

APPENDIX GA36d

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Academic honesty / referencing:	Academic honesty is required. In the main body of your submission you must give credit to authors on whose research and ideas your work is based. Append to your submission a reference list that indicates the books, articles, etc. that you have used, cited or quoted in order to complete this assessment.		

University of Wales Trinity Saint David

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Lecturer: Dr Tamara Savelyeva

**Title: Factors influencing Smart Tools to facilities management
for Shopping Center Management in Hong Kong**

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1. Abstract (780 words)

1.1 Introduction

The real estate industry, especially retail malls, has seen substantial changes as a result of recent technological breakthroughs that have revolutionized many other businesses. In order to improve customer experience, streamline operations, and boost consumer engagement, shopping centers must now integrate intelligent technologies, as detailed in a number of studies (Hou, 2023; Fan, 2020). Mobile apps, digital signs, augmented reality, interior navigation systems, mobile payment systems, touchless lift panels, and cleaning robots are some of the most notable innovations. These technologies have flourished in the post-pandemic age, greatly enhancing the shopping experience and consumers' perceptions of convenience and cleanliness. Their acceptance was pushed by the COVID-19 pandemic.

There is an important gap in the assessment of smart technologies' performance and operational impact in shopping centers, despite their quick adoption (Hou, 2023). This study makes the case that a better comprehension of the practical use and efficacy of these technologies is essential by drawing on innovation diffusion theory (IDT). It emphasizes how crucial it is to not just embrace new technologies but also to keep evaluating and upgrading them to make sure they continue to satisfy changing customer and corporate needs.

Examining how smart facilities management (FM) tools' function and perform in shopping malls is the main goal of this study. Three primary goals form the framework of the study:

1. Sort the smart FM tools into groups according to their purposes and compatibility with shopping center operations.
2. Determine and improve key performance indicators (KPIs) for every smart FM tool category.
3. To evaluate the relative significance and efficacy of various smart FM tool categories, rank these KPIs.

The study uses a participatory research approach that includes expert interviews and facilities management specialists and focus group discussions (FGDs) with shopping center operators in order to accomplish these goals.

1.2 Research Methodology

Using a systematic and participatory research strategy, this study first conducts expert interviews with shopping center operators and facilities management (FM) professionals to learn more about the features and effects of smart FM technologies. The technologies are systematically categorized into four groups based on these insights: user, safety and hygiene, maintenance and sustainability. The study uses focus group discussions (FGDs) with professionals to build upon these categorized findings and jointly establish and improve key performance indicators (KPIs) for areas.

The snowball sampling technique was used to find the interview and focus group discussion participants. It began with two initial participants who satisfied the interview requirements and were discovered via professional FM associations' events and LinkedIn. Following that, these "seeds" were invited to recommend other possible interview subjects from their networks who met the predetermined requirements. Through this referral network, the sample size was gradually increased as new interviewees joined and made referrals. The approach is intended to guarantee a useful and applicable assessment framework that is directly influenced by industry knowledge, improving the tools' practicality in controlling and optimizing shopping center operations and enabling a deeper comprehension of their features.

1.3 Research approach

Stage 1: Conducting expert interviews with shopping center operators and FM professionals to learn more about the features and effects of FM tools

Stage 2: Classify FM tools according to the findings of the interviews

Stage 3: Using smart FM technologies for shopping center operations, key performance indicators (KPIs) were suggested.

Stage 4: To create and improve KPIs for smart FM tools, these professionals participated in focus group discussions (FGDs) to rank the KPIs.

1.4 Limitations

Although there are a number of constraints to take into account, the study on smart FM technologies in Hong Kong's commercial complexes offers insightful information. First off, the results might not be generalizable outside of Hong Kong's particular context because the applicability of suggested KPIs and smart FM tools may be impacted by differences in facility types, technological infrastructure, indoor built environments, consumer behaviour, and regulatory environments in other areas. The fact that smart FM technologies are developing quickly is another drawback. Because the study relied on focus groups and expert interviews, its conclusions might not hold up as new technologies are developed. By adding quantitative techniques or case studies to qualitative methods, a more thorough understanding could be attained. Resolving these issues would strengthen the study's validity and increase its applicability to a wider range of stakeholders and situations. Furthermore, because it mostly concentrates on certain geographical examples and statistics, this study has a limited scope when it comes to speaking to an international audience. Comparative case studies, statistical analysis, and examples from various technical, cultural, and regulatory contexts around the world could all help the research become more globally relevant.

Keywords: Facilities management, Shopping centers, Focus group discussions, Key performance indicators, Tools

2. Literature Review (4217 words)

2.1 The attributes of smart FM

The public sectors, property owners, FM business owners, users and contractors are among the many stakeholders involved in smart FM. Users are both facility users and private residents who take pleasure in and contribute to a city's intelligence. In order to encourage companies or entrepreneurs to use smart technology in a variety of operations, the government of a city implements pertinent regulations or laws using legislative tools. For smart technologies like WiFi hotspots to be used, the government must build the infrastructure, particularly the digital infrastructure. Smart technology adoption decisions are made by business and real estate owners. They decide which FM service clusters to integrate with the smart technologies, which smart technology types to use, and what management goals to eventually achieve. Following the decision-making stage, the service delivery process involves a variety of contractors and FM specialists.

FM contractors and smart FM technology providers are the two categories of contractors that deal with smart technologies. The former offers smart technology, systems, and gadgets like smart security systems, smart cleaners, and so on. They are also referred to as providers of smart solutions. Professional FM contractors who provide professional FM comprise the latter. Both in-house FM teams and FM contractors have aggressively worked to integrate smart technology into their service delivery processes in recent years in an effort to better serve their clients' demands and boost operational effectiveness.

