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Public Policy Research Funding Scheme

Chief Executive's Policy Unit  
The Government of the Hong Kong Special Administrative Region

**Towards People-centric Smart City Development:  
Investigating the Citizens' Preferences and  
Expectations about Smart-city Services in Hong Kong**

邁向以人為本的智慧城市發展：香港居民對於智慧城市服務之偏好及期待調查

Project Number: 2021.A6.185.21D

**Final Report**

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- St James' Settlement
- Methodist Kwun Tong Community Service
- Neighborhood Advice-Action Council Mrs. Bai Bishop Elderly Center
- Neighborhood Advice-Action Council Sau Mau Ping Elderly Center
- Pong Wing Siu Neighborhood Elderly Center

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# **Final Report**

## **1. Project Title:**

(English) Towards People-centric Smart City Development:  
Investigating the Citizens' Preferences and Expectations about Smart-city Services in Hong Kong

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(Chinese) 邁向以人為本的智慧城市發展：香港居民對於智慧城市服務之偏好及期待調查

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## **Executive Summary**

### **Abstract**

### **Research Background and Summary**

In an era of rapid social, economic and technological change, Hong Kong (HK) as an international city in a globalized world is facing a range of challenges in high-density compact city urbanization, including high population density, population aging, and an economic shift from traditional to knowledge-based and innovative business models. Amid rapid advancements in information and communication technologies, the HK government increasingly recognizes the critical role of smart city (SC) development in mitigating these challenges. Transforming HK into an SC has become a major policy objective with the wider aims of enhancing the effectiveness of city management and improving citizens' quality of life.

In 2017, the Innovation and Technology Bureau published a Smart City Blueprint for Hong Kong (Blueprint), which highlights six dimensions of SC services, including Smart Mobility, Smart Living, Smart Environment, Smart Government, Smart Economy, and Smart People. In 2020, Blueprint 2.0 was published to enhance and expand the existing SC services further, along with proposing the seventh dimension "Smart Combating COVID-19" during the pandemic period. Since Blueprint 2.0 was released, more than 130 SC pilot initiatives have been conducted within the seven dimensions, such as digital personal identity, smart lampposts, and open government data.

Given that citizens are the end-users of SC services, Blueprint and Blueprint 2.0 both

emphasize that SC development should be people-centric and grounded in citizens' needs and expectations. Notwithstanding the HK government's notable achievements in SC development, the implementation of SC services may not meet citizens' needs if their preferences and expectations are not clearly understood. Nevertheless, so far not much is known about how citizens' preferences and expectations vary across the seven dimensions and citizens' different subpopulations. Given that the government budget shall be planned sensibly, the next step in SC development in HK would require more effective prioritizing of the wide range of existing and potential SC services across all seven dimensions based on the preferences and expectations of citizens' subpopulations. The proposed objectives of this research that have been attained are described below.

- 1. To investigate the preferences and expectations of HK citizens towards SC services via questionnaire survey.**
- 2. To examine the associations between citizens' preferences for and expectations of SC services and their demographic characteristics via statistical analysis.**
- 3. To identify policy implications and provide recommendations for informing people-centric SC strategic planning in HK.**

Having achieved the above-mentioned three objectives, this study investigated HK citizens' preferences and expectations about SC services through three stages: questionnaire design, data collection, and data analysis. **Firstly**, the questionnaire was designed to collect **1)** citizens' basic information on demographic characteristics and digital literacy, **2)** citizens' preferences for the selected 48 SC services within the seven dimensions from Blueprint 2.0, and **3)** citizens' expectations for the selected 48 SC services in the realization of human needs based on Maslow's hierarchy theory. **Second**, both online and face-to-face questionnaire surveys were conducted to collect a total of 5,004 responses from the citizens. Specifically, an online survey was conducted to collect 4,516 responses from the general public through email invitations, while a face-to-face survey was conducted to collect 488 responses from elderly residents through on-site visits. **Third**, the preferences and expectations of HK citizens for the selected 48 SC services among different subpopulations were analyzed using the Bradley-Terry model and rank-ordered logit model, respectively.

## **Major Research Findings**

The five key findings identified by this study are summarized as follows:

- 1. The respondents have a strong *preference* for Smart Environment services, particularly waste management, climate action, and green/intelligent buildings.**

Among the top five respondents' most preferred SC services, three of them – waste management, climate action, and green/intelligent buildings – were in the dimension of Smart Environment. Particularly, for all age, income, and digital literacy subpopulations, the Smart Environment dimension was the most preferred among the seven dimensions. The strength of such preference may be due to HK citizens' high awareness of environmental protection and may reflect that HK, as a highly dense city, is confronting a variety of environmental challenges, particularly involving waste management and energy consumption.

- 2. The respondents have a stronger *preference* for SC services that are closely related to their daily lives, expected to have long-term impacts on communities, and serve large user groups.**

The respondents have a stronger preference for Smart Living and Smart People services than Smart Economy services since the SC services of the former two dimensions were more likely to be used and experienced in their daily life. Conversely, respondents showed the least interest in Smart Combating COVID-19 services, which may be because such services were perceived as a short-term solution to a specific issue, rather than something that would have long-lasting impacts on their local communities. The top-five SC services, such as real-time traffic information service, have much larger user groups than the bottom five SC services, such as smart prison service.

- 3. Among different subpopulations of the respondents, at higher ages, with weaker digital literacy, or at lower income levels, the respondents' *preference* differences among the seven SC dimensions were smaller.**

The small differences between the respondents in these three subpopulations' preferences for seven dimensions of SC services are probably because older people, people with limited digital literacy, and people with low incomes are less likely to have good knowledge of SC services, which could make it challenging for them to

distinguish which SC services they prefer. Notably, the preferences of the subpopulations of old age, low income, and low digital literacy tend to be correlated.

**4. The respondents have high *expectations* for the SC services that are expected to support them in realizing their Physiological, Safety, and Self-actualization needs.**

Respondents most strongly expected the use of SC services to serve their Physiological needs, followed by Safety needs and Self-actualization needs. Particularly, Self-actualization needs were ranked third place, despite Maslow's hierarchy theory of five human needs holding that Self-actualization needs are the least critical. The higher expectation for Self-actualization needs found in our study implies that HK citizens place great importance on reaching their full potential for creativity, self-fulfillment, and personal growth by taking advantage of SC services. Such findings may also imply that HK citizens also have a strong desire to use SC services to participate in public affairs for the benefit of their personal development and to contribute to HK society.

**5. The respondents' *expectations* about SC services' fulfilment of their human needs vary by subpopulations of gender, education, age, and birthplace.**

Among all the respondents, women had higher expectations than men that SC services would meet their Safety needs, but lower expectations for their Self-actualization, Esteem, and Social needs. Highly educated people were more likely to have high expectations that SC services would help them achieve their Self-actualization, Esteem, and Social needs. Older adults had lower expectations for SC services in realizing Self-actualization needs than younger adults. Immigrants had lower expectations for SC services to meet their Self-actualization needs compared to native-born citizens.

## **Layman Summary on Policy Implications and Recommendations**

People-centric smart city (SC) development requires policymakers to tailor SC services to the preferences and expectations of different subpopulations. Accordingly, by taking into consideration of people heterogeneity, we make the following four policy recommendations regarding the strategic positioning of SC for HK's city administrators to enhance the delivery of SC services that better meet local citizens' preferences and expectations.

### **1. Enhance SC services in Smart Environment dimension, particularly for services of waste management, climate action, and green/intelligent building.**

Since the surveyed HK citizens have strong preferences for Smart Environment services and express the highest expectations for SC services in meeting their Physiological needs, more measures are suggested to be taken to improve environmental quality through SC services using smart technologies: for example, enhancing the usage of Internet-connected trash cans and Internet-of-Things-enabled fleet-management systems for waste collection and removal, or using sensors to measure water parameters and guarantee the quality of drinking water at the front end of the system, with proper wastewater removal and drainage at the back end. Another example is adopting more energy-related technologies in green/intelligent building design, such as renewable energy, or smart meter, to improve building energy efficiency.

### **2. Focus on SC services with long-term impacts and serving wider user groups.**

It is suggested to further invest in more environmental protection measurements, such as adopting renewable-energy technologies, creating incentives for companies to reduce their carbon footprints, and implementing policies that encourage citizens to practice conservation and sustainable daily-life activities. Especially, more resources could be allocated to the enhancement of smart waste-management systems capable of optimizing waste-collection schedules, reducing waste volumes, and improving recycling rates. Meanwhile, more enhancement of existing smart public-safety warning services that help to reduce citizens' response times during emergencies, such as typhoons and security incidents, or enhancement of the smart public-safety services that help to prevent and protect citizens from criminal activities.

### **3. Increase in citizens' acceptance of SC services by fulfilling their Physiological, Safety, and Self-actualization needs.**

To better fulfil citizens' Physiological needs, it is suggested to continue to invest in the use of sensors and data analytic technologies to monitor the air and water quality in the city, and alert citizens to potential health hazards. To better cater to citizens' Safety needs, the above-mentioned smart public-safety services are suggested to be enhanced to help citizens tackle emergencies and criminal issues. To better satisfy citizens' Self-actualization needs, it is advised to continue to offer citizens new ways of public participation (e.g., electronic voting) in decision-making on public affairs, as well as to create more opportunities for young people to become involved in the innovation and technology fields for realizing their potential and personal growth in these fields.

### **4. Disseminate SC knowledge among digitally marginalized groups.**

It is crucial to disseminate SC knowledge among digitally marginalized groups, including citizens at elderly ages, with weak digital literacy, or at low-income levels, to prevent their exclusion from the benefits of SC services. Lacking adequate knowledge and experience about SC services, the voices of these digitally marginalized groups can be ignored in SC development. More steps should therefore be taken to spread SC knowledge to older people as HK is predicted to become an aging society in the near future. These could include continuing to provide education and training that promote social learning through community workshops and provide updates on the state of SC and IT developments and so on.

## 執行摘要

## 研究摘要

### 研究背景和概要

在社會、經濟和科技瞬息萬變的時代，香港作為一個高密度緊湊型的國際化都市，在城市化進程中面臨著一系列挑戰，包括人口密度高、人口老齡化、經濟從傳統商業模式向以知識為基礎的創新模式轉變。隨著資訊和通信技術的快速發展，香港政府越來越認識到智慧城市發展在緩解這些挑戰方面的關鍵作用。事實上，香港向智慧城市轉型已成為主要的政策目標，期望以此提高城市管理的有效性和改善市民的生活質量。

香港創新及科技局於 2017 年發布了《香港智慧城市藍圖》（《藍圖》），提出了智慧城市服務的六個維度，包括智慧出行、智慧生活、智慧環境、智慧政府、智慧經濟、智慧市民。2020 年，《藍圖 2.0》發布，希望繼續加強和擴展現有的智慧城市服務，並在新冠疫情期間提出了第七個維度-智慧抗疫。自《藍圖 2.0》發布以來，香港政府已經開展了 130 多項智慧城市服務試點舉措，主要包括數字個人身份、智慧燈柱和開放政府數據。

鑑於市民是智慧城市服務的最終用戶，兩版藍圖都強調了香港智慧城市發展應以人為本，以市民的需求和期待為基礎。儘管如此，但如果不能清楚地瞭解市民的偏好和期待，智慧城市服務的實施將不一定能滿足市民的需求。在香港市民以及不同市民群體中，關於他們對政府所提供的智慧城市服務的偏好和期待則還沒有進行過深入的瞭解與討論。為了使香港政府更有效與經濟地發展與推廣智慧城市服務，考慮不同領域智慧城市服務的優先順序以及潛在需求點已成為當務之急。

以下是本研究的目標，所有目標均已實現：

1. 通過問卷調查探索市民對智慧城市服務的偏好和期待。
2. 運用統計分析來研究市民其偏好期待與不同市民群體特徵之間的關係。
3. 確定政策含義並提供相關政策建議，為香港以人為本的智慧城市發展提供參考。

為實現這三個目標，本研究通過問卷設計、數據收集和數據分析三個階段調查香港市民對智慧城市服務的偏好和期待。**第一**，問卷旨在收集 1) 市民的人口特徵和數字素養等基本資訊，2) 他們對藍圖 2.0 涵蓋 7 大維度的 48 項智慧城市服務的偏好，以及 3) 他們對智慧城市服務實現基於馬斯洛層次理論的個人需求的期待。**第二**，通過網上和面對面的問卷調查，共收集了來自 5,004 位香港市民的意見。其中，網上調查通過電子郵件邀請方式收集了 4,516 份普通市民的意見，面

對面調查通過現場走訪收集了 488 份長者的意見。**第三**，此研究分別使用 Bradley-Terry 模型和 rank-ordered logit 模型分析不同市民群體對智慧城市服務的偏好和期待。

## 主要研究成果

通過實現本研究提出的三個目標，我們總結了五個關鍵發現，具體如下：

1. 受訪的香港市民對智慧環境服務表達了強烈的**偏好**，尤其是廢物管理、氣候行動和綠色智慧建築服務。

在最受歡迎的五個智慧城市服務中，有三個都屬於智慧環境維度，它們是廢物管理、氣候行動和綠色智慧建築服務。對於所有年齡、收入和數字素養群體來說，智慧環境維度是七個維度中最受歡迎的智慧城市服務。這種偏好的強度可能是由於香港市民高度重視環境保護，也可能反映出香港作為高密度城市，正面臨著各種環境挑戰，特別是涉及廢物管理和能源消耗的挑戰。

2. 受訪的香港市民更**偏好**與他們的日常生活密切相關、有望對社區產生長期影響和/或有著廣泛使用者群體的智慧城市服務。

調查顯示受訪的香港市民更偏好智慧生活和智慧市民服務，較少偏好於智慧經濟服務，因為前兩維度的智慧城市服務更有可能在日常生活中得到使用和體驗。市民對於智慧抗疫服務的興趣最少，這可能是因為對抗疫情被認為是解決特定問題的短期解決方案，而不是對當地社區有長期影響的服務（例如，智慧環境服務）。前五個最受歡迎的智慧城市服務（例如實時交通資訊）的用戶群體要比最後五個智慧城市服務（例如智慧監獄）要大得多。

3. 對於年紀較高，數字素養較弱，有著較低的收入水準的受訪香港市民來說，他們在七大維度智慧城市服務之間的**偏好**差異不明顯。

受訪的這三組香港市民對於不同維度的智慧城市服務的偏好差異較小，可能是因為老年人、數字素養較弱的人、和低收入的人對智慧城市服務的瞭解是侷限的，這使得他們難以區分他們更喜歡哪些智慧城市服務。值得注意的是，年齡大、收入低、數字素養低往往是正相關的。

4. 受訪的香港市民對智慧城市服務在實現其生理需求、安全需求和自我實現需求等方面有著很高的**期待**。

受訪的香港市民最期待智慧城市服務可以幫助他們滿足其生理需求，其次是安全需求和自我實現需求。儘管馬斯洛層次理論認為滿足自我實現需求是排在社交需求和尊重需求之後的，但自我實現需求被受訪者排在了第三重要的位置。對自我



