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ASSESSING THE IMPACT OF PUBLIC INFRASTRUCTURE ON NEIGHBOURHOOD LIVEABILITY IN CYBERJAYA, MALAYSIA: A GLOBAL TECHNOLOGICAL HUB

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Abstract: The phenomenon of rapid urbanisation that has occurred since the 1950s has presented opportunities for growth and innovation in cities, primarily through the utilisation of urban agglomerations and economies of scale. Urban areas encounter diverse obstacles that restrict their ability to provide services to inhabitants and hinder the achievement of a sustainable urban future for the residents. This research examines the issue of urban functional weakness, with a specific emphasis on the emergence of a global technology hub such as Cyberjaya, Malaysia. This study analyses the relocation behaviours of the residents, with a focus on the international community, and it identifies the inadequate public infrastructure as the primary factor contributing to liveability issues within the urban area. This study employs a mixed-methods approach, utilising both quantitative data collection and in-depth interviews, to support its findings. This study examines the impact of social variables and public infrastructure on neighbourhood liveability and design quality. The findings suggest that social variables play a significant role in neighbourhood liveability, while public infrastructure has a positive effect on both liveability and design quality.

Keywords:

public infrastructure; technology hub; international community; quality neighbourhood design; neighbourhood liveability

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Introduction

Rapid urbanisation has caused problems for urban planning and design because cities lack the dynamism, efficiency, and ability to meet citizen needs and to provide comfort, safety, and welfare. Cities have become prisons, harming psychology, emotions, morals, and core human values (Zhang et al. 2019). Urban planners worry about the steep deterioration in urban living standards (Pacione 2003) while residents' needs must be considered to make cities habitable as understanding citizens' needs helps development succeed (Elliott 2008). Resident satisfaction is complex and impacted by both objective and subjective aspects, and urban and municipal services affect inhabitants' satisfaction and opinions in relation to temporal-spatial, social, economic, cultural, and physical factors (Bernhard et al. 2018). Close community interactions improve the inhabitants' happiness with the neighbourhood and services, so, while modern cities have better sanitation (sewage, garbage collection, and infrastructure) and services (police stations, fire stations, and health), the residents feel less connected to the neighbourhood and the local community (Dassopoulos et al. 2012).

Previous studies found that tangible elements improve resident satisfaction and quality of life the most (Smith et al. 1997). This study shows that residents' environmental impressions matter more. According to Holbert et al. (2021), neighbourhood satisfaction, which is correlated with urban liveability, is influenced more by social factors than physical ones. But, as public infrastructure is lacking in new communities, the human life cycle requires infrastructure planning and design. De Guimarães et al. (2020) describe infrastructure as a combination of facilities and services provided by the government, designers, and planners to cities and their residents so that they may use all areas of the city. However, the lack of attention to public infrastructures related to sociological and psychological understanding of the complex individual and social needs of contemporary humans for their neighbourhood appears to be the greatest obstacle in relation to contemporary space design (Dantas et al. 2021).

Public infrastructure (hard and soft infrastructure) in neighbourhood areas is generally used to improve urban liveability (Yeon et al. 2018, Ngeow 2021). However, research on how high-quality public infrastructure in residential neighbourhoods affects the viability and happiness of international Cyberjaya inhabitants is lacking, especially from the perspective of less-habitable societies (Zheng et al. 2020, Mirzahossein and Mohghaddam 2021). To address these concerns, this article examines the Cyberjaya neighbourhood liveability and the public infrastructure provision determinants.

Public infrastructure

The quality of public infrastructure increases the quality of life (Yhee et al. 2021). Transportation, communication, sewage, water, and power are all considered

"infrastructure" (Sobnath et al. 2020). These systems boost city capacity and liveability so that, for liveability, sustainability, safety, and quality of life, all cities need an infrastructure foundation (McShane and Coffey 2022). A study found that public infrastructure supports a city's long-term population as it improves city life (Layton and Latham 2022).