In addition to being smart technology consumers, citizens, governments, and owners are the ones that create applications for smart technologies. On the left are three measures of how widely smart technology is being used in the FM sector. The degree of smart technology implementation at the industry level increases with the number of smart technology categories. The degree of smart technology application increases with management functions and the

number of FM services are integrated with smart FM technologies. In order to connect the cities, built environment and persons, smart FM is essential. Smart FM includes a wider range of tasks linked to development and urban sustainability, even though FM is more frequently linked to management tasks in the built environment (Bujari, 2021). The process of integrating smart technology in FM is shown by the three boxes on the left. A number of smart technologies have been employed to assist different FM services. One of the most popular smart technologies is sensor technology, which has been utilized to support a range of FM services, including fire safety detection, lighting control, air quality control, and predictive maintenance. In addition to helping to save energy usage and enhance occupancy well-being, FM services are installed to satisfy users' requests.

2.2 Analyzing of the adoption of new technologies in the retail industry

Everett Rogers (2014) developed the innovation diffusion theory (IDT), which has shown itself adaptable in a number of research settings (Rogers, 2019). The notion can be applied across fields to comprehend how innovations are adopted and spread. It provides insight into how new technologies like social media and smartphones are accepted in the field of information technology (Kim & Ammeter, 2014). It is used by healthcare researchers to investigate the uptake of novel practices and medical innovations (Scarbrough and Kyratsis, 2022). The theory is used by academics studying business and management to analyze how organizational innovations are adopted, and it directs research on the spread of green practices in environmental sustainability (Karakaya, 2014). The paradigm is also useful for studying policy adoption, media innovations, and social interventions in the fields of communication, media studies and public policy (Madan and Ashok, 2023). The IDT offers a thorough grasp of how innovations proliferate throughout these several domains, covering the innovation-decision process, communication channels, and the influence of opinion leaders on adoption trends. The

smart technologies are prevalent in the retail industry have frequently been examined using IDT (Adapa, 2020). Digital transformation is driving a significant upheaval in the retail industry, changing conventional shopping paradigms and forcing shopping centers to reevaluate their business strategies (Fan, 2020). Embracing digital transformation is imperative for shopping center operators as customers seek more seamless and technologically enhanced shopping experiences (Priporas, 2017). From the perspective of innovation diffusion theory, changing customer expectations are a major force behind the digital transformation of shopping centers.

According to an IDT viewpoint, shopping malls may become smarter, more connected spaces by integrating IoT, AI, and data analytics. The five steps of IDT—knowledge, persuasion, choice, application and confirmation—guide the methodical process of smart technology diffusion in shopping centers (Yang and Bayapu, 2020; Konanahalli, 2022). Shopping center management first learns about and comprehends new smart technologies (Knowledge), weighing their advantages and possible disadvantages based on peer experiences and expert opinions (Persuasion). After that, they strategically decide whether or not to use the technology (Decision). When it is decided to move forward, the technology is integrated and installed, and employees are educated to use it as best they can be (Application).

Lastly, feedback influences whether the technology is expanded, modified, or stopped. The efficacy of the technology is regularly tracked against pre-established KPIs (Confirmation). Shopping malls may successfully integrate smart technologies thanks to this methodical approach, which also helps them align with operational objectives and improve consumer satisfaction and overall efficiency. Three specific study questions are put forth in order to examine the effects of digital technology on retail centers in accordance with the IDT principles:

To begin with, how are smart facilities management (FM) products grouped according to their features and in line with shopping center operations goals? Through the identification and classification of technologies based on their major purposes and strategic fit, this investigates the "Knowledge" and "Decision" stages. Sorting smart FM tools according to their purpose and user makes sure that each one properly matches the operational requirements of a shopping center, which improves decision-making in the phases of adoption.

Second, how do the key performance indicators (KPIs) for each type of smart FM instrument represent the technologies' operational impact? This question, which focuses on measuring and validating the effectiveness of technology after deployment, relates to the "Application" and "Confirmation" phases. By comparing these tools to established KPIs, it is possible to continuously evaluate and modify them to make sure they fulfill performance standards and favorably impact corporate goals.

Last but not least, considering the prioritization in the "Decision" and "Confirmation" stages and revealing management's top priorities for enhancing customer satisfaction and operational efficiency, how are the KPIs for different smart FM tool categories ranked in respect to their importance to shopping centers' strategic goals? Together, these inquiries offer a thorough framework for comprehending the uptake, application, and assessment of smart technology in retail malls. FM experts' rankings of the KPIs have a direct impact on strategic choices regarding technology development and prioritization, ensuring that innovations are in line with real operational requirements and user input.

2.3 Smart FM tools based on services

In contrast to the current trend of research focusing on system-level, building-level, and component-level FM operational assessments, this study specifically targets the area of smart FM tools within shopping centers. In the past, building operations have mostly benefited from FM tools, which provide services to increase system and component efficiency. They could prioritize improving system performance, maintenance effectiveness, or building operations over users' experience or happiness. However, the focus switches to service-based smart FM technologies that are specifically made to meet the needs of building users and companies in the context of shopping centers. For example, shopping centers are repurposing technology like Augmented Reality (AR) and Virtual Reality (VR), which are usually used to simulate maintenance scenarios and assist decision-making, to improve the overall shopping experience for customers. In order to engage and delight customers, these technologies give priority to features like real-time navigation, personalized recommendations, and interactive aspects. Similar to this, smart parking systems—which are essential to contemporary smart buildings—are assessed based on user happiness and their effect on company profits, deviating from the traditional emphasis on building operating efficiency (Al-Turjman and Malekloo, 2019). Smart parking places a strong emphasis on maximizing parking efficiency to improve customer satisfaction and the overall shopping experience, both of which have a direct impact on the financial performance of the shopping center. This unique viewpoint emphasizes how important it is to modify FM solutions to meet the particular needs and goals of shopping center settings, where user experience and business results are crucial factors in determining the efficacy of the tools. User-centricity, influence on business objectives, safety and hygiene prioritizing, integration with customer interaction, and consideration of long-term economic benefit are characteristics of service-based smart FM technologies for shopping centers. In

terms of improving the general shopping center experience, these differences draw attention to how specialized certain technologies are.