實現需求的高期待意味著受訪者十分重視通過利用智慧城市服務來充分發揮他們在創造力、自我實現和個人成長方面的潛力。他們還渴望借助智慧城市服務來更多參與公共事務，以促進個人發展並為香港社會做出貢獻。

5. 受訪的香港市民對智慧城市服務滿足其個人需求的期待因性別、教育、年齡和出生地而異。

在受訪者中，女性比男性對智慧城市服務滿足其安全需求有更高的期待，但對自我實現需求、尊重需求和社交需求的期待較低。受過高等教育的人更有可能對智慧城市服務滿足其自我實現需求、社交需求和尊重需求有著較高的期待。老年人在對智慧城市服務滿足其自我實現需求方面的期待值低於年輕人。與本地出生的香港市民相比，非本地出生香港市民對智慧城市服務滿足其自我實現需求的期待值較低。

## 政策建議

以人為本的智慧城市發展需要政策制定者根據不同人群的喜好和期待量身定制智慧城市服務。考慮到市民需求的異質性，我們為香港城市管理者就智慧城市的戰略定位提出了以下四點政策建議，旨在進一步發展符合當地市民的偏好和期待的智慧城市服務。

1. 加強智慧環境服務，尤其是廢物管理、氣候行動、綠色及智慧建築服務。

由於受訪的香港居民對智慧環境服務有著強烈的偏好，並對智慧城市服務在滿足其生理需求方面表達了最高的期待，因此建議政府採取更多智慧措施來改善環境質量。相關措施可包括加強使用物聯網垃圾桶，或基於物聯網技術的車隊管理系統進行廢物收集和清除，或在前端使用傳感器測量水參數並保證飲用水質量，以及在後端進行適當的廢水處理和排放。將可再生能源技術或是智慧電表更多的納入在綠色/智慧建築設計中以提高建築能源使用效率等也是可採取的相關措施之一。

2. 關注具有長遠影響、能服務更廣泛用戶群體的智慧城市服務。

建議政府可以進一步資助可再生能源技術的相關研究，為企業減少碳足跡提供激勵措施，實施資源保護和可持續利用的政策以促進環境保護。可以分配更多資源提升智慧廢物管理系統，以優化廢物收集、減少廢物量並提高回收率。繼續加強現有智慧公共安全系統以縮短在颱風、安全事故下的應急響應時間、或是降低犯罪率以保護市民人身安全。

3. 滿足市民的生理需求、安全需求和自我實現需求，以提高市民對智慧城市服務的接受度。

為滿足市民的生理需求，政府可以加強投資使用傳感器和數據分析技術來監測城市的空氣和水質，並提醒市民注意潛在的健康危害。針對市民的安全需求，可升級現有實時監控系統來檢測可疑犯罪行為，並實時提醒當局注意潛在威脅。為滿足市民自我實現的需要，建議政府繼續為市民提供各式各樣的公共決策參與方式（如電子投票），並為年輕人在創新創業領域創造更多機會，以實現他們的在此領域的潛力和個人成長。

#### 4. 在數字素養較弱的群體中推廣智慧城市的相關知識。

在數字邊緣化群體中推廣智慧城市相關知識至關重要，如此可以避免他們難以瞭解並享受到智慧城市服務所帶來的好處的缺點。由於缺乏足夠的智慧城市服務知識和經驗，這些數字邊緣化群體的意見在智慧城市的發展過程中往往被忽視。考慮香港即將邁入老年化的社會，尤其應採取更多措施向老年人傳播智慧城市服務的相關知識，例如通過社區研討會持續提供促進社會學習的教育和培訓，或是傳播有關智慧城市和資訊通信技術發展狀況的最新資訊。

## **1. Introduction**

### **1.1 Background**

Cities across the world are facing numerous challenges related to urbanization. Since 2018, more than 55% of the global population has been living in cities, and this figure is expected to climb to 70% by 2050 (United Nations, 2018). The rapidity of urbanization has meant that cities are both the causes and the victims of a range of environmental, social and economic problems. Hong Kong (HK), one of the most densely populated Asian megacities, is no exception to these urbanization-related challenges. In 2018, it had 7,096 people per square km of land, making it the fourth most densely populated city in the world (World Bank, 2018). Its population is also rapidly aging, with more than a quarter of residents aged 65 and above. This trend is expected to place considerable pressure on healthcare services and the labor market. Other issues, including an economic shift from traditional business models to knowledge-based and innovative ones, climate change, and resource scarcity are also posing considerable challenges to HK's urban development (PwC,2017). At the same time, there is an ever-growing community demand for a better quality of life. As such, city governments are disproportionately responsible for tackling these challenges and satisfying the demands but must find ways with economic prosperity and technology innovation.

### **1.2 Problem statement**

Amid rapid advancement in information and communication technologies (ICTs), several international cities like HK are increasingly recognizing the key role that smart city (SC) development can play in mitigating urbanization-related issues (Fernandez-Anez et al., 2018). In 2015, the U.S. administration announced a new "Smart Cities" Initiative for investing over 160 million U.S. dollars in federal research, aiming to help local communities tackle their urbanization challenges such as traffic congestion and climate-change effects (FACT SHEET, 2015). Other SC development plans in global cities include Singapore's Smart Nation Initiative (Ho, 2017), Japan's Kitakyushu smart community project (Chatfield & Reddick, 2016), and Amsterdam's Smart City program (Capra, 2016). Under the global SC development, different dimensions of SC services have been provided in cities for covering aspects of local citizens' urban life, e.g. Boyd Cohen Smart City Wheel (BCSCW) six dimensions (Cohen,2015) – smart mobility, living, environment, people, governance, and economy – which are widely adopted by

many cities, including HK, for their SC development. Nonetheless, although global cities have different endowments on SC services provision, one common theme of SC development has been widely acknowledged: SC development should be people-centric, serving the needs of local citizens with the wider aim of improving their well-being and quality of life (Caragliu et al., 2011; Fernandez-Anez et al., 2018; Macke et al., 2018; Neirotti et al., 2014; Yeh, 2017).

People-centric SC development requires the governments to see things through the eyes of the public, specifically, to provide the SC services that meet the needs<sup>1</sup> and preferences<sup>2</sup> of the citizens. On the one hand, despite the fact that the citizens are key stakeholders in every phase of SC development, their actual needs are often not well considered in SC projects' top-down implementation (Porumbescu et al., 2020). For example, researchers from Switzerland and Singapore conducted a massive survey among the citizens of 102 cities for assessing their perceptions<sup>3</sup> of the SC projects made available to them (Bris, 2019). The results found that in Paris after a local public bike-sharing project was implemented for five years to alleviate congestion and reduce pollution, the local citizens perceived this bike-sharing project as useless because they believed that air pollution was not a problem in Paris. Similar situations also happened in many other international cities (e.g., Shanghai, Tokyo, and Tel Aviv) where the citizens did not feel their needs were well satisfied by local government's massive investment in advanced smart technologies (Bris, 2019).

<sup>1</sup> Need is something which people believe they lack and ought to have, e.g., the citizens' usage of SC services for satisfying their physical and psychological needs.

<sup>2</sup> Preference is the selection of something over others, e.g., the citizens may prefer some specific types of SC services over other types.

<sup>3</sup> Perception is the organization, identification, and interpretation of sensory information for understanding the presented information or environment, e.g., the citizens may have different perceptions of the usefulness of SC services made available to them.

On the other hand, given limited government budgets, city administrators are often needed to set priorities for a wide range of SC services for optimizing the allocation of

resources. To avoid the massive investment of SC projects do not meet the citizens' needs and expectations, it is essential for city administrators to better understand local citizens' preferences for SC services, which can help to inform their decision-making on investment priorities and resource allocation for SC services that are urgently needed by the citizens (Lin et al., 2019). However, in the current academic community, most empirical studies mainly focus on the discussion of the benefits of SC services for citizens (Lin et al., 2019; Macke et al., 2018) and the factors affecting the citizens' usage of SC services (Belanche et al., 2016; Yeh, 2017), while there is generally a lack of empirical studies especially focusing on the citizens' needs and preferences about SC services.

### **1.3 Literature review**

#### **1.3.1 The definition of SC and SC services**

The term SC was first proposed in the 1990s, as part of a discourse on how new ICT might be used to modernize urban infrastructure and it has been evolutionarily enriched in two perspectives: “technological means” and “desired ends”. On one hand, technology corporations have often defined SC from the technological-means perspective; for example, IBM defined an SC as “an instrumented, interconnected, and intelligent city” (Harrison et al., 2010). Specifically, the term “instrumented” in that definition refers to a capability for data collection using various sensors; “interconnected” means a capability for data integration by using a powerful computing platform; and, “intelligent” refers to a capability for data analysis, optimization, and visualization in the service of better decision-making. Academics in the urban-planning field, in contrast, have tended to focus on desired ends – notably, citizens' needs – when designing SC services, with the wider aim of improving well-being and quality of life (Caragliu et al., 2011; Neirotti et al., 2014). For example, Caragliu et al. (2011) argued that “a city is smart when investments in human and social capital and traditional (transport) and modern (ICT) communication infrastructure fuel sustainable economic growth and high quality of life” (p.70). Similarly, Neirotti et al. (2014) deemed SC services to be successful only if they provide citizens with an improved way of living.

To develop people-centric SC, city administrators must provide citizens with a wide range of SC services. Such services can be broadly defined as any ICT-based urban services that serve citizens' day-to-day needs (Lee & Lee, 2014). As such, they can be further subdivided into “hard” and “soft” dimensions (Neirotti et al., 2014). The former

refers to the SC services where ICT systems play decisive roles in the functions of tangible urban infrastructure, including buildings, energy grids, natural resources, water and waste management, transport, and logistics. The soft dimension, in contrast, refers to SC services where ICT systems play auxiliary roles in less-tangible urban processes such as education, culture, entrepreneurship policies, innovation, social inclusion, and citizen engagement/e-government.

### **1.3.2 Citizens' perspectives on SC services**

The importance of municipalities' SC service provision being people-centric has been widely acknowledged in the academic community. A considerable body of literature has emphasized that using SC services can contribute to citizens' well-being and quality of life (Macke et al., 2018) and contribute to urban areas' social, economic, and environmental sustainability (Yigitcanlar et al., 2019). Due to SC services' presumed and actual benefits to citizens, an increasing number of empirical studies have sought to capture citizens' perspectives on such services (Lin et al., 2019; Macke et al., 2018). Some studies have empirically investigated how specific characteristics of SC services may influence people's well-being or quality of life. For example, Macke et al. (2018)'s case study of the city of Curitiba, Brazil revealed that its citizens' quality of life could be improved via SC services in the spheres of socio-structural relations, environmental well-being, material well-being, and community integration. Of course, it is not always possible to draw a hard line between perceptions and actual improvement: as in Lin et al. (2019)'s survey of Chinese SCs, which found that residents' experiences of SC services as safe, useful, and convenient positively affected their subjective senses of well-being.

Several other empirical studies have investigated factors affecting the uptake of SC services, or the usage of other urban services in SC contexts. For example, Belanche et al. (2016)'s case study of the city of Zaragoza, Spain found that its citizens' education levels, possession of smart user cards, and positive attitudes towards SCs appeared to boost their overall usage of urban services. Yeh (2017)'s subsequent survey of cities in Taiwan revealed that acceptance of SC services was affected by people's beliefs about innovation; their self-reported personal innovativeness; and their perceptions of privacy, trust, and SC service quality. Collectively, these studies highlight the usefulness of SC services, and identify several key factors that could contribute to their acceptance.

### **1.3.3 Citizens' needs and preferences about SC services**

Given that the ultimate goal of SC development is to satisfy citizens' needs, it will also be helpful for the government to attain a clear understanding of public expectations of how SC services fit into the realization of human needs. Human needs are the driving forces of human behaviors, and this has given rise to need theories of human behaviors and motivations (Caulton, 2012; Yang et al., 2011). However, studies that discuss SC services from a need-theory perspective are rare so far. The handful of exceptions includes the work of Xu and Geng (2019) and Kwon and Kim (2007). Adopting Alderfer's (1969) existence, relatedness and growth theory, Kwon and Kim (2007) regrouped the ubiquitous smart services offered by various ubiquitous-city projects in South Korea and found that citizens' existence needs were overemphasized, and their relatedness and growth needs were underemphasized. By adopting Maslow (1958)'s need-hierarchy theory, Xu and Geng (2019) created a framework for characterizing SC research and applications that they called people-centric service intelligence. That framework highlighted that the use of ICT in SCs should be derived from and comply with citizens' demand for support of their physiological, safety, love, esteem, and self-actualization needs. However, no empirical verifications of such claims have hitherto been published.

If they are to drive up rates of acceptance of specific SC services, it is also necessary for city administrators to understand citizens' preferences about and motivations for using those services. Yet, despite the fact that they are key stakeholders in every phase of SC development, citizens often are treated as peripheral to SC projects' top-down implementation (Porumbescu et al., 2020). Amid rapid advancements in ICT, the usage of SC services has become a norm rather than an exception in urban life (Lee & Lee, 2014). Thus, it is timely to seek empirical evidence about citizens' preferences regarding SC services – in particular, because such evidence could increase awareness of the role of citizens in driving smartness in city management (Vidiasova & Cronemberger, 2020); help increase the uptake of SC services by tailoring such services to citizens' expectations (Boll et al., 2014); improve the efficiency of SC service delivery, thus aiding governments' strategic positioning of SCs (Belanche et al., 2016); and provide indications of where new investment in SC services is urgently needed (Lin et al., 2019). All of these outcomes would facilitate the emergence of SC strategies that are cost-effective, people-centric, and locality-specific.

### 1.4 Research contributions of the present study to the success in HK’s SC policy implementation

HK’s provision of SC services adopts BCSCW's six dimensions, and the seventh dimension, Smart Combating COVID-19, was proposed in Blueprint 2.0 during the COVID-19 pandemic period. Based on HK’s local context and unique urbanization-related issues, its Innovation and Technology Bureau has proposed a set of development strategies and initiatives under each SC dimension, as highlighted in Blueprint 2.0. Figure 1 illustrates some examples of such initiatives, grouped by dimension. Meanwhile, the Report elaborates on potential scenarios under each SC dimension, including stakeholder impacts and expected outcomes over the short- (2017-20), medium- (2021-25), and long-term horizons (2026-30 and beyond).

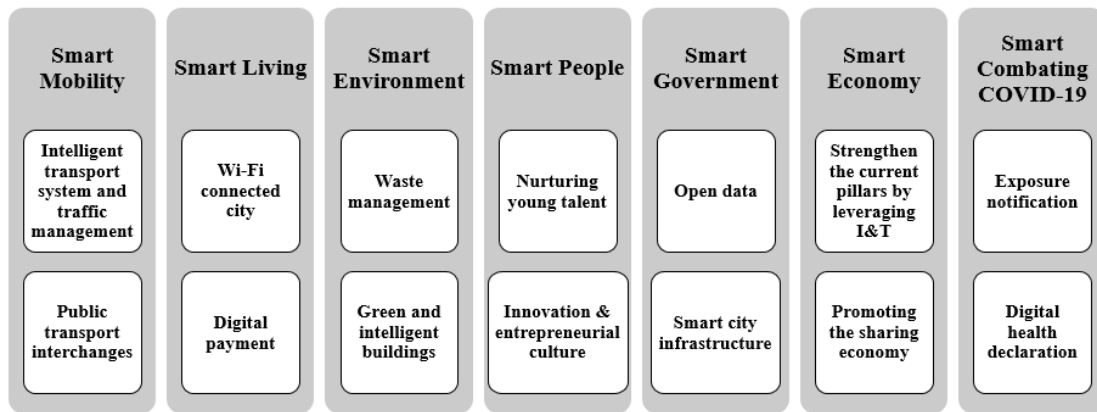


Figure 1. Hong Kong’s seven smart-city dimensions, with example initiatives.