To address urbanisation, public policy and society need smart city initiatives (Shehab et al. 2022). Smart technology is part of sustainability, resilience, and liveability to build future cities (Kutty et al. 2022). Soft infrastructure — arts, cultural institutions, public space, and amenities — is considered important for economic growth and creativity, and the internet of things and ICT are among the components of required urban architecture and planning (Cities Alliance 2019). Figure 1 depicts the conceptual framework for the interaction of hard and soft connectedness and the network infrastructure needed to construct urban systems, and it also improved the public infrastructure needed by Cyberjaya neighbourhoods to promote liveability.

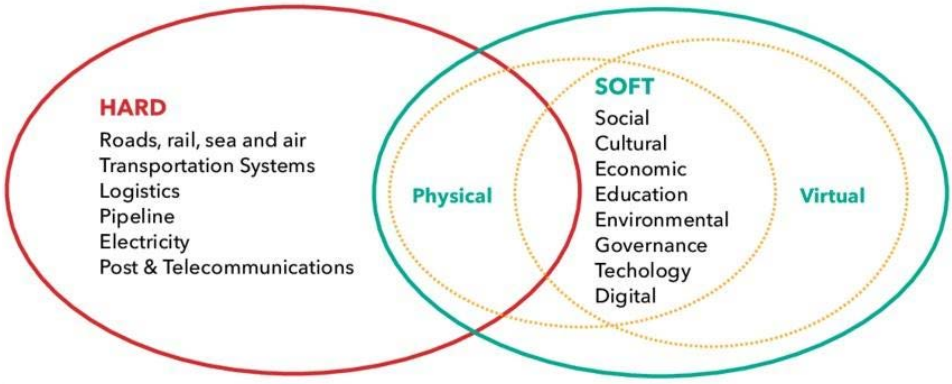

Figure 1. Framework of the interrelationship between hard and soft connectivity and network infrastructure
Source: Cities Alliance (2019)

On the one hand, hard connectivity consists primarily of physical connections: networks of transportation, communication, and utility services that link communities (Cities Alliance 2019). On the other hand, a variety of other political, economic, social, and cultural factors determine the characteristics of hard connections (Cities Alliance 2019). Also, a soft connection is characterised by both virtual and physical characteristics, while virtual features manifest themselves in a variety of ways, including transfers or transactions of intangible capital, ideas, information, and data, as well as knowledge exchanges between governments, organisations, and communities, and the relationship is technological rather than physical (Cities Alliance 2019). Also, online education, blogging, and social media are greatly increasing access to and the breadth and depth of vital information, knowledge, and experience for human capital development, social development, and local economic growth (Cities Alliance 2019).

Cyberjaya, a technology hub, requires the presence of both soft and hard infrastructure for its sustenance. Inequity in fair distribution arises from an imbalance between these two groups. International citizens express dissatisfaction with smart city living based on their subjective opinions. Cyberjaya, a technology hub located on the outskirts of Kuala Lumpur, was originally a large expanse of land covered in natural vegetation before undergoing urban development.

The concept of developing a smart centre with an emphasis on economic growth is aligned with the fundamental principles of smart city models and it reflects the neoliberal ideology. Ortiz-Báez et al. (2022) argue that land use changes in urban areas are indicative of the influence of neoliberalism on urbanisation. The conversion of natural land, including green areas and agricultural land, to urban expansion on the outskirts of cities can have notable impacts on the quality of urban life. Over time, these changes can impact the environmental, economic, and social policies of the city, potentially leading to shifts in political positions regarding future city plans. One important aspect that has been noted is the necessity of urban development towards the suburbs in order to establish adequate infrastructure and to prevent the emergence of low-quality living conditions and welfare deprivation in these areas. Physical and social infrastructures play a crucial role in the growth of urbanisation by supporting sociological approaches. Urban transportation infrastructures have significantly influenced land use patterns by facilitating the concentration of construction activities along major arterial routes connecting cities. However, it is crucial to ensure that these connections are designed in a manner that minimises the fragmentation of urban development. Disruption in the context of urban expansion can lead to the proliferation of low-quality settlements in suburban areas. The limited functionality of urban infrastructure has implications for the quality of life and well-being of the residents, as well as the long-term growth and sustainability of urban areas (Borsdorf 2003, Ortiz-Báez et al. 2022).