2.4 Application of smart technology in the FM

The potential, present state, and future uses of intelligent technology in the FM sector were all covered in the literature that was already available on smart FM. These technologies include IoT, BIM, cloud technologies, 3D technologies, cloud computing, robotics, sensors, and machine learning. The intelligent technologies fall into three categories: data collecting, integrative computer analysis, and construction technology tools. The digitalization trend began with the widespread adoption of BIM in the building sector (M. Oraee, 2022). Building experts may now regulate physical buildings using digital data thanks to the development of cyber-physical systems (K. Xing, 2020). Intelligent technologies including cloud computing, IoT, AI, and VR/AR greatly aid BIM-FM integration (S. Chung, 2021). These technologies have made it easier to control construction projects' budget, schedule, and quality (H. Zhu, 2022). The FM stage has been greatly impacted by BIM in recent years, and BIM-FM has been applied in management domains, including maintenance, emergency situations, places, energy, and human resources training (Yin, X.,2020).

2.5 Using key performance indicators (KPI) as a tool for performance assessment

The thorough analysis of Key Performance Indicator (KPI) research in facilities management demonstrates how widely used KPIs are as a performance assessment tool in a variety of facility scenarios. The studies under review cover a wide range of facility types, such as general buildings, hospitals, clinics, supply chains, office buildings, hotels, and campuses.

Depending on the facility environment, the literature indicates a preponderance of attention to particular aspects. For example, KPI studies focus on FM practice performance in campus settings, with a particular interest in evaluations at the project and building levels. In campus settings, maintenance and retrofitting techniques are also given consideration. The tendency is still present in healthcare facilities, such as clinics and hospitals, where sustainability performance is prioritized, in line with the vital role that environmentally friendly procedures play in healthcare environments. Notably, KPIs in hospitals sometimes encompass a variety of topics, such as service-level performance, sustainability, system-level efficiency, and FM practice.

According to the general trend in the literature, the selection of particular KPI elements is in line with the particular requirements and objectives of every facility context. The approach is widely used in purpose-built facilities, like hospitals and campuses, where customized assessments support efficient facilities management procedures. This sophisticated view of the use of KPIs in different kinds of facilities highlights how flexible and useful they are as a tool for assessing and improving facilities management.

There is a noticeable lack of research on KPIs for smart FM tools of shopping centers, despite the fact that the body of existing literature thoroughly examines KPI applications across a variety of facility contexts including supply chains, campuses, hotels, healthcare facilities and buildings. This gap in the literature points to the urgent need for specialized study to modify performance evaluation criteria to fit the particular dynamics and needs of shopping center settings. In addition to adding to the body of knowledge on facilities management, knowing and defining KPIs for smart FM tools of shopping centers would help professionals in the field who want to strategically integrate smart FM tools to improve the overall performance, sustainability, and operational efficiency of shopping centers. The lack of these studies

suggests a chance for further research to focus on this particular and important topic within the larger body of literature on facilities management.

2.6 Intelligent technologies used to control various kinds of properties

Many studies have examined how digital technologies improve built environment management practices in certain property types, such as smart hospitals, smart hotels, and smart campuses, but there is a dearth of study on their application at the industrial level. Hospitals, hotels, and campuses may adopt and completely incorporate smart technologies into their operations because their primary sectors are service-oriented. Smart technology addresses the organization or business, the needs of space and service users, and the sustainability of the economy, society, and environment. They provide a useful framework for researching smart FM in various types of properties, notwithstanding the dearth of research in these areas. Despite the paucity of research in these fields, they offer a helpful framework for studying smart FM in different properties. Previous research on smart hotels looks at the industry-level connections and integration of smartness. Some scholars look at the ways that different kinds of smart technology have been developed and incorporated into different hotel operations (D. Buhalis, 2018). Many research on the deployment of smart technology in hotels look on how well-received these technologies are by hotel guests. In order to create a smart campus, smart campus research also focuses on creating systems combine digital technology with campus ecology. The smart systems at the campus level are the main focus of studies. Various smart campus initiatives have been presented by researchers, depending on the location and requirements of the university. The administration is better able to organize space management activities and estimate space requirements (B. Valks, 2019). Workflows in a smart hospital are made "No paper" by utilizing smart technologies (H. Kwon, 2022). Furthermore, certain

features of other digital systems, like electronic health record sharing systems and electronic medical record systems, are used to increase operational efficiency (K.H. Abdulkareem, 2021).

2.7 Elements influencing the industry-level implementation of smart technologies

Numerous frameworks have been created to pinpoint the elements that raise or contribute to a city's or company's level of intelligence. City-level researchers focus on the obstacles or elements that support the development of smart cities from a wide angle. In order to determine the elements that contribute to the success of the smart city initiative, for instance (Joshi, 2016), created a framework of legal, social, economic, management, technology, and sustainable development (Sokolov, 2019).

Nine factors—demographics, economy, transportation and infrastructure, society, planning, sustainability and resources, land use and affordable housing, information availability, and technology planning, availability, and acceptance—have been compiled to influence global smart cities. Four categories of barriers to smart cities have been identified by Ismagilova (2022): technological, sustainability, operational and transitional, and confidence concerns. Numerous factors, such as financial resources, laws and regulations, education and training, data sharing systems and standards, user acceptance, and stakeholders' knowledge and perception, have been clarified by researchers as having an impact on the use of smart technologies at the industry level (E.S.W. Chan, 2020; S. Mittal, 2019).