To date, the HK government has scored some important achievements in SC development, including but not limited to pilot initiatives implemented to examine the effectiveness of the SC development plans proposed in the Hong Kong 2030+, Blueprint, and Blueprint 2.0. For instance, in 2015, Kowloon East was designated as a testbed for SC projects, with advanced ICT being used to enhance pedestrian and vehicle accessibility, manage district facilities, and disseminate information to the public digitally. Since the end of 2017, the Hong Kong government has conducted more than 70 SC pilot initiatives, involving digital personal identity, smart lampposts, and open government data (Estopace, 2019). The usage of SC services has become a norm rather than an exception to many HK residents; thus, it is timely to seek empirical evidence about end-users' preferences and expectations regarding SC services in HK, since if priorities for each of the six SC service dimensions are to be set effectively, the HK government will require a clear understanding of such knowledge.



## 2. Objectives of the Study

According to our original plan, the present study aimed to ascertain HK citizens' preferences about SC services and their perceptions of the usefulness of such services to the realization of their human needs. Specifically, the aim was supposed to be achieved by addressing the following three objectives:

1. To investigate the preferences and perceptions of HK citizens towards the SC services, via questionnaire survey.
2. To examine the associations among citizens' preferences for and perceptions of SC services and their demographic characteristics, via statistical analysis.
3. To identify policy implications and provide recommendations for informing people-centric SC strategic planning in HK.

At the early stage of this project, we revised the first objective of the original plan from “investigating citizens' perceptions of the usefulness of smart city services” to “investigating citizens' expectations of such services”. Under the second objective, the term “perception” is also changed to “expectation” accordingly. In the original plan, we aimed to investigate the citizens' perception of the usefulness of SC services in achieving human needs based on Alderfer's ERG theory, and one of the examples of the corresponding survey question would be “我認為智慧城市服務給我帶來了更穩定和安全的生活”. In the revised objective, we aim to investigate the citizens' expectations for the SC services in achieving human needs, and the example survey question is “我希望智慧城市服務能滿足我基本的生存需求，例如通過智慧環境和智慧基建服務提升空氣、食物、水質、住房、睡眠等生活質素”.

The main reason for changing the term from perception to expectation is that, during the first pilot survey among university staff and students, many respondents expressed that it is difficult to comprehend how SC services could be associated with the satisfaction of human needs by reading the survey questions. As such, we observe that if the citizens can be expected to have good judgement on the usefulness of SC services in the realization of human needs, we should assume that the citizens can have good knowledge of SC services and also have experience in using the SC initiatives in their daily life. However, given that many SC initiatives proposed in Blueprint 2.0 are still under-going and have not been widely adopted in HK at present, the local citizens may

still have limited knowledge and experience in using those SC services. Therefore, we believe that it is more precisely and properly to reveal the citizens' expectations, instead of perceptions, in realizing human needs through the proposed SC services in Blueprint 2.0.

Accordingly, we now adopt Maslow's hierarchy of needs theory to replace Alderfer's ERG theory, which was originally proposed in objective one. There are two main reasons for changing the human-needs theory from Alderfer's ERG theory to Maslow's hierarchy of needs theory. Similar to the ERG theory, Maslow's hierarchy of needs theory is also a widely validated human-needs theory in the fields of psychology and organizational behavior. But the Maslow's hierarchy of needs theory decomposes human needs into more scrutinized categories than the ERG theory. In this case, the citizens' motivations for using SC services are expected to be more precisely and properly revealed through Maslow's hierarchy of needs five-stage model. According to Maslow's five-stage model, people are motivated to achieve the following needs: 1) psychological needs – the basic needs for people to survive, such as air, water, food, shelter, and sleep, 2) safety needs – the needs for people to feel safe and secure, such as personal safety, financial security, and health, 3) social needs – the needs for people to feel a sense of connection and belonging, such as family, friends, and intimacy, 4) esteem needs – the needs for people to feel a sense of self-worth and achievement, such as respect, recognition, and success, and 5) self-actualization needs – the needs for people to reach their full potentials, such as creativity, self-fulfilment, and personal growth.

We believe that the change using the terminology from “perception” to “expectation” can help to reveal the needs and expectations of Hong Kong citizens more precisely and properly with different knowledge backgrounds. Also, from the observation in our first pilot survey, we found that the respondents can better understand and comprehend the survey questions. Given the fact that many SC services and initiatives in Blueprint 2.0 are still at the early stage of development, we believe that understanding the general public's needs and expectations for SC services in realizing their human needs can better inform the people-centric SC development in HK. Policymakers can give priority to investing in those SC services that could meet the citizens' needs and expectations.

The survey questions will be revised accordingly by the PI and no remedial actions are needed as the impact on the research will not be changed.

Therefore, the revised research objectives are shown as follows:

1. To investigate the preferences and expectations of HK citizens towards SC services via questionnaire survey
2. To examine the associations between citizens' preferences and expectations of SC services and their demographic characteristics, via statistical analysis
3. To identify policy implications and provide recommendations for informing people-centric SC strategic planning in HK

Achieving these three objectives can help facilitate the SC strategies that are cost-effective, people-centric, and locality-specific by 1) increasing awareness of the role of citizens in driving smartness in city management; 2) increasing the uptake of SC services by tailoring such services to citizens' expectations; 3) improving the efficiency of SC service delivery to aid governments' strategic positioning of SC; and 4) providing indications of where new investment in SC services is urgently needed.

### 3. Methodology

As shown in Figure 2, the proposed study's investigation of HK citizens' preferences and expectations about SC services consists of four tasks: (1) questionnaire survey, (2) statistical analysis, (3) findings identification, and (4) public dissemination. The specific research methods that will be employed for achieving the first two objectives are presented in blue.

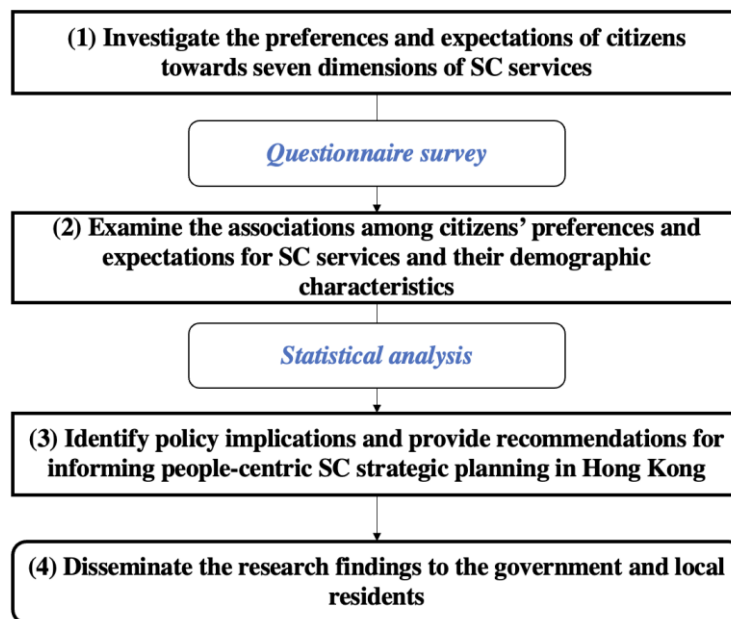


Figure 2. Research plan and objectives.

### 3.1 Investigate the Preferences and Expectations of Citizens towards Seven Dimensions of SC Services

#### 3.1.1 Questionnaire Design

The questionnaire survey consists of three parts, including 1) respondents' demographic characteristics and digital literacy, 2) preferences for SC services, and 3) expectations for SC services in the realization of their human needs. Detailed questionnaire designs are demonstrated as follows:

##### Citizens' demographic characteristics and digital literacy

The first part of the questionnaire survey aims to collect the citizens' basic information on their demographic characteristics and digital literacy. The demographic characteristics include gender, birthplace, years of residence in HK, HK residency status, age, education level, employment, personal health, district of residence, household size, family health, and household income (as shown in Table 1).

Table 1. Survey questions on demographic characteristics (in Cantonese).

<b>1) 性別</b>
<input type="checkbox"/> 男 <input type="checkbox"/> 女 <input type="checkbox"/> 其他
<b>2) 出生地</b>
<input type="checkbox"/> 香港 <input type="checkbox"/> 其他 <input type="checkbox"/> 不知道
<b>3) 居港年期(不適用於在香港出生者)</b>
<input type="checkbox"/> 3 年或以下
<input type="checkbox"/> 4-6 年
<input type="checkbox"/> 7-9 年
<input type="checkbox"/> 10-19 年
<input type="checkbox"/> 20 年或以上
<input type="checkbox"/> 不知道 / 不記得
<b>4) 香港居民身份</b>
<input type="checkbox"/> 香港永久性居民

香港非永久性居民 (如持工作 / 讀書 / 外傭簽證)

#### 5) 年齡

- 18–19 歲                      50–59 歲  
20–29 歲                      60–69 歲  
30–39 歲                      70–79 歲  
40–49 歲                      80 歲或以上

#### 6) 教育程度 (最高就讀程度, 即不論有否完成該課程, 包括現正就讀)

- 小學或以下  
初中 (中一至中三)  
高中 (中四至中七 / DSE / 毅進)  
專上教育: 非學位課程 (包括文憑 / 證書 / 副學位課程)  
專上教育: 學士學位課程  
專上教育: 研究院或以上

#### 7) 就業狀況

- 僱主                                      料理家務者 / 家庭主婦  
全職僱員                                  退休  
兼職僱員                                  因其他原因而沒有工作  
失業 / 待業                              其他: \_\_\_\_\_  
學生

#### 8) 你是否屬於以下類別人士?

	是	不是
長期病患者	<input type="radio"/>	<input type="radio"/>
殘疾人士	<input type="radio"/>	<input type="radio"/>

#### 家庭 / 住所資料

#### 9) 居住地區

- 中西區                      九龍城                      元朗

- |                              |                              |                             |
|------------------------------|------------------------------|-----------------------------|
| <input type="checkbox"/> 灣仔  | <input type="checkbox"/> 黃大仙 | <input type="checkbox"/> 北區 |
| <input type="checkbox"/> 東區  | <input type="checkbox"/> 觀塘  | <input type="checkbox"/> 大埔 |
| <input type="checkbox"/> 南區  | <input type="checkbox"/> 葵青  | <input type="checkbox"/> 沙田 |
| <input type="checkbox"/> 油尖旺 | <input type="checkbox"/> 荃灣  | <input type="checkbox"/> 西貢 |
| <input type="checkbox"/> 深水埗 | <input type="checkbox"/> 屯門  | <input type="checkbox"/> 離島 |

**10) 你現時是否和家人同住?**

- 是
- 不是, 獨居
- 不是, 住在宿舍 / 院舍  
(獨居 / 住在宿舍 / 院舍者無須回答)

**11) 不包括你自己, 你家中有多少人和你同住? 請包括家傭在內。  
(「同住」即一星期至少住四晚) \_\_\_人  
(獨居 / 住在宿舍 / 院舍者無須回答)**

**12) 不包括你自己, 你家中有沒有以下類別人士?**

	有	沒有
長期病患者	<input type="radio"/>	<input type="radio"/>
殘疾人士	<input type="radio"/>	<input type="radio"/>

**13) 你的家庭住戶平均每月收入大約是多少? 家庭住戶收入是指住在一起及分享生活的住戶成員 (不一定有親戚關係) 的總收入, 包括工資、家用、政府津貼 (如生果金)、退休金 (如強積金)、租金收入等。**

- |  |  |
|--|--|
| <input type="checkbox"/> 少於\$10,000      | <input type="checkbox"/> \$60,000–69,999 |
| <input type="checkbox"/> \$10,000–19,999 | <input type="checkbox"/> \$70,000–79,999 |
| <input type="checkbox"/> \$20,000–29,999 | <input type="checkbox"/> \$80,000–89,999 |
| <input type="checkbox"/> \$30,000–39,999 | <input type="checkbox"/> \$90,000–99,999 |
| <input type="checkbox"/> \$40,000–49,999 | <input type="checkbox"/> \$100,000 或以上   |
| <input type="checkbox"/> \$50,000–59,999 | <input type="checkbox"/> 不清楚             |

Considering that citizens' preferences and expectations for SC services vary in different digital-divide groups because many SC services require digital literacy of the citizens. This study collects the citizens' levels of digital literacy based on the Digital Skills Indicator (DSI) 2.0 developed by Eurostat, the Statistical Office of the European Union (Eurostat, 2022). This instrument can serve as a proxy for people's digital literacy by assuming that those who have performed certain digital activities possess corresponding digital skills. More specifically, the DSI 2.0 measures an individual's 1) information and data literacy, 2) communication and collaboration, 3) digital content creation, 4) safety, and 5) problem-solving. As indicated in Table 2, our respondents are asked to identify whether they had used computers/tablets or telephones to perform digital activities within the previous three months. Based on the number of digital activities they self-reported engaging in, we estimated whether each individual had no, limited/narrow, low, basic, or above-basic level of digital-literacy skills. For details on the methods used for calculating these levels of digital literacy, please refer to Eurostat (2022).

Table 2. Survey questions on digital literacy (in Cantonese).

