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Impact of Artificial Intelligence on Perceived Satisfaction in Living Smart Cities as mediated by Subjective Well-being and Trust

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Abstract

This study investigates the impact of artificial intelligence (AI) on trust, subjective well-being, and perceived satisfaction in smart cities. A cross-sectional survey was conducted with urban residents in Pakistan, using a 5-point Likert scale to gather responses. The study hypothesized that AI influences trust, well-being, and satisfaction, and that trust and subjective well-being mediate these relationships. Structural Equation Modeling using SmartPLS software was applied for data analysis. The results indicate that AI has a significant positive effect on trust, subjective well-being, and perceived satisfaction. Trust and well-being were found to mediate the relationship between AI and satisfaction, highlighting their critical roles in enhancing residents' experiences in smart cities. The findings emphasize the importance of designing AI systems that foster trust and improve well-being to maximize satisfaction among smart city residents. Theoretical contributions include the application of trust and subjective well-being frameworks in the context of AI and smart cities. Practically, the study offers insights for policymakers and urban planners to develop user-friendly, transparent, and reliable AI systems.

Keywords: artificial intelligence; satisfaction; smart cities; trust

1. Introduction

Smart cities are emerging as modern urban spaces driven by data and technology to improve quality of life (Georgiadis et al., 2021). Artificial intelligence (AI) plays a central role in automating processes, enhancing services, and ensuring sustainable urban environments. However, while these advancements have the potential to increase efficiency and convenience, it is crucial to assess how AI influences residents' satisfaction within smart cities (Ahmad et al., 2022). Perceived satisfaction, which reflects the overall contentment with life in smart cities, is subject to several mediating factors, including subjective well-being and trust in AI systems (Bokhari & Myeong, 2022). Despite technological advancements, smart cities face challenges related to citizens' emotional responses to automated systems, data usage, and the extent of AI implementation in their daily lives. Many residents may feel alienated or overwhelmed by such technology, affecting their subjective well-being and trust in AI systems (Quasim et al., 2021; Tripathi et al., 2022). This, in turn, could impact their overall satisfaction with city life. Understanding these dynamics is essential to improve smart city strategies for more inclusive and citizen-centric solutions.

The rapid advancements in AI have significantly influenced the evolution of smart cities across the globe (Chen & Chan, 2023). Smart cities represent a forward-thinking approach to urban development, leveraging AI technologies to address critical challenges such as population growth, resource management, and environmental sustainability (Javed et al., 2022). Through the integration of AI, these cities can optimize infrastructure, enhance public service delivery, and foster a more connected and efficient urban lifestyle. Examples include AI-driven traffic management systems that reduce congestion, predictive analytics that improve resource allocation, and smart grids that ensure efficient energy usage. These advancements not only aim to improve operational efficiency but also to elevate the overall quality of life for residents (Janani et al., 2021). Despite these technological achievements, the human dimension of AI integration in smart cities remains a critical area of exploration. The acceptance and effectiveness of AI in urban environments largely depend on how well it meets the needs and expectations of residents (Chen, 2023). Trust in AI systems is paramount, as it influences the willingness of individuals to adopt and rely on these technologies. Additionally, the extent to which AI contributes to residents' subjective well-being, including their emotional and psychological satisfaction, plays a vital role in determining its success (Gracias et al., 2023). This study focuses on understanding these human-centric aspects to ensure sustainable and inclusive smart city development.

Trust is a fundamental factor in the acceptance of AI technologies within smart cities. It reflects residents' confidence in the reliability, safety, and transparency of AI systems. Trust in AI systems is essential to building a positive relationship between residents and technology, particularly in urban settings where reliance on AI is growing (Chen et al., 2021). Similarly, subjective well-being, which encompasses emotional and psychological satisfaction, is becoming an important metric for evaluating the success of smart cities. Residents' perceptions of how AI improves their quality of life and overall happiness significantly influence their satisfaction with living in such cities (Costa et al., 2022). Perceived satisfaction with smart city living represents a holistic evaluation of residents' experiences, shaped by the interaction of various factors, including trust in AI systems and their contribution to subjective well-being (Han & Kim, 2021). While existing studies have highlighted the potential benefits of AI in enhancing urban environments, limited research has examined how these elements interrelate in the context of smart cities, particularly in developing countries like Pakistan. Understanding these dynamics is critical for designing AI systems that are not only technologically efficient but also aligned with the needs and expectations of residents.