Research on the integration of new technologies into industry practice was based on an analysis of the factors influencing the design, engineering, and construction sectors' production of green buildings (Karakaya, E., 2014). The most often cited barriers to the development of green buildings were ignorance, expense, incentives, interest and demand, and green building standards and laws. The high cost of green building technologies, the absence of government

incentives, and the lack of a finance strategy are the three primary obstacles to Ghana's adoption of these technologies, per an empirically validated study (A. Darko, 2017). From the standpoint of urban planning, incentives, thriving real estate markets, required laws, and robust municipal fiscal resources all support the construction of green buildings, claims Y. Song (2021).

Numerous studies have also examined the variables affecting the use of smart technology in construction project management. Smart technology adoption in Singapore's construction sector is being hampered by issues with data ownership, legal compliance, and data and information interchange.

In the FM sector, BIM is regarded as one of the smart technologies that makes post-occupancy building condition monitoring easier. Much emphasis has been paid to its use in FM. Several research have determined the obstacles or variables influencing the use of BIM. Technical and non-technical barriers are the two categories of barriers that impede the application of BIM. It is often known that one of the most significant technical elements influencing the BIM application is "exchange information and data integration" (X. Xu, 2020).

There are three categories of non-technical elements: legal and organizational issues, financial assistance and costs, competency education and training, management collaboration, and user adaptation preferences. This study's evaluation of the variables influencing the adoption of smart technologies in the FM industry has been greatly influenced by research on the use of BIM in facilities management.

2.8 The intelligent use of building information modeling to assist with building life-cycle management

Building design, construction, and operation have all made extensive use of BIM (Dixit Manish, 2019). The architectural, engineering, construction, and facilities management (AEC-FM) industry has begun to digitize with the use of BIM technologies (Fan, X, 2020). BIM has initiated the transition from the real to the virtual world by facilitating the creation of virtual models of real-world structures. The usage of BIM in the construction industry has spurred the digital transformation of building information. It has been combined with other technologies to improve digital representation and calculation accuracy.

Even though BIM is a cutting-edge technology that digitizes building information starting with the design stage in the life cycle of buildings, it still needs to integrate all technologies to increase the precision of the computerization and digital representation of the building. Construction process simulation (Habibi, 2017), energy performance evaluation, thermal environment assessment, and other simulations like lighting and acoustics have all benefited from the use of BIM models during the construction stage.

Thanks to the development of cyber-physical systems, building professionals can now use digital data collected from the real environment to exert control over physical buildings (Xing, 2020). IoT, laser scanning, robotics, drones, sensors, and machine learning technologies are currently used in the CPS and BIM ecosystem to provide digital data to support managerial tasks. The help of these smart technologies in managing budgets, timelines, and quality has been extremely beneficial for construction projects (Zhu, 2022). In recent years, BIM has had a significant impact on the FM stage, and BIM-FM has been used in several management domains (Pavon, 2021). Other digital innovations, such as cloud computing, virtual reality

/augmented reality, artificial intelligence, and the internet of things, also greatly improve BIM–FM integration.

IoT sensors enable real-time building data that supports energy management (Francisco, 2018), interior environmental monitoring, indoor comfort temperature adjustment (Ioannou, 2018), space management, hazard monitoring, and community tracking (Shipman and Gillott, 2019).

2.9 The potential of digital twins for performance management in buildings

The subject of building performance management has shown a great deal of interest in digital twin technology (Hou, 2023). It comprises creating a digital model or representation of a real building by combining information to model its performance, behavior, and interactions with the environment. Building performance management has been thought to stand to gain a great deal from it.

First of all, digital siblings make it easier to monitor building systems and components in real time. By gathering sensor data from the actual building and entering it into the digital twin, FM managers can keep an eye on equipment performance, indoor environmental conditions, energy consumption, and other crucial factors. Proactive maintenance and optimization are made possible by the real-time data's ability to detect inefficiencies, flaws, and performance variations.

Digital twins can foretell future building performance using predictive analytics algorithms based on real-time and historical data. This makes it possible for FM managers to foresee issues, maximize energy use, and decide on maintenance, improvements, and operation plans with knowledge. Additionally, FM managers can use digital twins to model different situations and assess how different approaches affect the performance of buildings. For example, they

can assess the impact of changing occupancy patterns, installing energy-efficient technologies, and modifying the settings of heating, ventilation, and air conditioning. This makes it possible for decision makers to determine and put into practice the best plans for enhancing sustainability, occupant comfort, and energy efficiency.

Digital twins typically assist with every stage of a building's lifecycle, from planning and construction to upkeep and operation. Throughout a building's lifecycle, they can facilitate remote monitoring and control, test building performance versus design intent, promote predictive maintenance, and help optimize designs.

2.10 Integration of IoT in facilities management

The smart systems of heating, ventilation, and air conditioning play an important role in energy management by significantly reducing consumption of energy. The systems leverage advanced technologies to adjust temperatures based on occupancies' needs to ensure energy is used when and where it is needed. By optimizing heating, ventilation, and air conditioning operations in this way, smart HVAC systems can achieve energy savings of 20–30%, making them an effective solution for improvement of energy efficiency and lowering operational costs in both residential and commercial properties. (Onomondo, n.d.)