<b>1) 你或你家中有沒有電腦 (包括桌上電腦 / 手提電腦 / 平板電腦)?</b>
<input type="checkbox"/> 有 <input type="checkbox"/> 沒有 <input type="checkbox"/> 不知道 / 很難說
<b>2) 你有沒有智能手機 / 智能電話?</b>
<input type="checkbox"/> 有 <input type="checkbox"/> 沒有 <input type="checkbox"/> 不知道 / 很難說
<b>3) 電腦 / 電話的使用 (1/5)</b> 你過去三個月有曾經使用電腦 (包括平板電腦) 或電話做以下事情 / 行為嗎? 請回答:有/沒有/不知道 / 很難說
a. 下載或安裝軟件 / 應用程式 b. 改變軟件 / 應用程式 / 設備的設定 c. 使用網上銀行服務 d. 網上購物 e. 網上銷售 f. 使用網上學習資源 g. 網上求職
<b>4) 電腦 / 電話的使用 (2/5)</b> 你過去三個月有曾經使用電腦 (包括平板電腦) 或電話做以下事情 / 行為嗎? 請回答:有/沒有/不知道 / 很難說
a. 搜尋商品或服務資訊 b. 搜尋健康資訊

<p>c. 閱讀新聞、報紙或雜誌</p> <p>d. 查核網上資訊及其來源真實性 (即 fact-check)</p>
<p><b>5) 電腦 / 電話的使用 (3/5)</b></p> <p>你過去三個月有曾經使用電腦 (包括平板電腦) 或電話做以下事情 / 行為嗎? 請回答:有/沒有/不知道 / 很難說</p>
<p>a. 發送 / 接收電郵</p> <p>b. 透過應用程式發送 / 接收訊息 (如透過 WhatsApp, 不包括 SMS)</p> <p>c. 透過應用程式語音 / 視像通話 (如透過 WhatsApp, 不包括傳統電話)</p> <p>d. 使用社交媒體 (如 Facebook、Instagram 等)</p> <p>e. 在網站或社交媒體上, 就時事或民生議題發表意見</p> <p>f. 在網上參與關於時事或民生議題的諮詢或投票</p>
<p><b>6) 電腦 / 電話的使用 (4/5)</b></p> <p>你過去三個月有曾經使用電腦 (包括平板電腦) 或電話做以下事情 / 行為嗎? 請回答:有/沒有/不知道 / 很難說</p>
<p>a. 移動或複製檔案 (如在文件夾、設備、雲端儲存空間之間)</p> <p>b. 創造 / 建立包含多種內容 (如文字、圖片、表格、圖表、動畫或音訊) 的文件、圖像或影片</p> <p>c. 編輯多媒體檔案 (如圖像、影片或音訊)</p> <p>d. 使用文書處理軟件 (如 Microsoft Word)</p> <p>e. 使用試算表軟件 (如 Microsoft Excel)</p> <p>f. 使用試算表軟件的進階功能 (如在 Microsoft Excel 輸入公式, 而非只用作輸入資料)</p> <p>g. 編寫電腦程式</p>
<p><b>7) 電腦 / 電話的使用 (5/5)</b></p> <p>你過去三個月有曾經使用電腦 (包括平板電腦) 或電話做以下事情 / 行為嗎? 請回答:有/沒有/不知道 / 很難說</p>
<p>a. 收緊瀏覽器內關於 Cookie 的設定</p> <p>b. 在提供個人資料前, 先評估網站的可信性或安全性</p> <p>c. 在提供個人資料前, 先閱讀私隱政策</p> <p>d. 限制或拒絕應用程式 / 網站存取你的地理位置</p> <p>e. 限制或拒絕應用程式 / 網站與合作機構分享你的個人資料</p> <p>f. 拒絕應用程式 / 網站將你的個人資料用於廣告目的 (如拒收推廣訊息、停用「個人化廣告」)</p>

### Citizens' preferences for SC services

The second part of the questionnaire survey aims to collect the citizens' preferences for SC services in different dimensions. The items of SC services are derived from the most recent version of Hong Kong Smart City Blueprint 2.0 which was published in 2020. Compared with Blueprint 1.0 in 2017 which contains 76 SC initiatives, Blueprint 2.0



puts forth over 130 SC initiatives and includes a new chapter on “Use of I&T in Combating COVID-19”. Therefore, compared with the original plan that covers SC services in six dimensions, we aim to investigate the respondents’ preferences for SC services in seven dimensions, including 1) smart mobility, 2) smart living, 3) smart environment, 4) smart people, 5) smart government, 6) smart economy, 7) smart combating COVID-19.

We designed the survey questions on SC services under the guidance of Blueprint 2.0. However, SC initiatives that did not involve the use of ICTs, such as the “Universal Accessibility Program that aims to retrofit barrier-free access to existing public walkways”, were excluded from consideration. For the remaining, i.e., ICT-based SC initiatives, we grouped SC initiatives with similar functions into categories, each of which was deemed to be one SC service for the purposes hereof. Nevertheless, we primarily followed the original categories proposed in Blueprint 2.0. For example, our category “Wi-Fi Connected City” comprises two SC initiatives: 1) continuing the implementation of the Wi-Fi Connected City Program to provide free public Wi-Fi service, and 2) implementing a pilot project to provide Wi-Fi services at welfare-service units. We synthesized them into one SC service called “providing free Wi-Fi service at public spaces and welfare service units”. Our main reason for this grouping was to reduce analytical complexity by highlighting the common purposes of similar SC initiatives. Meanwhile, due to the changes in immigration policy during the process of the present project, two SC services are no longer relevant to HK citizens’ daily life, including “implement a ‘home quarantine system’ for residents living in peace and health to support those arriving in Hong Kong who need home quarantine” and “develop health codes so that Hong Kong can resume its contacts with other places in an orderly manner” respectively. In all, this process led to over 130 SC initiatives being grouped into 48 SC services, as indicated in Table 3.

Table 3. A list of SC services.

分類 Dimension	編號 No.	服務 SC services	內容 Description
智慧生活 Smart Living	1	Wi-Fi 聯通城市 Wi-Fi Connected City	擴大免費 Wi-Fi 的覆蓋範圍，如擴展至社福設施和各類院舍 Expand the coverage of free Wi-Fi, e.g., to welfare service units and various residential institutions

分類 Dimension	編號 No.	服務 SC services	內容 Description
	2	數碼支付 Digital Payment	推廣「轉數快」和各種電子支付方式 (如流動支付和非接觸式付款) Promote "Faster Payment System" and various electronic payment methods, such as mobile payment and contactless payment
	3	數碼個人身份 eID	推廣一站式數碼服務平台「智方便」，讓市民透過平台使用政府服務、牌照服務和進行商業交易 Promote the one-stop personalised service platform "iAM Smart" to facilitate citizens to use digital government services, licensing services, and conduct commercial transactions
	4	長者與殘疾人士支援 Support for the Elderly and Persons with Disabilities	在安老院舍和康復中心引入新科技 (如跌倒預警)，以保障長者和殘疾人士 Introduce advanced technology products such as products for fall warnings in elderly and rehabilitation service units to support the elderly and persons with disabilities
	5	支援醫療服務 Support for Healthcare	推廣電子健康紀錄互通系統「醫健通」和網上預約門診，並研究讓病人可視像遙距應診 Promote the electronic health record sharing system "eHealth" and online booking of clinic appointments, and conduct research on allowing patients to conduct remote consultation through video-conferencing
	6	智慧康體服務預約 Intelligent Sports and Recreation Services Booking	改善康體服務預約系統「康體通」(如防止炒場) Improve the New Intelligent Sports and Recreation Services Booking and Information System "Leisure Link" (e.g., to combat suspected touting activities)
	7	智慧圖書館 Smart Library	在圖書館採用新科技，如容許以手提電話借出書籍、系統自動處理歸還書籍等 Adopt new technologies in the library, such as allowing books to be borrowed using mobile phones, and the system to automatically process the returned books

分類 Dimension	編號 No.	服務 SC services	內容 Description
	8	遠足定位 Hiking Positioning	運用新科技在偏遠地區定位追蹤遠足人士，方便搜救 Use new technologies to enhance location tracking of hikers in remote areas with weak or no mobile network coverage to facilitate search and rescue
智慧出行 Smart Mobility	9	實時交通燈號調節 Real-time Adaptive Traffic Signal System	讓交通燈按當時路面人流和車流調節紅綠燈時間 Optimise the green times of traffic lights allocated to vehicles and pedestrians according to the flow of people and vehicles on the road at that time
	10	不停車繳費 Free-Flow Tolling Service	自動偵測經過隧道的車輛以收取隧道費，無須停車繳費 Automatically detect vehicles passing through the tunnels to collect tunnel tolls, without having to stop or queue up at toll booths for payments
	11	實時交通資訊 Real-time Traffic Information	提供各種實時交通資訊，包括巴士到站時間、空置泊車位位置等 Provide various real-time traffic information, including bus arrival times and locations of vacant parking spaces
	12	人流車流管理 Crowd Management	使用影像分析技術，在大型活動舉行期間監察人流和車流，方便管理 Adopt image recognition technology to facilitate the monitoring of people and vehicle flows during major events
	13	交通違例打擊 Deterrence of Traffic Offences	使用影像分析技術，打擊違例泊車和不當使用上落貨區等違例事項 Use image recognition technology to deter improper use of loading and unloading bays, illegal parking, and other traffic offences
	14	智慧機場 Smart Airport	令出入境程序更方便，如除了指紋外亦容許以人臉識別出入境，並在機場外增加可辦理登機的地點 Make the entry and exit procedures more convenient at the airport, such as allowing face recognition in addition to fingerprints, and expand mobile check-in services at off-airport locations
	15	綠色交通運輸 Environmental Friendliness in Transport	引入電動渡輪和電動小巴 Introduce electric ferries and electric public light buses

分類 Dimension	編號 No.	服務 SC services	內容 Description
	16	行人及單車友善環境 Friendly Environment for Pedestrians and Cyclists	宣傳「香港出行易」應用程式可以查詢步行路線、單車徑和無障礙路線，並鼓勵步行和踩單車 Promote the mobile app "HKEMobility" which could allow to search walking paths, bicycle routes, and barrier-free public walkways, and encourage walking and bicycling
	17	自動駕駛車輛 Autonomous Vehicles	推動自動駕駛車輛在香港的測試和使用 Promote the testing and use of autonomous vehicles at suitable locations in Hong Kong
智慧環境 Smart Environment	18	氣候行動 Climate Actions	減少燃煤發電，改為使用天然氣 / 可再生能源 (如使用污泥發電，轉廢為能) Phase down coal-fired electricity generation and switch to natural gas/renewable energy such as using sludge to generate electricity and turn waste into energy
	19	綠色智慧建築 Green/Intelligent Buildings	採用綠色建築設計，提高建築物能源效益 (如改為使用 LED 燈照明) Adopt green building design to improve building energy efficiency (such as changing to LED lighting)
	20	廢物管理 Waste Management	增設更多智能回收箱，以鼓勵社區回收 (裝置能自動化收集並處理廢物，更清潔衛生) Add more smart recycling bins that can automatically collect and dispose of the waste for enhancing community recycling and making communities cleaner and more hygienic
	21	污染監測 Pollution Monitoring	運用新科技監測 / 改善空氣質素和水塘水質，並減低噪音影響 Use new technologies to monitor and improve air quality and reservoir water quality and reduce noise pollution
	22	環境衛生 Environmental Hygiene	運用新科技監察和改善環境衛生 (如自動通報臭味濃度和消耗品用量的智慧廁所、改善防治鼠患和滅蚊工作) Use new technologies to monitor and improve environmental hygiene, e.g., smart toilets that automatically report odour concentration and consumption levels of consumables, and advanced rodent-control and mosquito-control technologies

分類 Dimension	編號 No.	服務 SC services	內容 Description
智慧政府 Smart Government	23	數據公開服務 Open Data Service	進一步透過「資料一線通」網站發放更多政府和公營機構的數據，讓市民免費使用 Use government websites such as "data.gov.hk" to facilitate the dissemination of datasets provided by government departments and public organisations for free use by the public
	24	5G 流動技術 5G Mobile Technology	進一步推動 5G 流動網絡的使用 Further promote the use of the fifth generation (5G) mobile network
	25	數碼政府服務 Digital Government Service	運用大數據分析和資訊管理系統，令政府運作和提供公共服務時更有效率 Adopt new big data analytic platforms and information management systems to make government operations and delivery of public services more efficient
	26	網絡安全 Network Security	提升政府和社會對網絡安全的認識和發現網絡安全問題時的應變能力 Enhance the government and society's awareness of cybersecurity and capability of incident response in the face of cybersecurity problems
	27	城市協同創新 Urban Collaboration for Innovation	透過不同計劃 / 比賽，鼓勵公眾和業界建議如何運用創新科技改善生活 Encourage the public and the industry to suggest how to use innovative technologies to improve quality of life through different projects and competitions
	28	危險藥物管理 Dangerous Drugs Management	升級系統，以改善危險藥物的處理、補給及採購，提升緊急救護服務 Upgrade systems to streamline the handling, replenishment, and procurement process of dangerous drugs for enhancing emergency ambulance services
	29	建築資訊模型 Building Information Modeling	推動運用新科技（如「建築信息模擬」技術）管理和監督工程項目，以提升效率並減低意外風險 Promote the use of new technologies such as Building Information Modelling to manage and supervise construction projects to improve efficiency and reduce the risk of accidents

分類 Dimension	編號 No.	服務 SC services	內容 Description
	30	智慧供水 Smart Water Supply	透過安裝感應器監察食水流失情況，並透過應用程式向用戶提供實時用水數據 Monitor freshwater loss by installing sensors and provide real-time water consumption information to users through mobile apps
	31	智慧渠務 Smart Drainage Services	安裝感應器監察污水渠水位，並運用機械人檢測和維修地下排水系統 Install sensors to monitor water levels in sewers and use robots to inspect and repair underground drainage systems
	32	智慧海關 Smart Customs	為海關引入可自動偵測違禁品的設備，並透過大數據分析相關罪行，提升通關效率和執法成效 Employ new technologies to automatically detect contraband and analyse crimes for enhancing customs clearance efficiency and law enforcement effectiveness
	33	智慧監獄 Smart Prison	在監獄採用新科技，如人工智能閉路電視系統和機械人，以減輕職員工作量和加強保安 Adopt new technologies in prisons, such as artificial intelligence CCTV systems and robots, to reduce staff workload and enhance security
	34	招牌監管 Signboard Control	運用新科技分析圖像，以識別違例、危險或棄置招牌，再要求拆除 Use new technologies for signboard control, such as image analysis to detect unauthorised, dangerous and abandoned signboards and request removal
智慧經濟 Smart Economy	35	金融科技 FinTech	繼續推動網上銀行服務、虛擬銀行和「積金易」的發展，令市民能更方便地使用金融服務 Promote the development of Internet banking services, virtual banks, and electronic Mandatory Provident Fund platforms so that the public can use financial services more conveniently
	36	智慧旅遊 Smart Tourism	改善並推廣香港旅遊發展局的官方網站，並在景點增設擴增實境 (AR) 體驗項目，吸引旅客 Enhance and promote the official website of the Hong Kong Tourism Board and add Augmented Reality (AR) experiences at places of interest to attract tourists

分類 Dimension	編號 No.	服務 SC services	內容 Description
	37	法律科技 LawTech	發展和推廣協助解決跨境 / 本地商業爭議及提供交易促成服務的網上平台 Develop and promote an online platform to provide online dispute resolution and deal-making services for cross-border and local enterprises
	38	研發和再工業化 R&D and Reindustrialisation	鼓勵企業進行科技研發，並促進科研合作 (如建立合作平台、興建創科園、提供稅務優惠等) Encourage enterprises to conduct research and development and promote scientific research cooperation (such as establishing collaborative platforms, building innovation and technology parks, and providing enhanced tax deductions for qualified enterprises)
	39	創新及新經濟 Innovation and New Economy	透過「科技券」計劃提供資助，鼓勵本地企業 / 機構運用科技提高營運效率 Provide subsidies for local enterprises/organizations to encourage them to adopt technological solutions to enhance operational efficiency through the “Technology Voucher Program”
智慧市民 Smart People	40	STEM 教育 STEM Education	加強對中小學生的科學、科技、工程及數學 (STEM) 教育和資訊科技 (IT) 教育，鼓勵學校推行更多相關課程和活動 Strengthen science, technology, engineering, and mathematics (STEM) and information technology (IT) education for primary and secondary students and encourage schools to implement more STEM-related classes and activities
	41	青年創科實習及研究人才庫 Youth IT Internship and Research Talent Hub	為青年提供到科技企業實習的機會，並提供資助鼓勵企業僱用畢業生進行科技研發工作 Provide internship opportunities for young people to practice in IT companies and provide subsidies for companies to encourage the hiring of graduates for research and development
	42	吸引 IT 人才 Attract IT-professionals	吸引和挽留生物科技、人工智能、網絡安全等創科範疇的人才 Attract and retain more IT professionals, especially in technological areas such as biotechnology, artificial intelligence, and cyber security