In addition to public amenities, a pleasant view, and quality schools are factors that contribute to the desirability of a neighbourhood. The quality of a neighbourhood is determined by various factors, including the presence of facilities and other contextual factors (Li et al. 2019, Kim et al. 2020). Kerimoglu and Ekinci (2021) argue that urban innovation on both regional and global scales can be facilitated by technological and economic advancements, as well as the availability of adequate social and physical infrastructure. In prosperous and liveable innovative global cities, a diverse range of public urban infrastructures contributes to their complex and well-maintained infrastructural structure. The infrastructures considered in this study encompass high-tech exports, patent counts, and the number of entrepreneurs. Additionally, the social and physical environment is considered, which includes the number of libraries, art galleries, festivals, opera houses, green buildings, and foreign visitors (Koçer and Karakayaci 2018).

Infrastructure is a collection of social, economic, and physical services that improve the quality of life and well-being of governments, businesses, and community members (Nesticò and Russo 2022). Planners and developers are focusing on city infrastructure to improve services and to make cities more enticing to live in. The city's neighbourhoods have many public facilities. These urban districts are linked to the neighbouring neighbourhoods and they serve as hubs for human interaction due to their evident character. According to government studies and publications (Yusof and Van Loon 2012, Salman 2018, Nakano and Washizu 2021), cities need well-designed public infrastructure. Prioritising high-quality infrastructure and services increases neighbourhood liveability and city improvement. Excellent infrastructure design allows people to improve their communication and social lives. Public infrastructure affects cities' functions, social structures, identities, and liveability (Carmona 2021, Jabareen and Eizenberg 2021).

Cyberjaya's inclusion in the category of innovative cities positions it as a brand city (Kavaratzis and Hatch 2013). The theory of Ortiz-Báez et al. (2022) posits that land use change influences urban expansion policies. Another influential factor in the transformation of city expansion is known as city branding. The alteration of urban development patterns and city design policies can lead to issues including even the absence of a distinct urban identity at both regional and global levels. In this sense, Vesalon and Creţan (2019) proposed that the integration of urban policies and economic interests is a significant factor affecting cities in Central and Eastern Europe. In contrast, the development plan for Cyberjaya city in Asia has prioritised an economic approach to this integration. However, urban life in suburban neighbourhoods lacks a distinct identity (Ortiz-Báez et al. 2022).

Design criteria for Global Technology Hubs

Innovation should drive smart city investment (Ajala 2018). However, a city is a human-inhabited area with a variety of services and economic activities. Cities, unlike towns and villages, are heavily populated metropolises with several roles. Urbanisation worldwide has raised demand for city infrastructure and services and its survival depends on meeting this demand. Bibri and Krogstie (2017) identified six smart city features – intelligent economics, mobility, environment, governance, people, and life are covered. They are the city features that smart initiatives affect to achieve smart city goals of sustainability, efficiency, and good quality of life (Albino et al. 2015).

A technology hub is a city that prioritises economic development, environmental stewardship, quality of life, and natural resource management, with ICT at its centre – and cities, in general, must evolve into intelligent, dynamic infrastructures that serve citizens while meeting all energy efficiency and sustainability criteria (Pellicer et al. 2017). This research is crucial to evaluating how neighbourhood smartening affects

quality of life. The analysis must identify which intelligence components satisfy foreign citizens as the city becomes more liveable and business friendly. Vesalon and Creţan (2019) found that the proximity of developed cities to transportation corridors plays a crucial role in fostering regional business connections. Cities that serve as growth poles, offering abundant business opportunities, can attract immigrants and investments, thereby improving the overall liveability of the city.

Cyberjaya has emerged as a prominent technology hub in Malaysia, fostering the exchange of knowledge and fostering innovative creativity (Vesalon and Creţan 2019, O'Brien et al. 2023). Technology and innovation are significant factors in shaping city branding, while multiculturalism also plays a crucial role in this phenomenon. Rotaru et al. (2023) argue that ethnic polarisation and fractionalisation significantly influence regional ethnic connectivity and diversity. These factors can have detrimental effects on various socio-economic outcomes, including economic development, social trust, and democracy. And the presence of innovation and multiculturalism in a city contributes to its involvement in the regional competition.