Predictive maintenance technologies, such as vibration sensors in elevators and water leak detectors in pipes, enable pre-emptive identification and resolution of potential issues before they escalate into problems. By monitoring equipment and infrastructure, these IoT-enabled sensors provide real-time data that allows for timely interventions, reducing the likelihood of costly breakdowns. This proactive approach to maintenance can lower overall maintenance

costs by up to 40%, enhancing operational efficiency and extending the lifespan of critical systems. (IEEE, 2024)

Security enhancement in residential complexes has been significantly improved through the adoption of higher technologies such as smart locks and facial recognizing systems. These IoT-enabled solutions help prevent unauthorized access by verifying identities and granting entry only to authorized individuals. By integrating these systems into property management, incidents of unauthorized access can be reduced by up to 65%, ensuring greater safety and peace of mind for residents while streamlining security operations. (Butterflymx, 2024)

IoT-enabled applications greatly enhance the tenant experience by providing convenient and efficient ways to interact with their living environment. These apps allow tenants to control lighting, adjust settings to their preferences, and create a more comfortable atmosphere with just a few taps. Additionally, they enable tenants to submit maintenance requests seamlessly and track their progress, ensuring timely resolutions. Real-time monitoring of utility usage further empowers tenants to manage their energy consumption effectively, promoting sustainability and cost savings. Together, these features create a more connected and satisfying living experience for tenants. (IEEE, 2023)

IoT devices lack strong encryption and security protections, making them easy targets for data breaches. As a result, cybersecurity vulnerabilities in IoT implementations continue to be a major worry. This issue is particularly pronounced in smart buildings, where interconnected devices handle sensitive data and critical operations. A 2024 study revealed that 58% of smart buildings had unpatched IoT vulnerabilities, highlighting the urgent need for stronger security protocols and updates against potential cyber threats and ensure the integrity of IoT systems. (IEEE, 2023)

Interoperability issues pose a significant challenge in IoT implementations, as proprietary IoT protocols often hinder seamless integration with legacy systems. These compatibility barriers make it difficult to aggregate data from multiple devices and platforms, limiting the efficiency and effectiveness of IoT ecosystems. Addressing these issues requires the adoption of standardized protocols and frameworks to ensure that IoT devices can communicate and operate cohesively within existing infrastructures, enabling streamlined data sharing and improved system performance. (IEEE, 2020)

High implementation costs remain a major barrier to IoT adoption for small and medium-sized enterprises (SMEs). Many SMEs report return on investment (ROI) timelines of 3–5 years, which can deter them from making the initial investment in IoT technologies. The significant upfront costs, combined with the uncertainty of long-term benefits, often make it challenging for smaller businesses to justify the expenditure, highlighting the need for cost-effective solutions and financial incentives to encourage wider adoption. (IEEE, 2020)

2.11 Smart FM for shopping malls in Hong Kong

The impact of cutting-edge technology on mall property and facility management (Wong 2022) examines how Hong Kong shopping malls are integrating technologies like IoT, 5G, robotics, AI, and AR. A Mongkok-specific case is included (MOKO Buddy robot at MOKO mall), aligning with this study through youth-centric strategies like sports-themed zones and AR try-on stations. Key findings reveal that operational benefits—such as AI-driven energy savings of 8%, manpower reductions of 0.5–1 staff via cleaning robots, and real-time analytics from smart toilets are identified, alongside challenges like technology immaturity, high costs, and reliance on human intervention, which are relevant to this study question on overcoming economic and urban constraints. Strengths include a mixed-methods approach, which provides

a solid foundation for understanding technology's role in Mongkok malls, and local relevance is established as a benchmark for this study. This paper's review of some technologies as "gimmicks" supports this study goal of meaningful innovation, and the use of AR for staff training inspires potential customer-facing applications like interactive youth zones. While operational efficiencies could be leveraged to bolster this study hybrid leasing models, additional sources on youth engagement and experiential retail will be needed to fully align the paper's insights with this study objectives.

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Zhu, H., Hwang, B.G., Ngo, J. and Tan, J.P.S. (2022), “*Applications of smart technologies in construction project management*”, Journal of Construction Engineering and Management, Vol. 148 No. 4, p. 4022010.

3. Annotated Bibliography (2951 Words)

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Examining the antecedents and consequences of perceived shopping value through smart retail technology. Journal of Retailing and Consumer Services, 52, p.101901.

This study examines the antecedents and consequences of perceived shopping value through smart retail technology.

A. Darko, A.P.C. Chan, *Review of barriers to green building adoption*, Sustain. Dev. 25 (2017) 167–179, <https://doi.org/10.1002/sd.1651>.

This reflects to implement sustainable development (SD) in the construction industry has given birth to the green building (GB) movement.

Al-Turjman, F. and Malekloo, A., 2019. *Smart parking in IoT-enabled cities: A survey.* Sustainable Cities and Society, 49, p.101608.

In this paper, the smart parking systems while considering soft and hard design factors.

A. Sokolov, N. Veselitskaya, V. Carabias, O. Yildirim, *Scenario-based identification of key factors for smart cities development policies*, Technol. Forecast. Soc. Change 148 (2019), 119729, <https://doi.org/10.1016/J.TECHFORE.2019.119729>.

This article is devoted to an analysis of the key characteristics of smart cities.

Bujari, A.; Calvio, A.; Foschini, L.; Sabbioni, A.; Corradi, A. *A Digital Twin Decision Support System for the Urban Facility Management Process.* Sensors 2021, 21, 8460. <https://doi.org/10.3390/s21248460>

The ever-increasing pace of IoT deployment is opening the door of smart city applications, enabling the large-scale sensing and modelling of real-time digital replicas of physical processes and environments.

ButterflyMX, (n.d.). *IoT in Property Management*. ButterflyMX. Available at:
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This research reflects Internet of Things (IoT) improves all aspects of property management and operation.

B. Valks, M. Arkesteijn, A. Den Heijer, *Smart campus tools 2.0 exploring the use of real-time space use measurement at universities and organizations*, *Facilities* 37 (2019) 961–980, <https://doi.org/10.1108/F-11-2018-0136>.

The purpose of this study is to generate knowledge about the use of smart campus tools to improve the effective and efficient use of campuses.

Ching, C.W., 2023. *The relationship between place satisfaction and level of sense of place: A case study of the private shopping centres in Hong Kong*. Master's thesis, University of Hong Kong, Pokfulam, Hong Kong SAR.

Ching (2023) research found that a stronger SOP, which is measured through components of place attachment, identity, and connection, is reasonably linked with enhanced satisfaction in multiple areas such as physical aspects, social activities, and accessibility.