分類 Dimension	編號 No.	服務 SC services	內容 Description
	43	創新及創業文化 Innovation and Entrepreneurial Culture	為初創企業提供財政支援 (如投資於該企業) 和非財政支援 (如為其開拓商機) Provide financial support (such as investing in the business) and non-financial support (such as developing business opportunities) for start-ups
	44	區塊鏈證書平台 Blockchain Certificate Platform	應用區塊鏈技術，建立可在網上驗證專上教育學歷的平台 Establish online platforms using blockchain technology to facilitate verification of tertiary education qualifications
	45	公務員 IT 培訓 IT Training for Civil Servants	加強培訓公務員對創新科技的認識和應用能力，以配合政府推動智慧城市進程 Strengthen the training of civil servants on the understanding and application of innovative technologies, to cooperate with the government to promote the smart city process
智慧抗疫 Smart Combating COVID-19	46	感染風險通知 Exposure Notification	繼續推行「安心出行」應用程式，記錄市民出入場所資訊，以提供感染風險通知及相關的健康建議 Continue to implement the mobile app “LeaveHomeSafe” to record the information of citizens entering and exiting places, to provide infection risk notification and related health advice
	47	公共場所消毒殺菌 Public Space Disinfection	推廣運用消毒機械人和防菌科技來消毒殺菌 (如在機場 / 街市 / 巴士等) Promote the use of robots and anti-microbial technology to provide environmental-hygiene services in airport terminals, public markets, and buses
	48	健康申報電子化 Digital Health Declaration	推出簡化的電子表格，方便抵港人士於網上完成健康申報，節省人手和時間 Introduce streamlined electronic forms to facilitate inbound persons to complete health declarations online, saving manpower and time

Our original plan was to use a five-point Likert scale to measure the citizens' preferences for SC services. Specifically, the respondents are required to rate the importance of one SC service using five scores where one refers to very unimportant and five refers to very important. However, when we conducted a pilot survey among university staff and students, they expressed that it was difficult to distinguish the



importance between different SC services because they perceived all SC services are important to their daily life. As such, nearly all SC services were rated with four or five scores. In addition, even though over 130 SC initiatives had been reduced to 48 SC services, the respondents expressed that it was very exhausting to rate each single SC service using a five-point Likert scale. Taking into consideration the feedback from university staff and students, we change the preference measurement tool from rating questions to pairwise comparison questions, which enables respondents to compare their preferences for two services easily. Specifically, we asked our respondents to look at 10 sets of pairwise comparisons and to select the SC service in each pair that they preferred the government would implement or enhance to improve HK residents' quality of life, as indicated in Table 4. In this case, both the undergoing SC services that citizens hope to be enhanced and the new SC services that citizens hope to be promoted can be evaluated. As it would be very impractical for the respondents to compare all 1,128 possible pairings of SC services, we proceeded from an assumption that the members of specific subpopulations would have similar preferences, and that, therefore, sets of pairwise comparisons could be considerably shorter (Kaye & Firth, 2017). A pilot study we conducted confirmed that completing 10 sets of pairwise comparisons was acceptable to all respondents. In the main study, the 10 sets of pairwise comparisons we used were randomly selected from a list of SC services across seven dimensions.

Table 4. Survey questions on the preferences for SC services (in Cantonese).

<b>1) 你比較希望政府 (進一步) 實施或推廣以下哪一項智慧城市服務, 以提升香港人的生活質素? (請盡量選擇其中一項服務)</b>		
<input type="checkbox"/> [服務 1]	<input type="checkbox"/> [服務 2]	<input type="checkbox"/> 不知道 / 很難說
... ..		
<b>10) 你比較希望政府 (進一步) 實施或推廣以下哪一項智慧城市服務, 以提升香港人的生活質素? (請盡量選擇其中一項服務)</b>		
<input type="checkbox"/> [服務 1]	<input type="checkbox"/> [服務 2]	<input type="checkbox"/> 不知道 / 很難說

#### Citizens' expectations for SC services

Based on Maslow's (1943) hierarchy theory, the third part of the questionnaire collected the respondents' expectations about SC services' roles in the realization of their human needs. As briefly noted above, according to Maslow's five-stage model, people are motivated to achieve 1) physiological needs – requisites for survival, such as air, water,

food, shelter, and sleep; 2) safety needs – to feel safe and secure, physically and financially; 3) social needs – to feel a sense of connection and belonging, such as through family, friends, and intimate partners; 4) esteem needs – to feel a sense of self-worth and achievement, e.g., via respect, recognition, and success; and 5) self-actualization needs – to reach their full potential for creativity, self-fulfilment, and personal growth. As indicated in Table 5, our respondents were asked to rank five human needs that they expected SC services to satisfy, with rank one referring to the highest expectation and rank five to the lowest. To facilitate respondents’ understanding, we provided examples of how SC services could help satisfy different stages of human needs. For example, the statement “Meeting my physiological needs” was exemplified by “Maintaining air- and water-quality standards through pollution monitoring and clean-energy technology to make the city greener, cleaner, and more livable”. We originally planned to measure citizens’ expectations for SC in realizing their human needs using a five-point Likert scale. However, according to the feedback from the pilot survey, it was difficult for respondents to score their expectations between different human needs because they perceived all human needs are important to be satisfied by SC services. As such, nearly all expectations were rated with four or five scores. Therefore, we choose the full-ranking questions to measure citizens’ expectations for SC services in realizing their human needs.

Table 5. Survey questions on the expectations for SC services in realizing human needs (in Cantonese).

<p>在實現你的個人需求方面，你對智慧城市相關服務措施有甚麼期望？(請為以下五項按期望大小由高至低排序。越高代表期望越大，越低代表期望越小)</p>
<p>_____ 滿足我的基本生活需求 (如透過污染監測和清潔能源技術，保持空氣質素、水質等達標，並令城市更綠色、清潔、宜居)</p>
<p>_____ 讓我感到安全和穩定 (如在疫情肆虐 / 颱風襲港 / 治安事件發生時，運用緊急應變系統，保障人身健康 / 安全；開發防詐騙應用程式，在尊重使用者私隱的同時，攔截詐騙電話、保障網路安全)</p>
<p>_____ 有助滿足我的社交需求 (如透過應用程式，了解康體活動資訊及租訂康樂設施，增加與他人情感聯繫的機會；透過數碼政府平台參與社區 / 城市建設，增加社會歸屬感)</p>
<p>_____ 讓我更加自信 / 獲他人尊重 (如透過創新安老 / 康復產品，協助市民獨立自主生活；透過網上平台，讓我和其他人都能夠平等地獲得資訊 / 表達訴求)</p>
<p>_____ 有助我個人成長和自我實現 (如透過科技創新，營造友善的學習 / 就業環境，為個人發展與實現社會價值提供多元化途徑)</p>

### 3.1.2 Data Collection

### Online survey

According to the random sample method (Daniel & Cross, 2018), 5,000 samples are expected to be collected by setting a 2% margin of error with a 99% confidence level given the 6.5 million adult citizens in HK. To ensure the sufficient size and representativeness of our sample and avoid unnecessary face-to-face contact during pandemic conditions, we delegated data collection to a reputable and professional online-survey organization, the Hong Kong Public Opinion Research Institute (HKPORI), which has conducted more than 2,000 independent online surveys over the past 30 years in partnership with academics in HK and overseas. HKPORI survey respondents' personal identities are confirmed via ID checks.

Before commencing formal data collection, we conducted two rounds of pilot surveys to pretest our questionnaire. During the first round, we asked ten university researchers to review the questionnaire and identify any likely sources of measurement errors, such as ambiguous or overly challenging questions. Given that university researchers tend to have a good working knowledge of SC services as well as strong interpretation skills, additional 50 respondents from the general public were the subjects of our second pilot survey, which had the same purpose as the first but was administered by HKPORI. Based on the results of both pilot surveys, we refined the questionnaire and requested the HKPORI team to conduct formal data collection from November 13 to December 18, 2022, targeting HK residents aged 18 and above.

As indicated in Figure 3, the formal online survey was conducted by sending email invitations to a total of 81,271 email addresses of HKPORI panellists. Of these, 81,191 invitations were successfully delivered, and 39,030 were opened by the recipients. Among those who opened the invitation email, the survey was commenced by 4,023 respondents. Meanwhile, with the help of HKPORI, the research team also created an online platform where 493 samples were collected from February 6, 2023, to March 13, 2023. Finally, a total of 4,516 samples were collected.

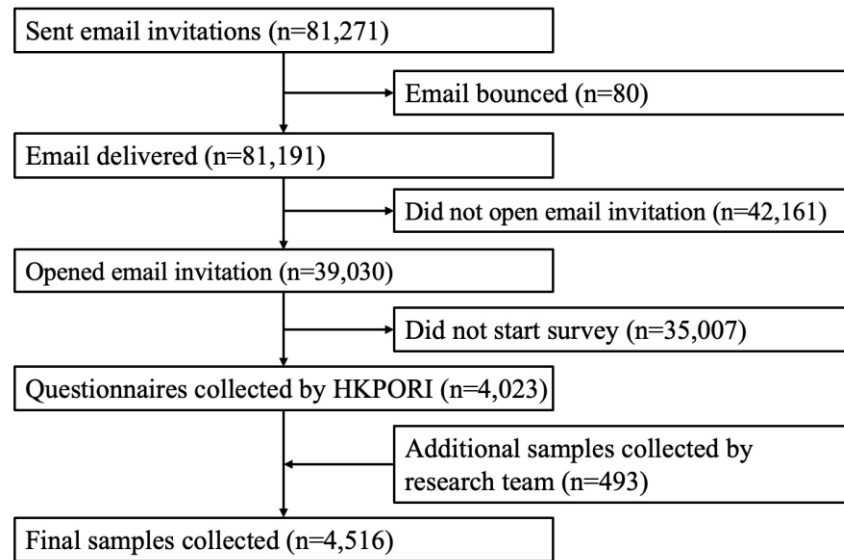


Figure 3. Flow chart of online survey recruitment and exclusion process.

### Face-to-face survey

We conducted a face-to-face questionnaire survey as a complement to the online survey. Face-to-face survey can help to approach some of the residents who may be difficult to be approached through an online survey (e.g., older people). We planned to seek help from about 10 community centers or NGOs to support the recruitment of residents as respondents. After collecting detailed contact information from 30 community centers, we sent emails to seek their help to invite local seniors to participate in our questionnaire survey. We received replies from six non-government organizations (NGOs), as indicated in Table 6. After negotiating the schedule of the face-to-face survey with local communities, we started to recruit and train part-time student helpers for ensuring they were familiar with the contents of the questionnaire and survey process. Considering elderly respondents are difficult to complete the questionnaire independently, we requested the student helpers to assist one elderly person at a time. We conducted the face-to-face survey with 500 elderly residents from October 1, 2022, to January 10, 2023, in three Hong Kong districts, as indicated in Table 7. By removing 12 invalid samples, a total of 488 questionnaires were collected. In a summary, we finally collected 5,004 samples from online survey and face-to-face survey, which exceeds our proposed goal of 5,000 samples.

Table 6. Non-government organizations who help to invite elderly respondents.

<b>Name of the NGOs</b>
Hong Kong Young Women’s Christian Association Kwun Lung Lau Community Work Office (香港基督教女青年會觀龍樓社區工作辦事處)
St James' Settlement (聖雅各福群會)
Methodist Kwun Tong Community Service (循道衛理觀塘社區服務處)
Neighborhood Advice-Action Council Mrs Bai Bishop Elderly Center (鄰舍輔導會白會督夫人康齡中心)
Neighborhood Advice-Action Council Sau Mau Ping Elderly Center (鄰舍輔導會秀茂坪康齡中心)
Pong Wing Siu Neighborhood Elderly Center (龐永紹長者鄰舍中心)

Table 7. Face-to-face questionnaires collected in three HK districts.

District	Frequency	Percentage
Hong Kong Island	144	28.8%
Kowloon	204	40.8%
New Territories	152	30.4%

## **3.2 Examine the Associations among Citizens’ Preferences and Expectations for SC Services and Their Demographic Characteristics**

### **3.2.1 Defining Subpopulations**

After data collection, we conducted data analysis in three steps. The first step was to define subpopulations based on the distributions of demographic attributes and digital literacy. As shown in Table 8, we combined several attribute categories into groups to avoid defining any subpopulation around a very limited number of samples. These combinations of attribute categories were guided by authoritative literature. For example, we defined three subpopulations based on age groups, including young adults aged 18-39 (Prakken et al., 2011), middle-aged adults aged 40-59 (DiSilvestro et al., 2012), and older adults aged 60 and above (Forman et al., 1992). Similarly, we defined subpopulations with different income levels based on their average monthly household income and household size. Specifically, an individual was defined as having low income if their average monthly household income was less than the median monthly income of HK households with the same household size; otherwise, they were considered to have a high income (Census and Statistics Department [C&SD], 2021). In terms of digital literacy, we categorized citizens into three groups: citizens with

above-basic digital literacy, citizens with basic digital literacy, and citizens with below-basic digital literacy. This process led to the identification of the 10 subpopulations indicated in the fourth column of Table 8.

Table 8. The definition of subpopulations based on the respondents' personal and family information.