Quality neighbourhood design and its liveability

According to this hypothesis, the quality of a living space is a major factor in human life and enjoyment (Jones et al. 2019, Lam 2021). Neighbourhood quality is closely related to location satisfaction and attachment (Poortinga et al. 2017). Lewicka (2011) has elaborated on the concept of sense of place, which has garnered attention across multiple disciplines such as psychology, sociology, human geography, and economics. It is evident that individuals' emotional connection to their environment influences their sense of place and attachment to it, ultimately impacting their overall satisfaction with residing in that specific location (Lewicka 2011). Also, the physical environment and individual experiences establish a connection between the individuals and a particular place.

Cervero (2009) identifies the liveability concept as a highly effective characteristic of quality neighbourhood design. The ongoing debate within urban studies and the existing literature revolves around the significance of liveability as a key aspect of urban planning and design. Its importance lies in its ability to enhance quality of life by impacting lifestyle, health, sustainability, and power dynamics (Dsouza et al. 2023). But many studies define liveability differently, as ecology, geography, sociology, and urban planning all discuss liveability (Norouzian-Maleki et al. 2015, Paul and Sen 2020). Heylen (2006) defines liveability as how people view the environment. Also, the location, culture, and circumstances of a city affect its liveability (Lutz et al. 2021).

Liveability includes four components that affect environmental and place quality (Leby and Hashim 2010). Functionality and a safer environment are linked to social issues. However, liveability is linked to quality of life and place. The quality of the

neighbourhood is directly affecting the liveability of the area. So, numerous researchers have dedicated their efforts to assessing the quality of life by examining the quality of residential environments. McCrea et al. (2005) found that the primary concerns of younger residents in their research were regional services, including health and education, as well as the cost of living. On the one hand, the studies conducted by Mittal et al. (2020), and by Emami and Sadeghlou (2021) found that neighbourhood satisfaction was most accurately predicted by assessments of social interactions, neighbourhood crime, and public facilities such as parks and libraries. On the other hand, housing satisfaction was primarily predicted by the age of the home and homeownership (Davoodi and Dağli 2019).

The standard concept of livability emphasises physical, functional, social, and safety aspects (Mouratidis 2020). Hoogerbrugge and Burger (2018) said that the social dimension of liveability includes all aspects of community, life, and social interaction. That is why one of the most crucial aspects of liveability is neighbourly interaction. According to Paasch (2015), a liveable smart city can find interactions between people from different backgrounds, and it should be receptive to people with different life perspectives. Thus, city architects and designers should offer income-based housing to accommodate diverse populations (Castells 2020). Also, residential neighbourhood architecture, public infrastructure, and services affect liveability. So, the social, physical, and environmental infrastructure of a neighbourhood determine its liveability (Figure 2).