This study aims to investigate the direct and indirect impacts of AI on trust, subjective well-being, and perceived satisfaction in the context of smart city living. Specifically, it examines the mediating roles of trust and subjective well-being in these relationships. This paper is structured to examine the impact of AI on trust, subjective well-being, and perceived satisfaction in smart city living. The literature review establishes the context and theoretical framework, followed by a methodology detailing data collection and analysis. Results, discussion, and conclusion sections present key findings, implications, and future research directions.

2. Literature Review and Hypotheses Development

2.1. Smart Cities

Smart cities represent a transformative approach to urban planning and development, leveraging technology to improve the quality of life for residents, enhance sustainability, and optimize resource utilization (Ramírez-Moreno et al., 2021). By integrating advanced technologies such as AI, the Internet of Things (IoT), big data, and renewable energy systems, smart cities aim to address challenges like traffic congestion, pollution, and inefficiency in public services. These cities prioritize connectivity, with data serving as the backbone for real-time decision-making and efficient resource allocation (Lytras et al., 2021). Innovations in smart transportation, energy management, and infrastructure development have made smart cities a beacon of hope for sustainable urbanization (Makani et al., 2022). Living in a smart city offers residents numerous benefits, enhancing their everyday experiences. For instance, smart transportation systems improve mobility by using real-time traffic data to reduce congestion and optimize public transit routes (Elahi et al., 2021). Smart homes equipped with IoT devices provide greater convenience, allowing residents to control appliances, lighting, and security remotely (Mishra & Singh, 2023). Public safety is also elevated through the use of intelligent surveillance systems and AI-driven crime prediction tools. Moreover, smart waste management and energy-efficient infrastructure contribute to a cleaner, greener environment, fostering a healthier lifestyle for citizens.

The concept of living in a smart city goes beyond technological advancements. It involves fostering a sense of community through participatory governance, where residents play an active role in decision-making processes. By using digital platforms, governments can engage with citizens, addressing their concerns and tailoring solutions to meet local needs (Batool et al., 2021). Education and healthcare also benefit from smart city initiatives, as digital classrooms and telemedicine platforms make these services more accessible and efficient. However, living in smart cities is not without challenges. Issues such as data privacy, cybersecurity threats, and the digital divide must be addressed to ensure inclusivity and safety for all residents. Effective policies and ethical frameworks are essential to balance technological innovation with residents' rights and freedoms. Furthermore, the transition to smart cities demands significant investments and collaboration among governments, businesses, and communities (Almihat et al., 2022).

Smart cities embody the future of urban living, offering solutions to some of the most pressing challenges faced by modern cities (Wang et al., 2021). They promise a more sustainable, efficient, and connected urban environment, enhancing the overall quality of life for residents. While challenges persist, strategic planning and inclusive approaches can unlock the full potential of living in smart cities.

2.2. Artificial Intelligence

The integration of AI in smart cities has emerged as a transformative force, shaping residents' experiences and perceptions (Okonta & Vukovic, 2024). AI technologies enable real-time decision-making, efficient service delivery, and personalized solutions, fostering trust in living within these technologically advanced urban spaces (Syed et al., 2021). Trust is pivotal for the success of smart cities, as it underpins citizens' willingness to engage with digital systems and services (Neupane et al., 2021). AI-driven innovations, such as smart traffic management, predictive maintenance, and intelligent governance, create a sense of reliability and transparency, leading to a positive direct impact on trust. Furthermore, AI plays a crucial role in enhancing perceived satisfaction by addressing everyday urban challenges. Through predictive analytics and automated processes, AI optimizes resource allocation, reduces waiting times, and improves the efficiency of public services. These advancements contribute to a seamless urban living experience, promoting satisfaction among residents (Herdiansyah, 2023). AI also influences subjective well-being, a holistic measure encompassing physical, emotional, and social dimensions of quality of life. By fostering safer, cleaner, and more sustainable environments, AI improves overall livability (Habib et al., 2023). Personalized healthcare, adaptive learning platforms, and AI-powered public safety measures collectively enhance residents' well-being, establishing a direct positive relationship between AI adoption and subjective well-being in smart cities. Thus, the following hypotheses are proposed.

