. 18% in Koszalin), may reflect varying levels of corporate engagement and investment in technology across the two cities. Companies in Szczecin might be more proactive in exploring and adopting emerging technologies, which aligns with the findings of Xia et al. (2022), who emphasize the importance of stakeholder involvement in the adoption of green technologies, suggesting that internal and external stakeholders significantly influence technology adoption decisions. This indicates that local businesses in Szczecin may be more attuned to market demands and technological advancements, leading to higher adoption rates of less popular technologies. This discrepancy between Szczecin and Koszalin may reflect varying local governance and community engagement strategies, as discussed by Pilsudski et al. (2019), who argue that the social and political contexts significantly influence technology adoption in urban settings. The significance of adopting technological solutions to safeguard the natural environment is also underscored in cross-cultural analyses, where eco-helping actions and engagement are crucial (Manuel et al., 2024; Miah et al., 2024)

Moreover, the balanced split in Technology 6 (security-related applications) adoption and the higher usage of Technology 9 in Szczecin (44% vs. 33% in Koszalin) further illustrate the role of local business strategies in technology adoption. Companies that actively invest in technology and foster a culture of innovation are likely to see better adoption rates, as highlighted by Sousa et al. (2023), who found that willingness to invest in technology significantly influences managers' intentions to adopt innovative solutions. This suggests that corporate strategies and investment decisions are crucial in determining the extent to which less popular technologies are embraced.

Interestingly, Koszalin's greater intent for future adoption of certain technologies, despite its current lower usage rates, indicates a potential shift in corporate strategy and stakeholder engagement. This aligns with the observations of Ghanouni et al. (2020), who noted that stakeholders often face barriers to technology adoption due to a lack of critical appraisal skills and access to relevant information. Therefore, enhancing communication and knowledge dissemination among stakeholders could facilitate increased adoption rates in Koszalin, as companies may become more informed and willing to invest in emerging technologies.

This also aligns with the findings of Alkdour et al. (2023), who identified perceived security and trust as critical factors influencing the adoption of smart city services, suggesting that cities with lower current adoption may be more open to future technological integration if these factors are addressed. The variability in technology adoption between Szczecin and Koszalin underscores the importance of local context and companies' engagement in shaping urban technology landscapes.

In conclusion, the comparison between Szczecin and Koszalin reveals that while both cities exhibit similar trends in the adoption of widely used technologies, the differences in less adopted technologies underscore the influence of corporate strategies and stakeholder engagement. Future research should focus on how local businesses can enhance their technology adoption strategies through collaboration with educational institutions and by fostering a culture of innovation, thereby bridging the gap in technology usage between the two cities.

Conclusions

The aim of this paper was to obtain significant insights into the experiences of companies in the utilisation of smart city technologies in two cities – Szczecin and Koszalin.

The results from Szczecin reveal significant variation in the adoption of different technologies. Technologies 1 (intelligent payment systems) and 2 (e-government and mobile-government) exhibit the highest levels of active use, with 96% and 93% of respondents respectively, indicating strong acceptance. In contrast, Technologies 5 (applications for environmental protection) and 6 (security-related applications) show higher non-usage rates (54% and 45%), suggesting they are less widely adopted. Technologies 7 (intelligent water and sewage meters) and 8 (smart electricity meters) present a balanced distribution across users, non-users, and those with future intent, reflecting more varied familiarity. Additionally, a higher proportion of respondents expressed future intent to use Technologies 7 (intelligent water and sewage meters), 8 (smart electricity meters), and 10 (intelligent transport applications), highlighting potential areas for growth in these areas.

The results from Koszalin demonstrate a diverse range of patterns in technology usage. Technologies 1 (intelligent payment systems) and 2 (e-government and mobile-government) are the most popular, with 89% and 82% of respondents indicating that they are active users. However, Technologies 2 (e-government and mobile-government) has a slightly higher proportion of non-users or those considering future use. Technologies 3 (health applications) and 4 (applications for cultural activities) exhibit a more balanced distribution, with 53% and 43% of respondents utilising them, while the remainder evince no interest or future intent. Technologies 5 (applications for environmental protection) exhibits the highest non-usage rate (60%), while Technologies 6 (security-related applications), along with Technologies 7–10 (intelligent water and sewage meters; smart electricity meters; free Wi-Fi hotspots; intelligent transport applications), demonstrates an even distribution of active users, non-users, and those contemplating future use. This indicates the potential for expansion in the utilisation of these technologies as an increasing number of individuals contemplate their future adoption.

Future studies should utilize a more focused approach and consider a wider range of factors that influence companies' interactions with smart city technologies. Moreover, research should involve larger sample groups. By overcoming these limitations and building on current findings, future research can strengthen its relevance and offer valuable insights for the successful development of smart cities.

In summary, the pilot study emphasizes the need to increase awareness and ensure accessibility to smart city technologies to optimize their adoption and advantages. By catering to the unique needs and preferences of companies, cities can improve urban living standards and nurture a more engaged, tech-savvy community. This approach promotes sustainable development and encourages active involvement in the digital evolution of urban spaces. It is essential to involve companies in co-creating the city, rather than imposing popular solutions. When new technologies evoke mixed emotions, the focus should be on education, information sharing, and fostering social dialogue.

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