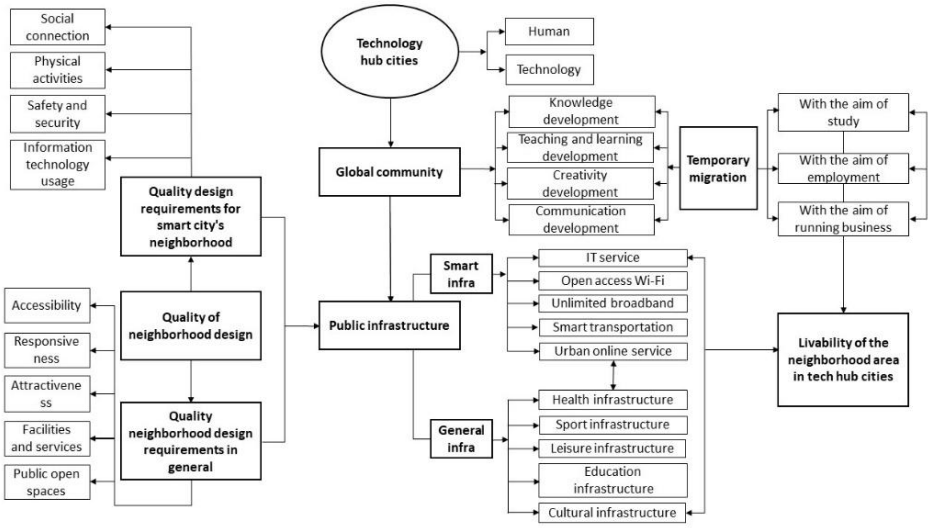

Figure 2. Theoretical framework of the analysis

Recent research has introduced the concept of liveability as a potential solution to address the challenges faced by smart cities in Asia. Randhawa and Kumar (2017)

argue that the holistic development of urban cities can be achieved by focusing on the economy, environment, and quality of life. This approach aims to make cities more liveable. However, both international ranking organisations and Indian standards share a similar perspective when evaluating urban liveability. India's emphasis solely on the physical dimensions has led to inadequacies in the provision of consumer and goods services. In the global context, international liveability tools aim to establish safe, healthy, economically prosperous, and environmentally vibrant cities for their residents. However, in the regional Asian context, these tools primarily focus on providing basic essential infrastructures in urban areas, with the expectation of achieving similar outcomes as the global standards. In a study conducted by Iyanda et al. (2018) on urban liveability in Malaysian cities, the authors examined the influential factors, and they identified the most significant indicator that enhances the residents' empowerment, so, urban liveability is influenced by factors such as environmental safety, urban facilities, and housing unit characteristics. This research employs a multidimensional concept to improve neighbourhood liveability in an urban setting, and it focuses on integrating smart city standards in an Asian tech hub.

Migration and its effect on international residents' life

Relocating to "global cities" with advanced service sectors, large economies, international hubs, political and cultural impact, is growing. These cities now have over one-third of migrant populations, and the Urban Future Agenda provides urban authorities with long-term solutions to related infrastructure and service issues. Affordable and social housing, quality education and health services, robust and congestion-free roads, transit infrastructure, easy access to essential utilities, and community cohesion are among these problems (O'Brien et al. 2023).

Although numerous migrants settle in cities, city migration data is scarce, and urban centres must address the migrants' urgent needs and assimilation issues. The growing migrant population requires metropolitan areas to provide vital infrastructure and services. As economic and social hubs, Asian cities are growing rapidly. Urbanisation has boosted regional productivity, but it also presents considerable obstacles, so that urbanisation may not benefit all city dwellers. Urban centres are expected to expand, but their full potential may not be realised due to poor coordination between spatial and economic planning, a lack of affordable housing, the marginalisation of dis-advantaged and vulnerable populations, high air and water pollution, inadequate climate change mitigation, and urban infrastructure deficiencies. The international migration policy shows that the states struggle to regulate migratory movements. So, the gap between policy and practice has shown that certain states, despite their restrictive language and public posturing, have large migrant populations and that migration controls often fail. As a young technology centre in Southeast Asia, Cyberjaya meets all the above issues, according to Angelidou (2017a, 2017b).

Methodology

The objective of this study is to investigate the perspectives of international residents regarding the adequacy of public infrastructure provision in Cyberjaya and its impact on the liveability of neighbourhood areas in Cyberjaya. The study will specifically focus on the planning and design of high-quality soft and hard infrastructure that enhances physical spaces and facilities.

This investigation employed a quantitative approach as its primary research methodology. Following this, the study employed solely a qualitative approach to corroborate the quantitatively derived data and to enhance the data's credibility. The selection of the methodology was appropriate as it pertains to an investigation that examines the impact of autonomous factors such as social, physical, and environmental infrastructures on the dependent variable of neighbourhood liveability. Employing a statistical approach is deemed more efficacious in addressing the research objectives. Partly, this is due to the fact that anticipated results can be quantitatively estimated by utilising characteristics obtained from the pre-existing research in the literature. The independent variables were derived from distinct categories of characteristics that relate to social, physical, and environmental factors. The tripartite fundamental classifications of standards are subsequently partitioned into a secondary inventory of particular elements that enhance the comprehensive calibre of neighbourhood configuration.