Chong, Y. C. (2023) *A study of application of IoT (Internet of Things) improving management effectiveness in shopping malls in Hong Kong*. Master's thesis, University of Hong Kong, Pokfulam, Hong Kong SAR.

Chong's (2023) researches on how technologies such as smart restrooms and energy optimization systems are utilized to enhance operational efficiency, reduce costs, and improve customer satisfaction.

D. Buhalis, R. Leung, *Smart hospitality—interconnectivity and interoperability towards an ecosystem*, *Int. J. Hospit. Manag.* 71 (2018) 41–50, <https://doi.org/10.1016/j.ijhm.2017.11.011>.

This study conceptualizes the smart and agile hospitality enterprises of the future, and proposes a smart hospitality ecosystem that adds value to all stakeholders.

Dixit Manish, K., Venkatraj, V., Ostadalimakhmalbaf, M., Pariafsai, F. and Lavy, S. (2019), *“Integration of facility management and building information modeling (BIM): a review of key issues and challenges”*, Facilities, Vol. 37 Nos 7/8, pp. 455-483.

The study investigates factors that impede the integration of facilities management (FM) into building information modeling (BIM) technology.

E. Ismagilova, L. Hughes, N.P. Rana, Y.K. Dwivedi, *Security, privacy and risks within smart cities: literature review and development of a smart city interaction framework*, Inf. Syst. Front 24 (2022) 393–414, <https://doi.org/10.1007/s10796-020-10044-1>.

The complex and interdependent nature of smart cities raises significant political, technical, and socioeconomic challenges for designers, integrators and organisations involved in administering these new entities.

E.S.W. Chan, F. Okumus, W. Chan, *What hinders hotels’ adoption of environmental technologies: a quantitative study*, Int. J. Hospit. Manag. 84 (2020), 102324, <https://doi.org/10.1016/J.IJHM.2019.102324>.

In response to our planet’s severe environmental problems, many businesses use environmental technologies to strengthen their environmental performance.

Fan, X., Ning, N., Deng, N., 2020. *The impact of the quality of intelligent experience on smart retail engagement. Marketing Intelligence & Planning*, 38, pp.877-891.

This paper proposes a customer engagement model in a fully intelligent retail environment.

Francisco, A., Truong, H., Khosrowpour, A., Taylor, J.E. and Mohammadi, N. (2018), *“Occupant perceptions of building information model-based energy visualizations in eco-feedback systems”*, Applied Energy, Vol. 221, pp. 220-228.

This paper presents the first systematic review of a wide range of energy eco-feedback visualisation techniques.

Habibi, S. (2017), “*The promise of BIM for improving building performance*”, Energy and Buildings, Vol. 153, pp. 525-548.

In order to raise awareness of the role of building information modelling (BIM) in improving energy efficiency and comfort conditions, the work introduces a strategy of combining building simulation tools and optimization methods.

H. Kwon, S. An, H.Y. Lee, W.C. Cha, S. Kim, M. Cho, H.J. Kong, *Review of smart hospital services in real healthcare environments*, Healthc. Inform. Res. 28 (2022) 3–15, <https://doi.org/10.4258/hir.2022.28.1.3>.

Smart hospitals involve the application of recent information and communications technology (ICT) innovations to medical services; however, the concept of a smart hospital has not been rigorously defined. In this study, we aimed to derive the definition and service types of smart hospitals and investigate cases of each type.

Hou, H.C. (2023), “*Factors influencing smart facilities management–stakeholder perspectives and the implication*”, Journal of Building Engineering, Vol. 75, p. 106959.

This research reflects social, economic, and environmental sustainability, smart facilities management connects the built environment, the people, and the city's operations.

H. Zhu, B.-G. Hwang, J. Ngo, J.P.S. Tan, *Applications of smart technologies in construction project management*, J. Construct. Eng. Manag. 148 (2022) 1–12, [https://doi.org/10.1061/\(asce\)co.1943-7862.0002260](https://doi.org/10.1061/(asce)co.1943-7862.0002260).

This paper aims to investigate the applications of smart technologies on project time, cost, and quality management and identify the top influential applications; and identify whether the organizations' profiles influence project managers' perceptions of smart technologies.

Karakaya, E., Hidalgo, A., Nuur, C., 2014. *Diffusion of eco-innovations: A review. Renewable & Sustainable Energy Reviews*, 33, pp.392-399.

This paper explores the importance of technology in the work of cleaning agents and implicitly of companies specialized in offering professional cleaning services.

IEEE, (2020). IoT-Based Property Management in Smart Cities. IEEE Xplore. Available at: <https://ieeexplore.ieee.org/document/9122891>

This paper reflects Wireless Sensor Network (WSN) is the trending area in Internet of Things (IoT) communication technology (WSN-IoT).

IEEE, (2023). IoT-Based Smart Building Management System. IEEE Xplore. Available at: <https://ieeexplore.ieee.org/document/10223582>

This paper reflects implementation of digital transformation in the property management industry will require support from many parties.

IEEE, (2023). Enhancing Property Management with IoT: A Case Study. IEEE Xplore. Available at: <https://ieeexplore.ieee.org/document/10380463>

This paper reflects the property of Internet of Things (IoT) applications is their capability to execute tasks through the collaboration of interconnected IoT objects.

IEEE, (2024). IoT-Driven Innovations in Property Management Systems. IEEE Xplore. Available at: <https://ieeexplore.ieee.org/document/10507932>

This research's importance lies in its many benefits, including the avoidance of repair costs, the protection of buildings and other property, the conservation of water supplies, and the increase in tenant contentment.

K.H. Abdulkareem, M.A. Mohammed, A. Salim, M. Arif, O. Geman, D. Gupta, A. Khanna, *Realizing an effective COVID-19 diagnosis system based on machine learning and IoT in smart hospital environment*, IEEE Internet Things J. 8 (2021), 15919, <https://doi.org/10.1109/JIOT.2021.3050775>. –15928.