H1: AI has a positive direct impact on trust in living smart cities
H2: AI has a positive direct impact on perceived satisfaction in living smart cities
H3: AI has a positive direct impact on subjective well-being in living smart cities

2.3. Trust

Trust plays a crucial role in shaping individuals' perceptions and experiences within smart cities. It directly influences the level of satisfaction residents derive from living in such environments (Kundu, 2019). When citizens trust the technologies integrated into their cities, such as AI systems, they are more likely to feel secure and satisfied with the services provided (Herdiansyah, 2023). Trust in these technologies fosters a sense of reliability and effectiveness, leading to enhanced perceptions of urban living. Research has shown that trust in smart city technologies is strongly linked to user satisfaction, as it reduces uncertainty and increases the willingness to engage with new systems (Neupane et al., 2021). Moreover, trust acts as a key mediator in the relationship between AI technologies and perceived satisfaction. While AI systems can offer numerous benefits to residents, including improved convenience, efficiency, and safety, the positive impact of these technologies on satisfaction is often contingent upon the trust residents place in them (Cole & Tran, 2022). When individuals trust AI-based systems, they are more likely to recognize and appreciate their contributions to urban life, which in turn boosts their overall satisfaction (Kundu, 2019). Therefore, trust in AI is essential for maximizing the benefits of smart city technologies and ensuring that residents experience a high quality of life. Thus, the following hypotheses are proposed.

H4: Trust direct impact on perceived satisfaction in living smart cities
H5: Trust in AI systems mediates the relationship between AI and perceived satisfaction

2.4. Subjective Well-being

Subjective well-being refers to individuals' self-reported assessment of their overall happiness and life satisfaction (Yang et al., 2020; Wang & Zhou, 2023). In the context of smart cities, subjective well-being plays a significant role in shaping residents' perceptions of urban living. A higher level of subjective well-being is directly linked to greater satisfaction with living in smart cities (Zhao, 2024). As AI technologies enhance the quality of services, infrastructure, and convenience, they positively contribute to individuals' sense of well-being. When people feel that their needs and desires are met through efficient and personalized services, they experience higher satisfaction with their living environment (Chen, 2023). Moreover, subjective well-being can mediate the relationship between AI and perceived satisfaction (Mouratidis, 2021). While AI technologies in smart cities can improve the overall living experience, the emotional and psychological benefits of using these technologies depend on how they influence individuals' well-being (Zhu et al., 2022). AI-driven solutions that cater to residents' well-being, such as personalized healthcare, improved public safety, and increased connectivity, can enhance life satisfaction (Bokhari & Sharifi, 2022). When residents perceive AI as contributing to their well-being, they are more likely to appreciate and trust these technologies, thereby increasing their overall satisfaction with smart city living (Mashhadi et al., 2016). Thus, the integration of AI systems in smart cities should focus not only on technological efficiency but also on enhancing subjective well-being to create more sustainable and fulfilling urban environments. Thus, the following hypotheses are proposed.

H6: Subjective well-being direct impact on perceived satisfaction in living smart cities
H7: Subjective well-being in AI systems mediates the relationship between AI and perceived satisfaction

Figure 1 depicts the research model for the study.

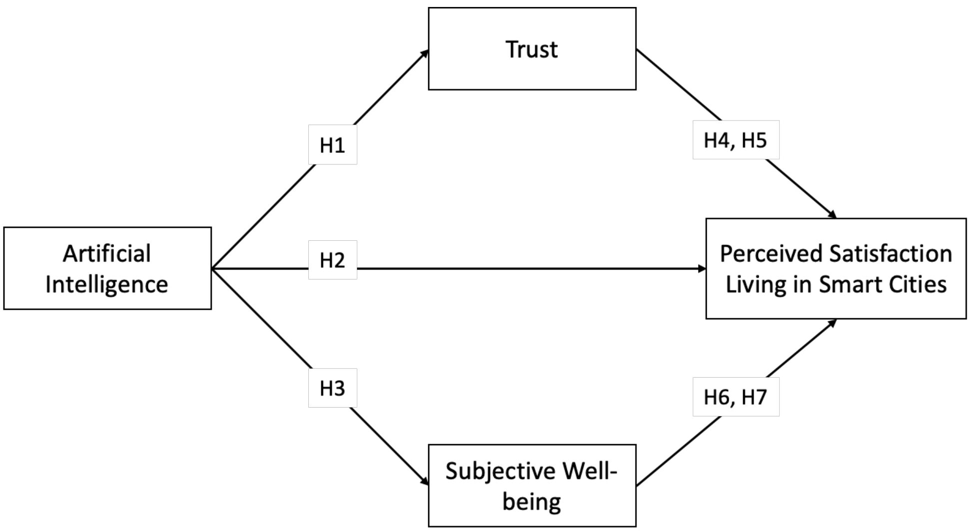

Figure 1. Study research model.