Factor	Attribute	Percentage	Subpopulation	Percentage
F1: Gender	Male	51.43%	Male	51.43%
	Female	47.39%	Female	47.39%
F2: Birthplace	Hong Kong	83.78%	Hong Kong	83.78%
	Other	15.09%	Other	15.09%
F3: Age	18-19 years old	0.55%	Young adults (18-39 years old)	35.54%
	20-29 years old	13.06%		
	30-39 years old	21.93%		
	40-49 years old	19.65%	Middle-aged adults (40-59 years old)	36.42%
	50-59 years old	16.77%		
	60-69 years old	16.08%	Older adults (60 years and older)	27.77%
	70-79 years old	8.40%		
	80 years old or above	3.29%		
F4: Education	Primary school or below	7.19%	Sub-degree or below	39.68%
	Junior Secondary (secondary one to three)	7.22%		
	Senior secondary (secondary four to seven/	11.88%		

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	Diploma of Secondary Education (DSE)/ Diploma Yi Jin)	Post-secondary education: Sub- degree (including higher certificate and higher diploma)	13.39%		
		Post-secondary education: degree	39.27%	Post-secondary education: degree	39.27%
		Post-secondary education: graduation and above	20.80%	Post-secondary education: graduation and above	20.80%

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F5:	Full-time	54.03%	Full-time	54.03%
Employment	employees		employees	
	Part-time	5.63%	Part-time and	45.97%
	employees		others	
	Employer	2.74%		
	Unemployment	3.27%		
	Students	3.32%		
	Housekeeper	4.28%		
	Retire	23.57%		
	No work due to	1.84%		

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	other reasons					
	Other		1.32%			
F6: District	Hong Kong		20.20%	Hong Kong		20.20%
	Island			Island		
	Kowloon		34.52%	Kowloon		34.52%
	New Territories		43.99%	New Territories		43.99%
F7: Monthly household income	Less than \$10,000		11.76%	Low-income level		39.84%
	\$10,000-19,999		8.71%			
	\$20,000-29,999		11.45%			
	\$30,000-39,999		12.07%			
	\$40,000-49,999		10.78%			
	\$50,000-59,999		8.66%			
	\$60,000-69,999		6.87%			
	\$70,000-79,999		4.69%			
	\$80,000-89,999		3.63%			
	\$90,000-99,999		2.49%	High-income level		60.16%
	Above \$100,000		11.47%			
	Unclear		7.43%			
F8: Family size/person	1		17.09%			
	2		21.14%			
	3		27.12%			
	4		20.69%			
	5		9.04%			
	>=6		4.91%			
F9: chronic disease(s) or family	Have No chronic disease(s)		82.67%	No chronic diseases and no family member(s) with		72.76%
	Have chronic disease(s)		17.33%			



member(s) with chronic disease(s)	No family member(s) with chronic disease(s) Have family member(s) with chronic disease(s)	80.76% 19.24%	chronic diseases Have chronic disease(s) or have family member(s) with chronic disease(s)	27.24%
F10: Belong to the disabled or there are disabled people in the family	Not disabled Disabled No disabled people in the family Have disabled people in the family	86.44% 13.56% 95.86% 4.14%	Not disabled and no disabled people in the family Disabled or have disabled people in the family	86.44% 13.56%
F11: Digital Literacy	No skills Limited Narrow Low Basic Above basic	4.56% 2.99% 2.33% 5.63% 13.58% 70.91%	Below basic Basic Above basic	15.51% 13.58% 70.91%

*Note.* The sums of percentages for some factors are not 100% due to some respondents declining to answer certain questions.

### 3.2.2 Preference Analysis

The second step involved examining citizens' preferences for SC services using the Bradley-Terry model (Bradley & Terry, 1952), a popular statistical method that determines the probabilities of each item – in this study, an SC service – being preferred over others through repeated pairwise comparisons (Agresti, 2012; Hunter, 2004; Kaye & Firth, 2017). For a given pair of SC services  $i$  and  $j$ , the Bradley–Terry model assumes:

$$P(i > j) = \frac{e^{\beta_i}}{e^{\beta_i} + e^{\beta_j}} \quad (1)$$

and

$$\log(P(i > j)) = \log\left(\frac{P(i>j)}{1-P(i>j)}\right) = \log\left(\frac{P(i>j)}{P(j>i)}\right) = \beta_i - \beta_j \quad (2)$$

where  $P(i > j)$  refers to the probability of service  $i$  being preferred to service  $j$ ;  $\beta_i$  can be interpreted as the “preference index” of service  $i$ ; and a higher  $\beta_i$  means that service  $i$  is more attractive. Assuming the independence of all pairwise comparisons, the parameter  $\beta_i$  ( $i = 1 \dots n$ , given  $n$  services) is estimated using the maximum-likelihood method. Because  $\beta_i$  is a relative rather than an absolute value, we can set the service  $k$  with the lowest ranking among  $n$  services as the baseline item and set its parameter  $\beta_k$  to zero. Then, the parameters of other services can be shown with positive values that reflect preference levels. Finally, we can obtain the preference index  $B_d$  for each dimension  $d$  as

$$B_d = \frac{\beta_1 + \beta_2 + \dots + \beta_m}{m} \quad (3)$$

where  $m$  represents the number of services in dimension  $d$ , and  $\beta_m$  represents the preference index of service  $m$  in dimension  $d$ .

### 3.2.3 Expectation Analysis

Our third data-analysis step was to examine citizens' expectations about SC services using a rank-ordered logit model: a standard statistical tool, based on random-utility theory, that is used to model the complete ranking of alternatives (Hossain & Fatmi, 2022). In the present study, such alternatives consisted of differing expectations about which human needs SC services would meet. Several studies have recommended the use of ranked-order logit models to achieve more accurate model estimation through

greater efficiency or lower asymptotic variance of maximum likelihood estimators (Johnson, 2023; Shahadat Hossain & Rahman Fatmi, 2022b). Here, each respondent  $p$  was asked to rank five SC expectations ( $Q = 5$ ) and the ranking choices were based on the respondent's perceived utility ( $\eta_{pq}$ ) of each such expectation  $q$  ( $q \in Q, q = Z$ ), i.e.,

$$\eta_{pq} = X_{pq}\beta + Z_p\alpha_q + \xi_{pq} \quad (4)$$

where  $X_{pq}$  are the choice-specific variables,  $Z_p$  the respondent-specific variables including demographic characteristics and digital literacy, and  $\xi_{pq}$  a random component deemed to be independent and identically distributed with an extreme value distribution. If we let  $Y_{pq}$  represent the ranking assigned to one of five SC expectations  $q$ , with an integer value ranging from one (highest ranking) to five (lowest ranking), we obtain an ordering vector of the set of five SC expectations  $Y_{pq} = (Y_{p1}, Y_{p2}, \dots, Y_{pq})'$ . And if we let  $r_{pq} = (r_{p1}, r_{p2}, \dots, r_{pq})'$ , where  $r_{pq}$  represents the SC expectation number that received rank  $q$  by respondent  $p$ , we can compute the probability of observing ranking  $Y_{pq}$  as follows:

$$\Pr [r_p] = \Pr [\eta_{pr_{p1}} \geq \eta_{pr_{p2}} \geq \dots \geq \eta_{pr_{pq}}] = \prod_{q=1}^{Q-1} \frac{\exp(X_{pr_{pj}}\beta + Z_p\alpha_{r_{pj}})}{\sum_{l=q}^Q \exp(X_{pr_{pl}}\beta + Z_p\alpha_{r_{pl}})} \quad (5)$$

Here, it should be noted that the present study mainly focuses on the influence of respondent-specific variables. All data analysis was conducted using the R programming language. Specifically, the Bradley-Terry model was run using the R package "BradleyTerry2" developed by Turner and Firth (2012), and the rank-ordered logit model was run using the R package "mlogit" developed by Croissant (2012).

## 4. Results

### 4.1 Citizens' Preferences for SC Services

Using the Bradley-Terry model, we estimated the preference indices of 48 SC services, with the service having the lowest ranking order serving as the baseline. The results are presented in Table A1. To facilitate the interpretability of these results, we have depicted the five SC services with the highest scores and the five with the lowest scores in Figure 4. As that figure indicates, our respondents preferred smart environment services the most, with this dimension containing three of the top five SC services: waste management, climate actions, and green/intelligent buildings. The third-rated SC service, belonging to the smart mobility dimension, was real-time traffic information; and the fourth, in the smart living dimension, was support for the elderly and persons with disabilities.

The COVID-19 exposure-notification service LeaveHomeSafe, from the smart combating COVID-19 dimension, was the least preferred. The second, third, and fourth least preferred were the smart prison service (smart government dimension), the smart crowd-management service, and the smart tourism service (both from the smart mobility dimension). The fifth least-preferred SC service was smart customs (smart economy).

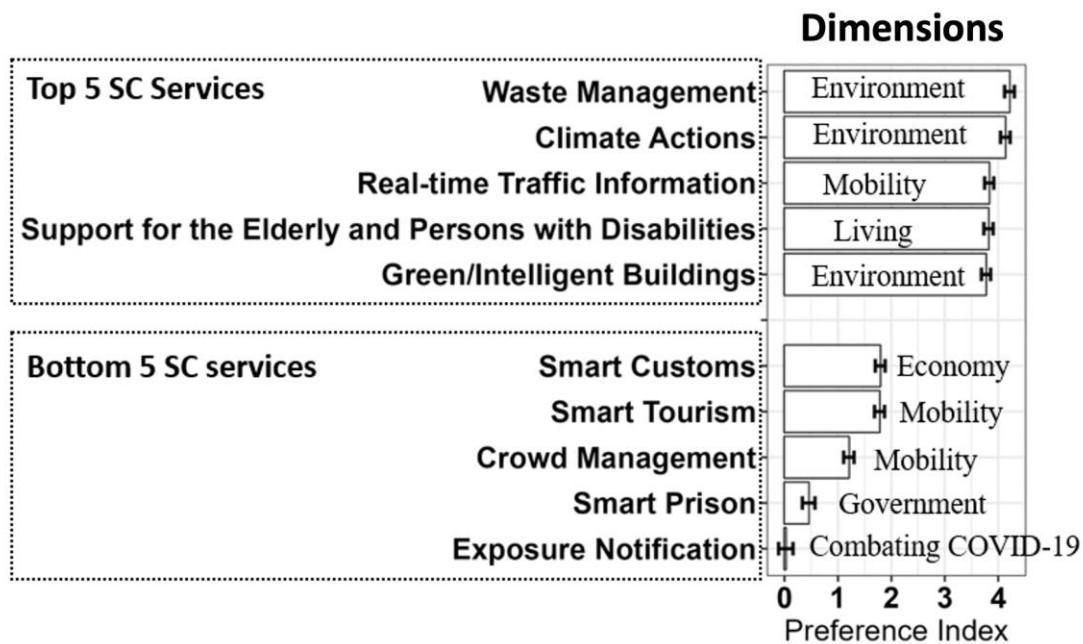


Figure 4. Hong Kong's top five and bottom five smart-city services, based on residents' preferences.

In addition to the respondents' preferences for individual SC services, we were able to capture their preferences for seven SC dimensions. Figure 5 presents the preferences expressed about the seven SC dimensions by age, digital literacy, and income. In it, we can observe two major patterns. First, for all age, income, and digital literacy groups, the smart environment dimension was the most preferred, and smart combating COVID-19 was the least preferred. The inter-group differences in relative preferences for the other five SC dimensions were non-significant, and those between the smart living and smart people dimensions were especially small. Second, differences in relative preferences for the seven SC dimensions were smaller among respondents who were older, less digitally literate, and on lower incomes.

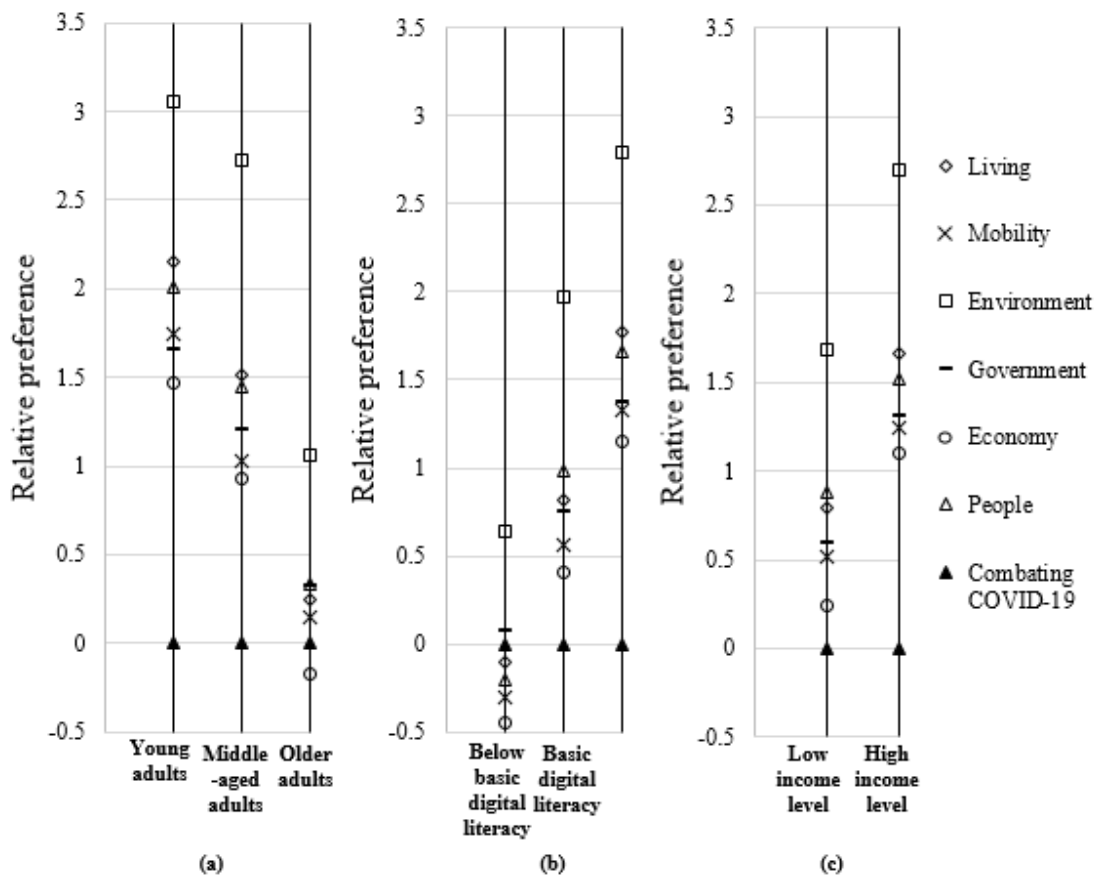


Figure 5. Hong Kong residents' relative preferences for smart-city service dimensions by (a) age, (b) digital literacy, and (c) income.

*Note.* The baseline SC dimension is Smart Combating COVID-19, whose preference index was set as zero.

We also investigated how population heterogeneity could influence preferences for individual SC services within one dimension. Taking the smart environment dimension as an example (Figure 6), we observe that waste management service and climate action

service are the top two preferred SC services for all age, income, and digital literacy groups, except for people with below basic digital literacy and older adults, who preferred pollution monitoring service over climate actions service. It is noted that most people with below basic digital literacy are also older adults (as indicated in Figure A.1). Perhaps older adults are more concerned about the air and water quality in their immediate surroundings, rather than focusing on global climate issues.

The green/intelligent buildings service was the least preferred among older adults, people on low incomes, and people with lower levels of digital literacy. A possible reason for this is these people have little knowledge of how green building design technology enhances the energy efficiency of buildings compared to middle-aged adults and people on high incomes. In contrast, the pollution-monitoring services were the least preferred services in the smart environment dimension among middle-aged adults, high earners, and people with above basic levels of digital literacy, conceivably because these three groups had experienced fewer negative health effects of air pollution.