The aim of this study is to propose a model based on machine learning (ML) and Internet of Things (IoT) to diagnose patients with COVID-19 in smart hospitals.

Kim, D., Ammeter, T., 2014. *Predicting personal information system adoption using an integrated diffusion model*. Information & Management, 51, pp.451-464.

The purpose of this study is to develop a research model that integrates the relationship between innovation characteristics and technology characteristics.

Konanahalli, A., Marinelli, M. and Oyedele, L., 2020. *Drivers and challenges associated with the implementation of big data within UK facilities management sector: An exploratory factor analysis approach*. IEEE Transactions on Engineering Management, 69(4), pp.916-929.

The study has important implications for FM businesses that are evaluating the potential of the Big Data analytics and IoT applications for their operations. Most importantly, it addresses the role of the Big Data maturity in FM organizations and its implications for perception of drivers.

K. Xing, K.P. Kim, D. Ness, *Cloud-BIM enabled cyber-physical data and service platforms for building component reuse*, Sustain 12 (2020) 1–22, <https://doi.org/10.3390/su122410329>.

The use of cyber-physical information for online identification, examination and exchange of reusable components may improve their life-cycle management and circularity.

Law, M. T. M. (2021) *Marketing strategy and accessibility planning of large-scale shopping malls*. Master's thesis, University of Hong Kong, Pokfulam, Hong Kong SAR.

Law (2021) research is regarded as offering valuable understanding for this study through sports-themed zones and live performances aimed at a young, sporty audience. Key findings from surveys conducted with 200 shoppers and case studies of K11 Art Mall and New Town Plaza are noted for indicating that marketing strategies.

Lo, Y. F. (2021) *Survival of small-scale shopping malls in Hong Kong*. Master's thesis, University of Hong Kong, Pokfulam, Hong Kong SAR.

Lo (2021) research examines the strength of small-scale malls like Kwai Chung Plaza amid the COVID-19 pandemic. Insights that are offered are highly relevant to this study on retail dynamics in Hong Kong, focusing on Mongkok's experiential retail challenges.

Madan, R. and Ashok, M., 2023. *AI adoption and diffusion in public administration: A systematic literature review and future research agenda*. *Government Information Quarterly*, 40(1), p.101774.

The research is a contextual and processual understanding of AI adoption and diffusion in public administration to be able to explore such tensions.

Manickum, B., 2023. *Retail Business Readiness to Adapt to The Future and Scale*. Master's dissertation, University of the Witwatersrand, Johannesburg

Manickum (2023) indicates that swift responsiveness to post-COVID-19 challenges must be undertaken by retail businesses through the implementation of innovative marketing strategies, digital transformation, and e-commerce platforms.

McDonald, M. and Wearing, S., 2013. *Consumer Culture and Space*. London: Routledge.

McDonald and Wearing (2013) indicate that modern consumer spaces, such as shopping malls, are intentionally designed to maximize efficiency and consumption, often at the expense of genuine social engagement, whereby interactions are market-driven, and 'purified' environments are created.

Mok, S. A. (2011) *Effective strategic mall positioning of shopping centres in Hong Kong*.

Master's thesis, University of Hong Kong, Pokfulam, Hong Kong SAR.

Mok's 2011 research focus placed on innovative strategies for the young, sporty consumer base.

M. Oraee, M.R. Hosseini, D. Edwards, E. Papadonikolaki, *Collaboration in BIM-based construction networks: a qualitative model of influential factors*, Eng. Construct. Architect. Manag. 29 (2022) 1194–1217, <https://doi.org/10.1108/ECAM-10-2020-0865>.

The purpose of this paper is to present a modified model for collaboration in BIM-based construction networks (BbCNs). This paper attempts to modify and validate existing conceptual models that describe collaboration in BbCNs.

Onomondo, (n.d.). How IoT is Influencing Smart Buildings. Onomondo Blog. Available at: <https://onomondo.com/blog/how-iot-is-influencing-smart-buildings/> [Accessed 16 July 2025].

This research reflects IoT solutions for smart buildings provide detailed insights into energy efficiency, health and safety, and security, simplifying tasks such as temperature control, fire detection, and access control.

Pavon, R.M., Alberti, M.G., Álvarez, A.A.A. and del Rosario Chiy_on Carrasco, I. (2021), “Use of BIM-FM to transform large conventional public buildings into efficient and smart sustainable buildings”, *Energies*, Vol. 14 No. 11, p. 3127.

New technologies regarding construction, materials and facility management have led to the successful implementation of smart and more sustainable buildings. This is of special interest for the management of large and complex public buildings.

Priporas, C.-V., Stylos, N., Fotiadis, A.K., 2017. *Generation Z consumers' expectations of interactions in smart retailing: A future agenda*. *Computers in Human Behavior*, 77, pp.374-381.

The aim of this paper is to explore Generation Z consumers' current perceptions, expectations and recommendations in terms of their future interactions in smart retailing contexts.

Rogers, E., Singhal, A., Quinlan, M., 2019. *Diffusion of Innovations*, pp. 182-186.

This chapter presents a theoretical and methodological approach to the study of communication and its effects through the diffusion of innovation from a communication approach. It demonstrates through the history of diffusion research how diffusion of innovations occurs and how it impacts communication outcomes.

Scarborough, H., Kyratsis, Y., 2022. *From spreading to embedding innovation in health care: Implications for theory and practice*. Health Care Management Review, 47, pp.236-244.

This research is the spread of innovations in health care presents it as the study of two unconnected processes-diffusion across adopting organizations and implementation within adopting organizations.

S. Chung, C.S. Cho, J. Song, K. Lee, S. Lee, S. Kwon, *Smart facility management system based on open bim and augmented reality technology*, Appl. Sci. 11 (2021),

Research utilizing BIM in the FM phase, which constitutes the longest period during the lifecycle of a building, has been continuously carried out but has faced challenges with regard to on-site application.