Study area

The government first introduced the plan to develop Cyberjaya into the Malaysia Super Corridor in 1996 (Salman 2018). Cyberjaya in Selangor, Malaysia, is becoming a prominent global technology city. Its success relies on effectively implementing the Global Tech Hub (GTH) Blueprint. This blueprint aims to create a thriving environment for technology entrepreneurs, multinational corporations, and small-to-medium-sized enterprises (SMEs). Additionally, it seeks to provide access to top-notch human resources and infrastructure.

The demography of the study area highlights the growing global population in this new urban development in Kuala Lumpur's suburbs and their connection to Cyberjaya's pioneers (Figure 3). Technology workers, professors, and residents have steadily grown the urban area. The city lies 40 kilometres south of Kuala Lumpur and it covers 2,800 hectares, consisting mostly of undeveloped land.

An analysis of public infrastructure development in relation to community age and service quality, as judged by the international residents, resulted in selecting three residential areas in several parts of the city. This approach does not involve a comparative methodology. There exist specific localities that exhibit a greater degree of

desirability among the inhabitants, resulting in a heightened need for residential accommodations.

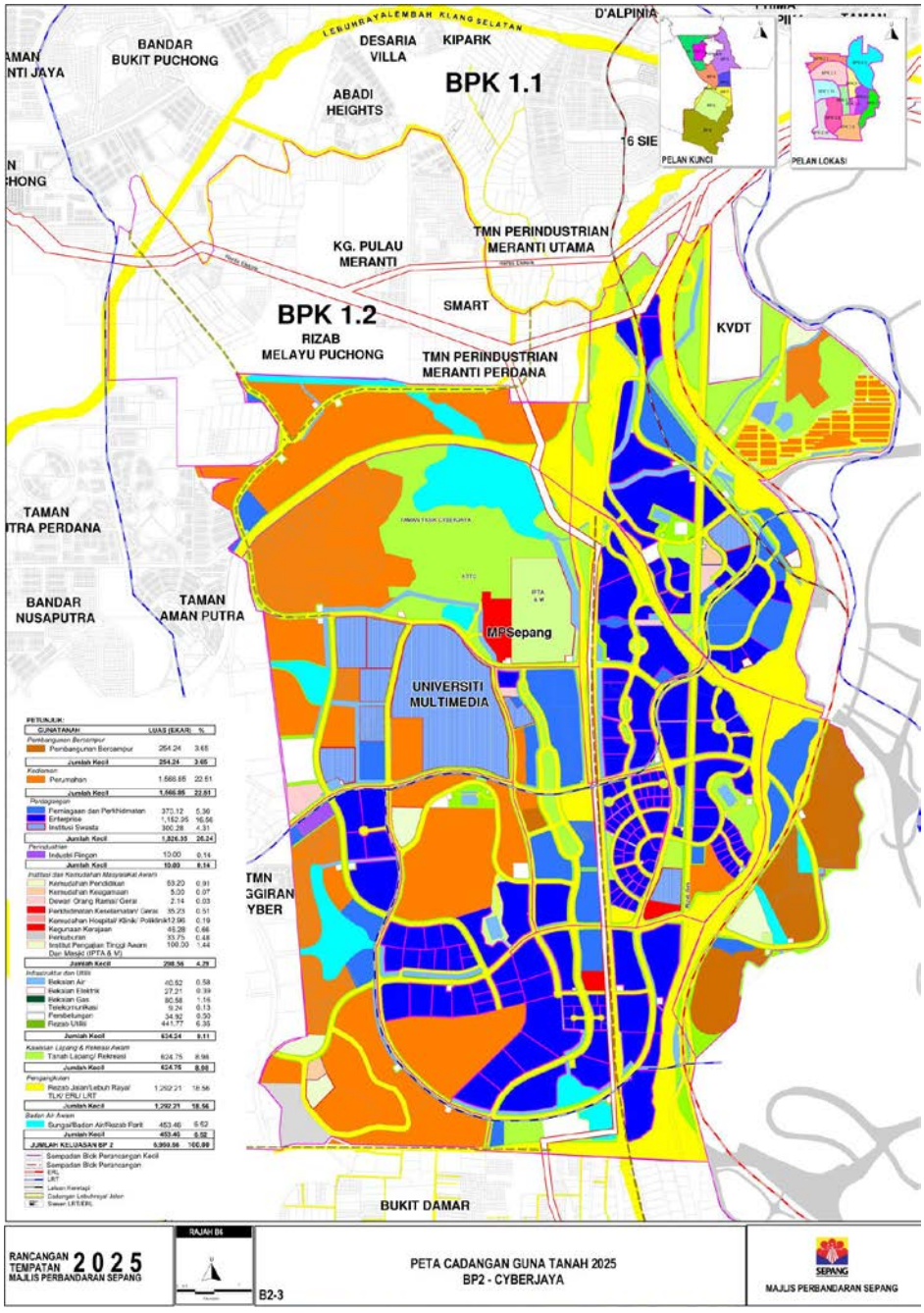

Figure 3. Case study location. Source: Sepang Action Plan (2025)

Data collection

The design step of this research recommended a quantitative approach using a questionnaire. Based on the demographics, a representative sample of residents from each neighbourhood was selected to complete the survey online or on paper. The survey's first segment examined the participants' demographics, and a total of 330 people took the survey – 110 respondents represented each neighbourhood; however, there is no reason to compare these three neighbourhoods.

According to Khorrami et al. (2021), liveability is a multidimensional and hierarchical concept that consists of various criteria and sub-criteria, and it can be evaluated in different ways. This study also includes an in-depth interview which was conducted to confirm the quantitative technique section's conclusions. In this sense, 15 interviewees from local governments associated with the Ministry of Housing and Urban Development and public-sector business organisations were chosen. City authorities and government officials were asked 10 open-ended questions about Cyberjaya's public infrastructure and services. 