3. Methodology

This study employed a cross-sectional study design to investigate the relationships between the variables. Data were collected from individuals residing in urban cities in Pakistan using a convenience sampling technique in November 2024. The use of a convenience sampling technique allowed for efficient data collection within the specified population. A structured questionnaire was designed to capture responses on a 5-point

Likert scale, ranging from 1 (strongly disagree) to 5 (strongly agree). The construct of AI was measured using 5 items adapted from Bokhari and Myeong (2023). Trust was assessed with 4 items adapted from Meyer-Waarden et al. (2021). Subjective well-being was measured with 3 items derived from Diener (1984), Diener and Chan (2011), and Meyer-Waarden et al. (2021). Perceived satisfaction was captured using 3 items adapted from Xu and Zhu (2021). For data analysis, structural equation modeling (SEM) was utilized to examine the relationships between variables. The analysis was conducted using SmartPLS software, which is well-suited for handling complex models and analyzing latent constructs. This methodological approach ensured robust and reliable insights into the hypothesized relationships.

4. Results

The demographic characteristics of the study sample (n=231) provide insights into the participants' profiles (Table 1). In terms of gender, the sample is nearly balanced, with 53% male and 47% female respondents. The majority of participants (45%) fall in the 35-44 age range, followed by 27% aged 25-34, and smaller proportions in other age groups. Regarding living status, half of the respondents (50%) own their houses, while 39% live in rental properties, and 11% reside in lease houses. In terms of employment, 63% are employed full-time, 24% work freelance, and 13% are part-time employees. Educational qualifications reveal that most participants (65%) hold a bachelor’s degree, followed by 20% with a master’s degree, 10% with an associate degree, and 5% with a high school diploma.

Table 1. Demographic characteristics (n=231).

		Frequency	Percent
Gender			
	Male	122	53%
	Female	109	47%
Age			
	18-24	11	5%
	25-34	63	27%
	35-44	104	45%
	45-54	38	16%
	55-64	15	6%
Living state			
	House owner	116	50%
	Rental place	89	39%
	Lease house	26	11%
Working			
	Full-time	145	63%
	Part-time	31	13%
	Freelance	55	24%
Education			
	High school diploma	12	5%
	Associate degree	23	10%
	Bachelor’s degree	149	65%
	Master’s degree	47	20%

Table 2 evaluates the reliability and validity of the constructs included in the study by examining loadings, Cronbach's alpha, composite reliability (CR), and average variance extracted (AVE). For AI, the loadings for the five items range between 0.701 and 0.785, indicating acceptable item reliability. The Cronbach's alpha is 0.709, above the threshold of 0.7, showing internal consistency, and the CR is 0.81, further confirming the construct's reliability. The AVE is 0.566, above the recommended value of 0.5, indicating adequate convergent validity. For trust, the loadings of the four items range from 0.731 to 0.828, demonstrating strong individual item reliability. However, the Cronbach's alpha (0.742) and CR (0.735) are relatively close to the minimum threshold, but they meet the acceptable range, ensuring reliability. The AVE is 0.518, slightly above the standard, indicating moderate convergent validity. The subjective well-being construct exhibits strong reliability and validity. Loadings for its three items range from 0.78 to 0.868. The Cronbach's alpha (0.797) and CR (0.881) are well above the thresholds, and the AVE (0.712) demonstrates strong convergent validity. Finally, for perceived satisfaction, the loadings of the three items are between 0.73 and 0.773, ensuring item reliability. The Cronbach's alpha (0.723) and CR (0.798) exceed the minimum requirements for reliability, while the AVE (0.568) confirms adequate convergent validity.

Table 2. Assessment of reliability and validity of constructs.