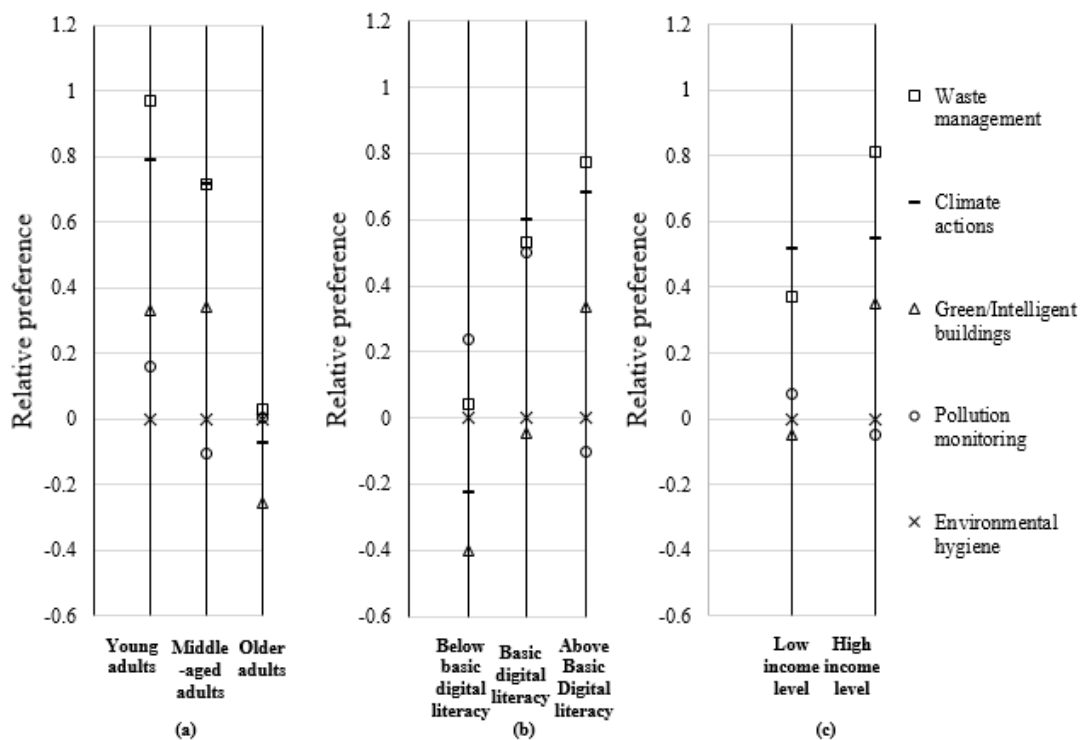


Figure 6. Respondents’ preferences for smart environment services by (a) age, (b) digital literacy, and (c) income.

*Note.* The baseline SC service is environmental hygiene, whose preference index was set as zero.

#### 4.2 Citizens’ Expectations for SC Services

Using a percentage-stacked bar chart (Figure 7), we visualized the relative contributions of different expectations about SC services to each ranking. From this chart, it can be observed that more than 50% of respondents expected SC services would help them realize their physiological needs, followed by their safety, esteem, self-actualization, and social needs. Social needs contributed most to rank-five expectations, with more than 30% of respondents reporting that realizing such needs was the least urgent use of SC services.

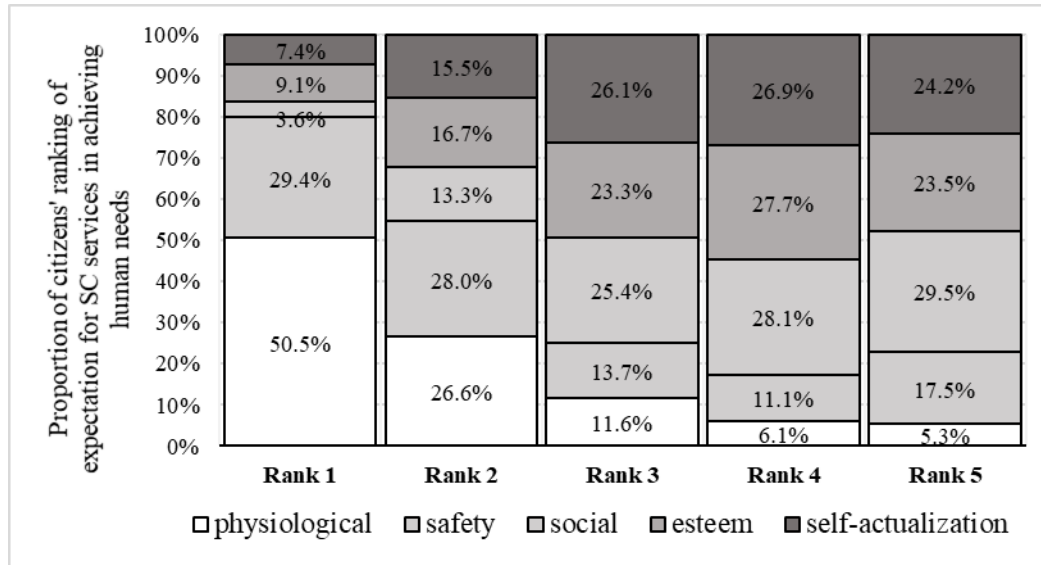


Figure 7. Distribution of the ranking of expectations for SC services in achieving human needs.

We analyzed HK citizens' expectations about SC services helping them realize five types of human needs using a rank-ordered logit model, as indicated in Table 9. We found that they most strongly expected the use of SC services to serve their physiological needs (rank=1), followed by safety needs, self-actualization needs, social needs, and esteem needs. This ranking of needs differs slightly from Maslow's (1943) hierarchy of needs, which posits that self-actualization needs come last. Table 9 also shows that there were statistically significant differences in the respondents' expectations that SC services would meet their human needs among different gender, education, age, and birthplace groups ( $p < 0.05$ ).

Specifically, as compared with males, females were more likely to have higher expectations that SC services would realize their safety needs (OR = 1.17,  $p = 0.019$ ) and lower expectations that such services would help them self-actualize (OR = 0.68,  $p = 0.000$ ), feel esteem (OR = 0.79,  $p = 0.001$ ), or have their social needs met (OR = 0.78,

$p = 0.000$ ). Compared with young adults, older adults are less likely to have higher expectations for SC services in realizing self-actualization needs ( $OR = 0.74, p = 0.006$ ). Respondents with college degrees or above were more likely than their less-educated counterparts to have high expectations that SC services would help them with their self-actualization ( $OR=1.25, p=0.025$ ), social ( $OR=1.31, p=0.006$ ), and esteem needs ( $OR=1.31, p=0.006$ ). Finally, compared with native-born citizens, immigrants are less likely to have higher expectations for SC services in realizing self-actualization needs ( $OR = 0.74, p = 0.006$ ).

Table 9. The results of the rank-ordered logit model for citizens' expectations for SC services in realizing five human needs.

<b>Rank</b>	<b>Human need</b>	<b>Frequencies</b>
1	Physiological	0.231
2	Safety	0.211
3	Self-actualization	0.191
4	Social	0.184
5	Esteem	0.183
<b>Coefficients*</b>		
	OR (95%CI)	P value
<b>Intercept</b>		
Physiological	1	
Self-actualization	0.58(0.33-0.99)	0.047*
Esteem	0.44(0.26-0.76)	0.003**
Safety	0.35(0.21-0.59)	0.000***
Social	0.56(0.32-0.96)	0.035*
<b>Gender</b>		
Male	1	
Female:		
Self-actualization: Physiological	0.68(0.59-0.77)	0.000***
Esteem: Physiological	0.79(0.70-0.91)	0.001***
Safety: Physiological	1.17(1.03-1.33)	0.019*
Social: Physiological	0.78(0.68-0.89)	0.000***
<b>Birthplace</b>		
Hong Kong		
Others		
Self-actualization: Physiological	0.74(0.60-0.92)	0.006**
<b>Age</b>		
Young adults	1	
Older adults		
Self-actualization: Physiological	0.76(0.61-0.96)	0.021*
<b>Education</b>		
Sub-degree or below	1	



Post-secondary education: degree			
	Self-actualization: Physiological	1.24(1.04-1.47)	0.015*
	Safety: Physiological	0.84(0.71-1)	0.045*
Post-secondary education			
	Self-actualization: Physiological	1.25(1.03-1.52)	0.025*
	Esteem: Physiological	1.31(1.08-1.6)	0.006**
	Social: Physiological	1.31(1.08-1.6)	0.006**

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Log-Likelihood: -14076

Likelihood ratio test:  $\chi^2 = 12904$  (p-value =  $< 2.22e-16$ )

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*Note.* OR refers to odds ratio and CI refers to confidence interval.

## 5. Discussion

Five major findings were derived from the answers to our research questions. The first is that the respondents have a strong preference for smart environment services, given that three out of five most preferred SC services – waste management, climate action, and green /intelligent buildings – were in the smart environment dimension. The strength of this preference may be due to HK citizens' high awareness of environmental protection and reflect that HK, as a highly dense city, is confronting a variety of environmental challenges, particularly involving waste management, air pollution, and energy consumption (Govada et al., 2017; Lai, 2022). In 2021, for example, the total weight of solid waste disposed of at the city's strategic landfills was 5.67 million tons, or 15,533 tons per day: an increase of 5.4% on the previous year (EPD, 2021). Moreover, PM<sub>2.5</sub> concentration in Hong Kong is 4.7 times the World Health Organization's air-quality guideline value (IQAir, 2023). To tackle these challenges, HK's government has launched a series of environmental initiatives, including the Energy Saving Plan for the Built Environment 2015-2025+, the Biodiversity Strategy and Action Plan, and the Hong Kong Waste Reduction Website. Against this backdrop, most HK citizens are likely to be aware of the importance their government assigns to protecting the environment using smart technologies and to share its desire for further enhancement to smart environment services and the development of new ones. This would be consistent with the findings of prior studies by Wirtz et al. (2022) and Chen and Chan (2022). The former found that smart waste/recycling services were among the five top-rated SC services in Germany, and the latter, that Macao citizens were very interested in how new technologies were being used to improve waste management, water management, urban planning, air quality and energy efficiency.

Our second major finding is that the respondents are more likely to prefer those SC services that are more closely bound up with their day-to-day lives, expected to have long-term impacts on communities, and/or that serve large user groups. Looking at each SC dimension, we found that our respondents had stronger preferences for smart living and smart people services than for smart economy services. This may have been because the SC services in the two former dimensions, e.g., the use of ICTs to support the elderly and persons with disabilities, were more likely to be used and experienced in daily life. This echoes findings by Oh (2020) that Korean citizens prefer SC services closely linked to their everyday lives. The HK residents we sampled expressed the least

interest in the smart combating COVID-19 dimension. Although the COVID-19 pandemic is an important issue, they may have perceived combating it as a short-term solution to a specific problem, rather than something that would have long-lasting impacts on their local communities. Given that our survey was conducted almost three years after the COVID-19 outbreak, they could also have perceived that efforts to combat the pandemic were sufficient. In this context, it is worth noting that the HK government eliminated the requirement for mandatory scanning of QR codes for COVID-safe travel in December 2022 (Office of the Government Chief Information Officer [OGCIO], 2022). The idea that the respondents preferred SC services that can serve a wide range of people can be confirmed via a comparison of the top five and the bottom five SC service preferences. For example, among the bottom five, smart prison and smart airport services mainly serve people in prison and those who need to travel by plane, while smart crowd-management service chiefly serves those people who attend occasional large events. The top five services, in contrast, have much larger user groups: with the top three benefiting everyone in the city, and the real-time traffic information service those who rely on public transport to commute: i.e., more than 92% of the population (SRD, 2023).

Third, we found that at higher ages, digital literacy was weaker; and that at lower income levels, the respondents' preference differences among the seven SC dimensions were smaller. This was probably because older people, people with limited digital literacy, and people with low incomes are more likely to have poor knowledge of SC services (Wang & Wu, 2021), which could make it difficult for them to distinguish which SC services they prefer. Some SC services such as digital payments and e-government services are often delivered through digital devices and require Internet usage, but older adults tend to be relatively unfamiliar with digital devices, relatively unlikely to be exposed to new technologies, and relatively limited in their experience of Internet use (Friemel, 2016; Lüders & Gjevjon, 2017). Similarly, people with low digital literacy have limited skills and competencies to perform tasks and solve problems in digital environments and may struggle to navigate the digital interfaces of smart applications (Reddy et al., 2020). Notably, old age, low income, and low digital literacy tend to go hand in hand (Bélanger & Carter, 2009; Hacker & Dijk, 2000; Perrin, 2015; Seo et al., 2017).

Fourth, the HK residents we sampled expressed higher expectations that SC services

would help them realize their self-actualization needs than their social or esteem needs, despite Maslow's (1943) hierarchy theory holding that self-actualization needs are the least critical. One possible reason for this is that HK citizens attach great importance to reaching their full potential for creativity, self-fulfilment, and personal growth by taking advantage of SC services. They hope the local government can develop a creative and engaging city with open-minded, tolerant, and diverse pools of talent (Florida, 2014). When surrounded by a culture of tolerance for ambiguity and respect for diversity, citizens' creativity and innovation potential can be motivated, and such an innovative social culture provides citizens with rich opportunities for work and personal development (Frodeman et al., 2017; Marcos Lima, 2020). Another possible reason is that HK is a city with a high degree of autonomy, and in which public participation plays an essential role in urban development. In that context, HK citizens tend to have a strong desire to participate in public affairs to benefit their personal development. Such an interpretation echoes a prior survey-based study by Zhang et al. (2019) on urban residents' demand for intelligent SC functions, which reported self-actualization as the *most* desirable such function. Our finding is also in line with one by Ban et al. (2022), who surveyed perceptions of the attributes of Oradea as an SC, and found that citizen engagement in public decisions through the use of ICTs was perceived as one of the top three most important attributes.

Finally, the sampled HK residents' expectations about SC services' fulfilment of their human needs varied by subpopulations of gender, education, age, and birthplace. Specifically, as compared to men, women had higher expectations that SC services would meet their safety needs, but lower expectations that such services would help with their self-actualization, esteem, and social needs. This might be a reflection of women assigning greater importance to safety needs due to generally being not as physically strong as men and more likely to experience violence or harassment, especially in public places at night (Hyndavi et al., 2020). Men, meanwhile, may have higher expectations that SC will enable them to form emotional connections and achieve personal development due to societal expectations and gender norms, as they tend to be socialized to prioritize success, achievement, and independence (Kirkwood, 2016). Our finding that better-educated people were more likely to have high expectations that SC services would help them realize their self-actualization, social, and esteem needs could have been because such individuals have greater exposure to

smart technologies and more access to educational resources and training, which in turn could have led them to have a better understanding of how SC services might satisfy their higher-level human needs (Wirtz et al., 2022). Additionally, citizens with higher education levels are more likely to participate in community and civic activities, which could increase their desire to achieve personal development and realize social value through using SC services (Schulte, 2018). The lower expectations of older adults for SC services to realize their self-actualization needs can be explained by the fact that they are at a different life stage where retirement and leisure activities are their major focus, while young adults focus more on career development and personal growth (Ivtzan et al., 2013). Similarly, compared to native-born citizens, immigrants are less likely to have high expectations for SC services to realize their self-actualization needs. This could be because many immigrants may perceive themselves as being at a disadvantage compared to native-born citizens (Law & Lee, 2006). In addition, low socioeconomic status and low levels of political participation among immigrants could also contribute to their lower expectations for SC services to realize their self-actualization needs in HK (Li & Jones, 2020).