15 meetings with Sepang city officials and professionals were scheduled. In general, the independent variables of this research were categorised into three categories of general social, physical, and environmental infrastructures, and all the subgroups of the variables of each group were evaluated both through the survey as well as through the in-depth interviews.

Analytical method

According to the proposed method of this research, as well as the steps of data collection, and also following Zhao et al. (2019) that employed a quantitative method supported by a qualitative method in their research to find the correlated relationship between the residents' quality of life in the countryside and the urban infrastructure provision, the main analysis method of this study is the statistical analysis method in the first phase of data analysis. Considering that the main research method is a quantitative one and that a large amount of data has been obtained during the data collection stage, the best method for data analysis is to use a precise statistical and numerical method. A statistical analysis using the SPSS software was proposed and implemented in order to examine the data generated from the quantitative method of this research. Afterwards, the information gathered through in-depth interviews was analysed using the standard content analysis method. With the help of a content analysis approach, the information from the interviews was assessed and categorised.

The first stage of data analysis is concerned with the examination of pre-processed data from the quantitative phase. The residents who participated in the survey included students, employees of various enterprises, proprietors of their own businesses, as well as housewives (Table 1).

Table 1. Demographic characteristics of the statistical sample

	Valid	Frequency	Percent	Valid Percent	Cumulative Percent
Gender	Female	139	42.1	42.1	42.1
	Male	191	57.9	57.9	100.0
	Total	330	100.0	100.0	
Age	19-23 years old	88	26.7	26.7	26.7
	24-28 years old	117	35.5	35.5	62.1
	29-33 years old	100	30.3	30.3	92.4
	34-39 years old	25	7.6	7.6	100.0
	Total	330	100.0	100.0	
Education	High school	19	5.8	5.8	5.8
	Bachelor's degree	128	38.8	38.8	44.5
	Master's degree	146	44.2	44.2	88.8
	PhD or higher	37	11.2	11.2	100.0
	Total	330	100.0	100.0	
Employment	Employed Full-Time	82	24.8	24.8	24.8
	Employed Half-Time	23	7.0	7.0	31.8
	Seeking opportunities	51	15.5	15.5	47.3
	Just study	174	52.7	52.7	100.0
	Total	330	100.0	100.0	