Items with constructs	Loadings	Cronbach's alpha	Composite reliability	Average variance extracted (AVE)
Artificial Intelligence		0.709	0.81	0.566
AI1: "In my opinion, information from artificial intelligence science community is trustworthy"	0.704			
AI2: "In my opinion, artificial intelligence science community has much influence on society"	0.767			
AI3: "I have very much confidence in the artificial intelligence science community"	0.701			
AI4: "In my opinion, artificial intelligence has helped to ease working in the community"	0.785			
AI5: "In my opinion, government services have improved with artificial intelligence"	0.752			
Trust		0.742	0.735	0.518
TR1: "I think that a smart home would provide 100% reliable services"	0.828			
TR2: "I think a smart home and its connected services would not fail me"	0.756			
TR3: "I think a smart home and its connected services would be 100% trustworthy"	0.752			
TR4: "I would have 100% confidence in a smart home and its connected services"	0.731			
Subjective Well-being		0.797	0.881	0.712
SW1: "If I lived in a smart home my life quality would be improved too ideal"	0.78			
SW2: "If I lived in a smart home my feelings of well-being would be improved"	0.88			
SW3: "If I lived in a smart home my feelings of happiness would be improved"	0.868			
Perceived Satisfaction		0.723	0.798	0.568
PS1: "I am satisfied with the smart city construction at the moment"	0.73			
PS2: "I am effective in adopting and using new functions generated by smart city construction"	0.759			
PS3: "Smart city construction has helped me to provide reliable services"	0.773			

Table 3 assesses discriminant validity using the Fornell-Larcker criterion, which compares the square root of the AVE for each construct with the correlation coefficients between constructs. Discriminant validity is established when the square root of the AVE (diagonal values) is greater than the inter-construct correlations (off-diagonal values). The diagonal value for AI is 0.683, which is higher than its correlations with perceived satisfaction (0.44), subjective well-being (0.373), and trust (0.385), indicating discriminant validity for this construct. Similarly, for perceived satisfaction, the diagonal value (0.754) exceeds its correlations with subjective well-being (0.497), and trust (0.507), confirming discriminant validity. For subjective well-being, the diagonal value (0.844) is higher than its correlations with trust (0.619), establishing discriminant validity. Lastly, for trust, the diagonal value (0.646) is greater than its correlations.

Table 3. Discriminant validity (Fornell-larcker criterion).

	AI	Perceived Satisfaction	Subjective Well-being	Trust
AI	0.683			
Perceived Satisfaction	0.44	0.754		
Subjective Well-being	0.373	0.497	0.844	
Trust	0.385	0.507	0.619	0.646

Table 4 presents the results of the path coefficient analysis, which evaluates the direct and indirect relationships between constructs in the model. The relationship between AI and trust is significant, with a beta value of 0.385 ($p = 0.00$), supporting H1. Similarly, the influence of AI on perceived satisfaction is significant, with a beta value of 0.384 ($p = 0.003$), supporting H2. The impact of AI on subjective well-being is also significant, with a beta value of 0.373 ($p = 0.00$), confirming H3. Trust significantly influences perceived satisfaction, with a beta value of 0.286 ($p = 0.00$), supporting H4. Additionally, the indirect effect of AI on perceived satisfaction through trust is significant, with a beta value of 0.322 (p = 0.00), validating H5. The relationship between subjective well-being and perceived satisfaction is significant, with a beta value of 0.216 (p = 0.00), supporting H6. Lastly, the indirect effect of AI on perceived satisfaction via subjective well-being is significant, with a beta value of 0.278 (p = 0.00), confirming H7.

Table 4. Path coefficients.

Paths	Beta	Standard deviation	T statistics	P values	Results
AI -> Trust	0.385	0.088	4.386	0.00	H1 supported
AI -> Perceived Satisfaction	0.384	0.129	2.967	0.003	H2 supported
AI -> Subjective Well-being	0.373	0.088	4.259	0.00	H3 supported
Trust -> Perceived Satisfaction	0.286	0.14	5.046	0.00	H4 supported
AI -> Trust -> Perceived Satisfaction	0.322	0.058	6.043	0.00	H5 supported
Subjective Well-being -> Perceived Satisfaction	0.216	0.14	4.117	0.00	H6 supported
AI -> Subjective Well-being -> Perceived Satisfaction	0.278	0.057	5.028	0.00	H7 supported

The R-square (R^2) values indicate the explanatory power of the model for the dependent variables (Figure 2). For perceived satisfaction, the R^2 value is 0.414, showing that 41.4% of its variance is explained by predictors such as AI, trust, and subjective well-being, highlighting a moderate explanatory power. Similarly, for subjective well-being, the R^2 value of 0.339 implies that 33.9% of its variance is explained by AI, reflecting a moderate impact. For trust, the R^2 value of 0.348 indicates that 34.8% of its variance is accounted for by AI. These results demonstrate the model's reasonable ability to explain the dependent variables, supporting the robustness of the relationships.