## 6. Policy Implications and Policy Recommendations

In line with the above findings about heterogeneous groups of HK residents' SC service preferences and expectations, we can make the following four policy recommendations regarding the strategic positioning of SCs to HK's city administrators. It is also suggested that relevant administrators be informed of these policy recommendations in the hope that these administrators are more well-acknowledged with and benefit from the found citizens' preferences and expectations about the SC services relevant to these administrators.

1. The first is that *enhance SC services in Smart Environment dimension*, particularly for services of waste management, climate action, and green/intelligent building. HK, as one of the most densely populated cities in the world, inevitably experiences various environmental challenges, including air pollution, waste-disposal problems, and energy shortages. Since HK residents have strong preferences for smart environment services and express the highest expectations for SC services in meeting their physiological needs, it is suggested that more measures could be taken to improve environmental quality through smart technologies: for example, enhancing the usage of internet-connected trash cans and Internet-of-Things-enabled fleet-management systems for waste collection and removal, or using sensors to measure water parameters and guarantee the quality of drinking water at the front end of the system, with proper wastewater removal and drainage at the back end. The heavy investment would be required to bring waste management up to the same standard as Singapore, which boasts an overall recycling rate of 60% (Carrière et al., 2020).

For the above-mentioned waste-management-related services, the Environmental Protection Department (EPD) in Environment Bureau has issued the “waste blueprint for Hong Kong (2035)” as part of the waste management service. Conveying the findings that citizens have a high preference for waste management services could help EPD to better promote and facilitate their waste-reduction and -management services to the public. This finding could also be shared with the relevant authorities to collaborate with EPD, such as Health Bureau (HB) helping to turn source-separated food waste into useful resources by advanced biological treatment technologies. Additionally, the Architectural Services Department (ASD) could contribute by converting restored landfills into recreational facilities such as recreational grounds, sports facilities, parks, etc.

More investment can be allocated to energy-saving and climate-action services, such as reducing power generation from coal and switch to natural gas/renewables by new technologies, e.g., using sludge for general electricity and turning waste into energy. HK's government has been developing and implementing SC initiatives for energy saving, as indicated in its Energy Saving Plan for the Built Environment 2015-2025+, which sets out policies, strategies, and targets aimed at reducing energy use to 40% of the 2005 level by 2035. Also, recognizing the findings that citizens have a strong preference for energy-saving and climate-action services, it would be beneficial for various relevant authorities, including the Environment and Ecology Bureau (EEB), Transport and Logistic Bureau (THB), Health Bureau (FHB), Development Bureau (DB), Electrical and Mechanical Services Department (EMSD) and Architectural Services Department (ASD), to integrate their efforts. These efforts could focus on providing low-carbon living, saving energy, green office management and greener transportation. It is also significant to communicate the citizens' intense preference for green/intelligent building services to the Buildings Department (BD), Home Affairs Department (HAD) and the Hong Kong Green Building Council (HKGBC). Such communication could motivate these authorities to strengthen collaboration in the SC services related to green building development.

2. Second, because our respondents reported stronger preferences for SC services that are closely tied to their daily lives, have long-term impacts on their communities, and can be used by a wider array of people, it is suggested to *focus on SC services with long-term impacts and serving wider user groups*. Notably, such services include the environmental ones discussed in the previous paragraph. The HK government could therefore invest in environmental protection by funding research on renewable-energy technologies, creating incentives for companies to reduce their carbon footprints, and implementing policies that promote conservation and sustainable resource use (see also Soundarajan & Vivek, 2016). Because people prefer SC services that are closely linked to their daily routines, more resources could be allocated to the development of smart waste-management systems capable of optimizing waste-collection schedules, reducing waste volumes, and improving recycling rates, e.g., through the use of smart waste bins, waste-sorting robots, and real-time waste tracking (Fatimah et al., 2020).

Additionally, it can be useful to enhance smart public-safety systems that improve emergency-response times, reduce crime rates, and protect public safety, e.g., via smart

surveillance cameras, real-time crime mapping, and emergency-response alerts. Priority could also be given to SC services that serve a wide range of people, such as smart public services that improve service delivery, reduce costs, and enhance citizen satisfaction. These could include SC kiosks, mobile apps for making service requests, and digital portals for accessing government services (Nesi et al., 2016).

3. Third, in line with Maslow's (1943) hierarchy theory, HK citizens ranked physiological and safety needs as the first and second most important for SC services to satisfy; accordingly, it is suggested to *increase citizens' acceptance of SC services by fulfilling their physiological, safety, and self-actualization needs*. As suggested by Ji et al. (2021), physiological and safety needs can be satisfied by SC services in the hard dimensions, including smart environment, smart safety, and smart health. For example, to fulfil citizens' physiological needs, sensors and data-analytic technologies could be enhanced to monitor the air and water quality in the city, and alert residents to potential health hazards. To cater to people's safety needs, surveillance cameras equipped with video analytics could be enhanced to detect suspicious behaviors and alert authorities to potential threats in real time.

In addition to these two fundamental needs, our respondents exhibited a relatively high expectation that SC services would help them realize their self-actualization needs. To fulfil this widely perceived promise, residents can be offered more new ways of participating in decision-making (e.g., electronic voting), and develop new employment opportunities that will help them realize their true potential by contributing to SC development (Leung & Lee, 2023b). More opportunities are suggested to be created for young people to practice in technology companies and provide subsidies to encourage companies to hire graduates for technology research and development. It is also important to continue attracting and retaining talents in innovation and technology fields, such as biotechnology, artificial intelligence, and cybersecurity, to foster a creative and vibrant society that can contribute to the realization of citizens' self-actualization needs.

4. Fourth, we found that the sizes of people's preference differences among the seven studied SC dimensions were markedly smaller if they were older, low-income, and/or low in digital literacy, with many answering "I don't know" to pairwise service-comparison questions; thus, it is essential to *disseminate SC knowledge among digitally*



*marginalized groups*. Because they lack baseline knowledge and experience of SC services, the voices of these groups are usually ignored in SC development (Kolotouchkina et al., 2022; Mullick & Patnaik, 2022; Shin et al., 2021).

Since 2014, HK's Office of the Government Chief Information Officer (OGCIO) has launched four rounds of an ICT Outreach Program for the Elderly, which provides funding to nongovernmental organizations that teach the elderly how to use tablets and other mobile devices and/or help them to better understand how digital technologies could enhance their quality of life (OGCIO, 2012). From December 2018 to April 2021, the Outreach Program served more than 7,300 senior citizens in HK, but this is still far cry from the 1.45 million who live there (OGCIO, 2012). More steps could be taken to promote SC knowledge among older people. This can be achieved by providing more education and training programs that promote social learning through community workshops, and by providing regular updates on the state of SC and ICT development. Additionally, it is important to extend digital inclusion initiatives in the OGCIO to ensure that older adults are not left behind in the digital age.

## **7. Public Dissemination**

The research findings were disseminated through two different channels: government channels and community channels. Regarding the government channels, as this project is directly related to public policies and the findings can serve as references for policymakers, the research team shared the research findings with relevant government bodies by holding a university forum and discussing the implications for policy and practice. This forum took place on March 15, 2023, at Block Z, Department of Building and Real Estate, the Hong Kong Polytechnic University, and was attended by over 20 university staff and students, as well as two government officials. The officials included Mr. CHAN Yue Chun, Head of the Spatial Data Office, and Ms. WONG Pui Yu, Senior Land Surveyor, from the Development Bureau, Planning and Lands Branch. They are responsible for overseeing the Common Spatial Data Infrastructure, which provides public and private organizations with an information infrastructure to promote sharing of spatial data and support the development of various SC applications.

The project also aimed to raise awareness about community development among residents in various neighborhoods through the usage of SC services. Therefore, we shared the preliminary findings through community workshops. Three workshops were held in different communities in HK. The first workshop took place on 28 November 2022 at the Hong Kong Young Women's Christian Association Kwun Lung Lau Community Work Office, with 20 elderly attendees. The second workshop was held on 1 December 2022 at the Pong Wing Siu Neighborhood Elderly Center with 19 elderly attendees. The third workshop was held on 12 January 2023 at the Neighborhood Advice-Action Council Mrs. Bai Bishop Elderly Center with 20 elderly residents in attendance. The elderly attendees reported that they gained valuable knowledge about SC services from these workshops.

## **8. Conclusion**

People-centric smart city (SC) development requires city administrators to consider citizens' preferences and expectations for SC services to meet their needs. The present study surveyed 5,004 citizen respondents regarding their preferences for 48 SC services across seven dimensions, as well as their expectations for SC services in realizing their human needs. The associations between citizens' preferences and expectations for SC services and their demographic characteristics were explored.

We found that smart environment was these sampled HK residents' most preferred SC service dimension. Indeed, waste management, climate action, and green/intelligent building services were the three of the top five preferred services, and all are part of that dimension. The strength of this preference may be ascribable to HK residents' high environmental awareness. However, there is still room for improvement in the smart environment dimension. The respondents also showed relatively strong preferences for SC services that are closer to their daily lives, have long-term impacts on their communities, and serve broader arrays of people. This implies that resources could be allocated to those SC services that possess these characteristics, such as the smart living and smart people dimensions. In addition to physiological and safety needs, the sampled HK residents reported relatively high expectations that SC services would help them realize their self-actualization needs. It is recommended to enhance SC services that can offer citizens more opportunities to participate in public affairs and create more opportunities for young people to become involved in the innovation and technology fields. Finally, we demonstrated that older people, people with lower digital literacy, and people on lower incomes were less able to decide which of the seven SC dimensions was more important to them. Therefore, it is suggested to disseminate SC knowledge among these digitally marginalized groups through community workshops.

The proposed study has multi-faceted implications for HK's future people-centric SC development policy. Firstly, the findings about HK citizens' SC-service preferences can provide useful guidelines for the government's strategic positioning of SC, helping to inform investment priorities and resource allocation. Secondly, understanding HK citizens' expectations of SC services from the perspective of needs theory can help reveal the motivations and other driving forces that underlie the usage of such services. Overall, it is hoped that equipped with knowledge of the results of the present study, urban planners, city administrators, SC-service designers and providers will be able to

tailor SC services to meet the needs and expectations of HK citizens, boost the usage of such services, and thereby improve citizens' well-being and quality of life.

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## Appendix

Table A.1. Ranking of smart city services preferred by HK citizens.

Services	Preference Index	S.E.	Dimensions
Waste Management	4.211	0.092	Environment
Climate Actions	4.132	0.090	Environment
Real-time Traffic Information	3.832	0.086	Mobility
Support for the Elderly and Persons with Disabilities	3.818	0.086	Living
Green/Intelligent Buildings	3.771	0.086	Environment
Pollution Monitoring	3.606	0.086	Environment
Environmental Hygiene	3.600	0.087	Environment
Real-time Adaptive Traffic Signal System	3.539	0.084	Mobility
Dangerous Drugs Management	3.517	0.088	Government
Smart Drainage Services	3.447	0.088	Government
Building Information Modeling	3.437	0.088	Government
Youth IT Internship and Research Talent Hub	3.388	0.091	People
STEM Education	3.352	0.091	People
Support for Healthcare	3.214	0.083	Living
Intelligent Sports and Recreation Services Booking	3.150	0.082	Living
Open Data Service	3.145	0.085	Government
Smart Water Supply	3.039	0.087	Government
Wi-Fi Connected City	3.000	0.000	Living
Attract IT-professionals	2.997	0.091	People
Free-Flow Tolling Service	2.914	0.083	Mobility
Innovation and Entrepreneurial Culture	2.887	0.092	People
R&D and Reindustrialisation	2.883	0.089	Economy
Friendly Environment for Pedestrians and Cyclists	2.861	0.084	Mobility
eID	2.694	0.083	Living
Urban Collaboration for Innovation	2.664	0.087	Government
Environmental Friendliness in Transport	2.626	0.084	Mobility
Digital Government Service	2.606	0.086	Government
Innovation and New Economy	2.563	0.090	Economy
Digital Health Declaration	2.561	0.094	Combating COVID-19
Network Security	2.554	0.086	Government
Smart Library	2.545	0.082	Living
Hiking Positioning	2.489	0.083	Living

Public Space Disinfection	2.478	0.094	Combating COVID-19
IT Training for Civil Servants	2.418	0.093	People
5G Mobile Technology	2.369	0.086	Government
FinTech	2.296	0.090	Economy
Signboard Control	2.255	0.089	Government
Digital Payment	2.191	0.085	Living
LawTech	2.184	0.091	Economy
Deterrence of Traffic Offences	2.114	0.086	Mobility
Blockchain Certificate Platform	2.001	0.095	People
Autonomous Vehicles	1.948	0.088	Mobility
Smart Airport	1.792	0.090	Mobility
Smart Customs	1.790	0.092	Government
Smart Tourism	1.779	0.093	Economy
Crowd Management	1.205	0.096	Mobility
Smart Prison	0.453	0.117	Government
Exposure Notification	0.025	0.136	Combating COVID-19

Note. S.E. refers to standard error.

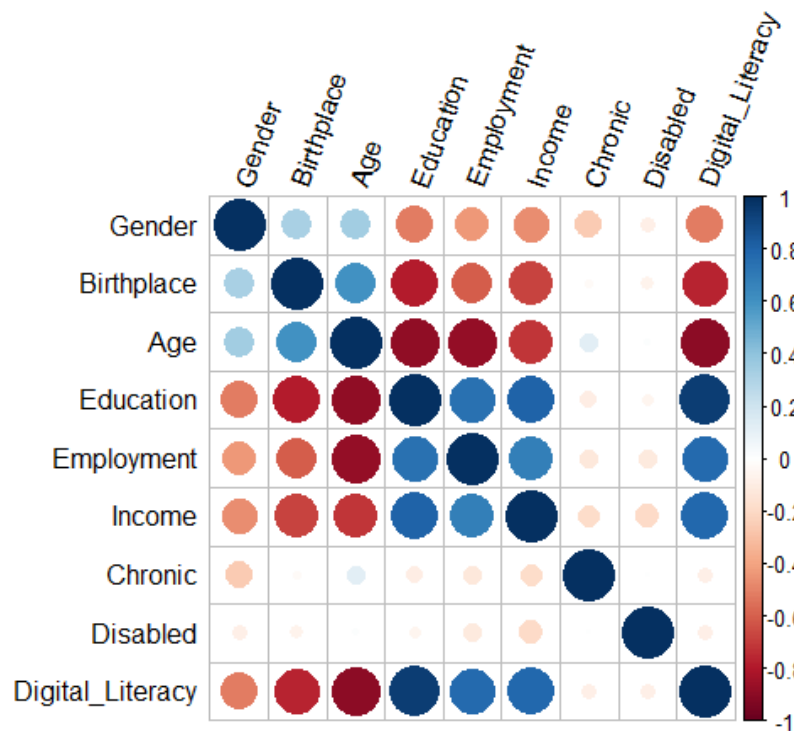


Figure A.1. Correlation matrix of demographic characteristics and digital literacy.

Note. In this plot, correlation coefficients between factors are colored according to the value, where blue color indicates a positive correlation, while red color indicates a negative correlation. The size of the circles reflects the strengths of the correlated relationships, where the stronger the relationship, the size is larger.