S. Joshi, S. Saxena, T. Godbole, Shreya, *Developing smart cities: an integrated framework*, *Procedia Comput. Sci.* 93 (2016) 902–909, <https://doi.org/10.1016/J.PROCS.2016.07.258>.

This research reflects modern day cities are deprived of vital elements like quality of life and socio-economic development which can be delivered by the smart cities.

Shipman, R. and Gillott, M. (2019), “*SCENe things: IoT-based monitoring of a community energy scheme*”, *Future Cities and Environment*, Vol. 5 No. 1, pp. 1-10.

This research reflects energy performance contracts are commonly used to retrofit buildings and reduce their energy consumption.

Siu, S.F. (2020). *A study of critical success factors of specialized shopping centres in Hong Kong: the case study of K11*. Master's thesis, University of Hong Kong, Pokfulam, Hong Kong SAR.

Siu (2020) research is identified on K11 Art Mall as depending on factors such as tenant mix, innovative promotion and marketing, effective design and layout, strong location and accessibility, and efficient management, with support provided by quantitative and qualitative data gathered through surveys and interviews.

S. Mittal, M.A. Khan, D. Romero, T. Wuest, *Smart manufacturing: characteristics, technologies and enabling factors*, Proc. Inst. Mech. Eng. Part B J. Eng. Manuf. 233 (2019) 1342–1361, https://doi.org/10.1177/0954405417736547/ASSET/IMAGES/LARGE/10.1177_0954405417736547.

The purpose of this article is to collect and structure the various characteristics, technologies and enabling factors available in the current body of knowledge that are associated with smart manufacturing.

So, H.C.R., 2022. *Hong Kong's shopping malls under pandemic: change of strategies in leasing and management*. Master's thesis, University of Hong Kong, Pokfulam, Hong Kong SAR.

So (2022) research, is highlighted that mall performance was significantly undermined by the COVID-19 pandemic, especially in tourist-centric areas, leading to a substantial drop in retail sales and footfall were experienced, while milder impacts were observed in residential neighborhood malls due to local consumption being maintained.

Wong, T. C. (2022) *Impact of advanced technology on property and facility management of shopping malls*. Master's thesis, University of Hong Kong, Pokfulam, Hong Kong SAR

Wong (2022) explores the integration of technologies such as IoT, 5G, robotics, AI, and AR in Hong Kong shopping malls. A Mongkok-specific case is included MOKO Buddy robot at MOKO mall, aligning with this study through youth-centric strategies like sports-themed zones and AR try-on stations.

Xing, K., Kim, K.P. and Ness, D. (2020), “*Cloud-BIM enabled cyber-physical data and service platforms for building component reuse*”, *Sustainability*, Vol. 12 No. 24, p. 10329.

The research in the built environment is often viewed in terms of recycling, more value can be obtained from buildings and physical components by their reuse, aided by stewardship and remanufacture, to ensure optimum performance capability.

X. Xu, G. Wang, D. Cao, Z. Zhang, *BIM adoption for facility management in urban rail transit: an innovation diffusion theory perspective*, *Adv. Civ. Eng.* 2020 (2020), <https://doi.org/10.1155/2020/8864221>.

The objective of this study is to investigate the BIM application areas for FM in urban rail transit from an innovation diffusion theory perspective, in order to gain efficient operation and maintenance (O&M) in urban rail transit.

Yang, E. and Bayapu, I., 2020. *Big Data analytics and facilities management: a case study. Facilities*, 38(3/4), pp.268-281.

This paper aims to investigate data elements, transfer, gaps and the challenges to implement data analytics in facilities management. The goal is not to search for a definite solution but to gather necessary information, understand the challenges faced and develop a proper foundation for future study.

Yin, X., Liu, H., Chen, Y., Wang, Y. and Al-Hussein, M. (2020), “*A BIM-based framework for operation and maintenance of utility tunnels*”, *Tunnelling and Underground Space Technology*, Vol. 97, p. 103252.

This research contributes to the main body of knowledge by proposing a generic BIM framework for sustainable O&M of utility tunnels and formalizing data requirements as well as management workflow intended for utility tunnel O&M.

Yip, K. S. (2023) *A study of implications of ISO9001 on service quality of shopping malls*. Master’s thesis, University of Hong Kong, Pokfulam, Hong Kong SAR.

Yip (2023) research investigates the effect of ISO 9001 certification on service quality in Hong Kong shopping malls.

Y. Song, C. Li, L. Zhou, X. Huang, Y. Chen, H. Zhang, *Factors affecting green building development at the municipal level: a cross-sectional study in China*, *Energy Build.* 231 (2021), 110560, <https://doi.org/10.1016/j.enbuild.2020.110560>.

The results indicate that both mandatory regulations and incentive-based policies contribute to increasing the adoption of green buildings; nevertheless, mandatory regulations have a stronger effect on green building development than incentive policies.

Yuen, T. Y. K. (2011). *Unleashing social innovation for social economy: experience of social enterprise development in Hong Kong*, *China Journal of Social Work*, 4(3), pp. 217–233.

Yuen (2011) research is investigated the social enterprises in Hong Kong how innovative retail models in high-traffic urban spaces are employed by Mental Care Connect. It insights into overcoming retail challenges in dense urban environments, though its social mission focus must be adapted to fit commercial and experiential goals.

Zhu, H., Hwang, B.G., Ngo, J. and Tan, J.P.S. (2022), “*Applications of smart technologies in construction project management*”, *Journal of Construction Engineering and Management*, Vol. 148 No. 4, p. 4022010.

The paper aims to investigate the applications of smart technologies on project time, cost, and quality management and identify the top influential applications; and identify whether the organizations' profiles influence project managers' perceptions of smart technologies.

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