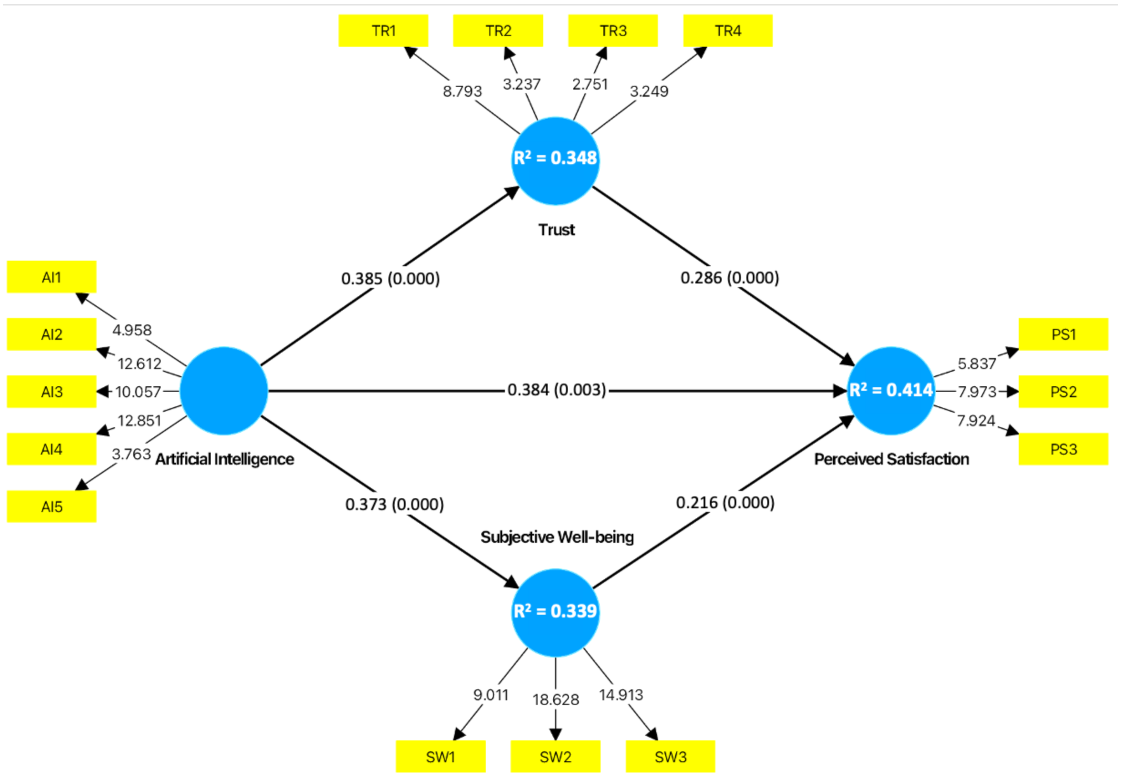

Figure 2. Structural model.

5. Discussion

The findings of this study provide valuable insights into the relationships between AI, trust, subjective well-being, and perceived satisfaction in the context of living in smart cities. The hypotheses were tested using structural equation modeling, yielding significant and robust results. AI demonstrated a significant and positive direct impact on trust (H1), perceived satisfaction (H2), and subjective well-being (H3). These findings indicate that the integration of AI into smart city systems enhances residents' confidence in such technologies, improves their satisfaction levels, and contributes to their overall well-being (Allam et al., 2022). This aligns with prior research (e.g., Bokhari & Myeong, 2023), which highlights the transformative role of AI in urban living environments. Trust was found to have a significant direct impact on perceived satisfaction (H4), affirming that confidence in AI systems is a crucial determinant of residents' satisfaction in smart cities. Additionally, the mediating role of trust (H5) between AI and perceived satisfaction suggests that trust acts as a conduit through which the benefits of AI influence satisfaction. These findings are consistent with the trust-centric framework proposed by Meyer-Waarden et al. (2021), emphasizing the importance of building reliable AI systems to enhance user satisfaction (Shankar et al., 2021).

Subjective well-being also exhibited a significant direct impact on perceived satisfaction (H6), suggesting that a higher sense of well-being derived from smart city technologies contributes to overall satisfaction. Moreover, the mediating role of subjective well-being (H7) between AI and perceived satisfaction highlights that well-being serves as an intermediary mechanism through which AI affects satisfaction. These results support previous literature (e.g., Diener, 1984; Diener & Chan, 2011), which underscores the link between well-being and satisfaction in technologically advanced environments.

This study reinforces the critical role of AI in shaping trust and subjective well-being, which in turn significantly enhance perceived satisfaction in living smart cities (Tantau & Şanta, 2021). The findings advocate for the development and implementation of AI-driven solutions that prioritize trustworthiness and promote residents' well-being to achieve sustainable satisfaction in urban environments (Ashraf, 2021). The findings of this study offer significant theoretical and practical implications for the development and adoption of AI in smart cities. This study contributes to the existing body of knowledge by empirically validating the role of AI in enhancing trust, subjective well-being, and perceived satisfaction in the context of smart cities (Xiao & Xie, 2021). The research extends the application of trust theories and subjective well-being frameworks by demonstrating their relevance in AI-enabled urban environments. The mediation roles of trust and subjective well-being provide new insights into the mechanisms through which AI influences satisfaction, enriching the theoretical discourse on human-technology interactions in smart cities. The results underscore the importance of building AI systems that inspire trust among urban residents. Policymakers and city planners should prioritize the development of transparent, secure, and reliable AI technologies to foster confidence in smart city systems (Nasar et al., 2019). Furthermore, initiatives aimed at improving residents' subjective well-being through AI-enabled services can lead to greater satisfaction, highlighting the need for human-centric AI design and implementation. For organizations, the findings suggest that investments in AI systems must go beyond functional capabilities and focus on enhancing the emotional and psychological well-being of users. Engaging stakeholders through participatory approaches can ensure that AI systems align with the needs and values of urban communities. Lastly, these implications emphasize the need for interdisciplinary collaboration between AI developers, urban planners, and social scientists to create smarter, more inclusive cities that balance technological innovation with residents' well-being and satisfaction. Future research should examine the long-term effects of AI adoption and include diverse populations to generalize the findings across different urban contexts.

6. Conclusion

This study investigates the impact of AI on trust, subjective well-being, and perceived satisfaction in the context of smart cities. The findings reveal that AI has a significant positive influence on trust, subjective well-being, and satisfaction, with trust and well-being serving as important mediators between AI and satisfaction. Specifically, the study demonstrates that AI systems in smart cities enhance residents' trust in technology, contribute to their overall well-being, and improve their satisfaction with urban living. The theoretical implications of the study are substantial, as it extends existing knowledge by highlighting the mediation roles of trust and subjective well-being in the AI-satisfaction relationship. This provides a deeper understanding of the mechanisms through which AI influences residents' perceptions and experiences in smart cities. Furthermore, the research contributes to the literature by applying trust theories and subjective well-being frameworks in the emerging context of AI-powered urban environments, thus enriching the discourse on human-technology interaction. From a practical perspective, the study underscores the importance of developing AI systems that prioritize transparency, security, and user-centered design to foster trust among urban residents. Policymakers and urban planners must focus on creating AI solutions that not only improve efficiency but also promote the emotional and psychological well-being of citizens. By doing so, they can ensure higher levels of satisfaction with smart city initiatives. This research highlights the transformative potential of AI in shaping urban living experiences. To maximize its benefits, smart city developers should invest in AI technologies that build trust and enhance well-being, leading to greater satisfaction among residents. Future research could explore the long-term effects of AI adoption and include diverse populations to further validate and generalize these findings across different urban settings.

Author Contributions:

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Formal analysis: Barezah Anayat.
Funding acquisition: Barezah Anayat.
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Project administration: Barezah Anayat.
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Visualization: Barezah Anayat.
Writing – original draft: Barezah Anayat.
Writing – review & editing: Barezah Anayat.

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