Source: Cyberjaya neighbourhood areas survey

Results

Public infrastructures needed by the residents of a neighbourhood

Table 2 extensively evaluates the details of the infrastructure and public services required by the city in residential neighbourhoods from the resident's point of view and then it prioritises them according to their relevance in terms of ratings and their significance has been established. Totally 29 infrastructures were the most commonalities among the residents, which should be considered in the design of neighbourhood areas. The method of calculating the scores given to each variable was inverse. And, according to the obtained averages, the first 10 significant rankings were explained as an example. Hence, the most important public infrastructures in the neighbourhood area of cities, based on the international residents' perceptions, are: welfare infrastructure; transportation infrastructure; housing infrastructure; economy and finance infrastructure; safety and security infrastructure (including security teams, police, fire department, emergency services); governance; administrative and urban management infrastructure; food, restaurant, and food delivery infrastructure;

commercial and business infrastructure; soft infrastructure (ICT, IT, internet connection, digital technology and telecommunication); and education infrastructure.

Table 2. The most important public infrastructure in the neighbourhood areas of the city

Row	Public infrastructure and services	Rank	Mean	Std. deviation	5	4	3	2	1
1	Welfare infrastructure	25	1/00	0/00	330		0	0	0
2	Housing infrastructure	25	1/00	0/00	330		0	0	0
3	Education infrastructure	16.5	1/12	0/320	292	38	0	0	0
4	Food, restaurant, food delivery infrastructure	19	1/09	0/288	300	30	0	0	0
5	Commercial and business infrastructure	19	1/09	0/288	300	30	0	0	0
6	Transportation infrastructure	25	1/00	0/00	330	0	0	0	0
7	Soft infrastructure (ICT, IT, internet connection, digital technology and telecommunication)	16/5	1/12	0/330	289	41	0	0	0
8	Safety and security infrastructure (including security teams, police, fire department, emergency services)	21/5	1/06	0/244	309	21	0	0	0
9	Governance, administrative and urban management infrastructure	21/5	1/06	0/244	309	21	0	0	0
10	Economy and finance infrastructure	25	1/00	0/00	330	0	0	0	0

Source: Cyberjaya neighbourhood areas survey

According to the respondents' ratings of the variables, it can be stated that they carefully picked the requirements for their new living environment in Cyberjaya as a technology centre. Residents rely on services in this category of welfare because they are identified as one of their key requirements in the residential neighbourhood. Following that, consideration was given to transportation services. As previously mentioned, a large percentage of survey respondents indicated dissatisfaction with the existing level of transportation services, while providing convenient and easily accessible transportation for residents was one of the indicators of the world's smart cities. Communication services were listed third on the list of required infrastructure requirements for residential neighbourhoods. In terms of social life, the urge to engage with other neighbourhood or city residents is crucial for both city residents' mental health and the environment's liveliness.

Influential public infrastructure on urban neighbourhood liveability

Table 3 mentions the infrastructure and public services that impacted neighbourhood liveability. Residents could list any infrastructure or services they desire in response to the open-ended question. Following data collection, the frequency of similar responses was used to code this section. It was then compared to the data collected during the

literature review section to create a set of critical public infrastructures. This set was analysed, prioritised, and evaluated using SPSS software. The neighbourhoods' infrastructures were evaluated, and the residents ranked them according to the importance of the service from their perspective. Additionally, the prioritisation method was used in this section to determine the most critical services, reflecting the impact of public infrastructures on neighbourhoods from the perspective of residents. The following are the respondents' top priorities. The scoring system was switched around. The residents assigned a value between one and five points to each variable. A score of 1 indicates the greatest importance, while a score of 5 indicates the least importance. As a result, the lower the mean column value, the more statistically significant the variable is.

Table 3. Influential public infrastructure on neighbourhood liveability

Row	Influential public infrastructure on neighbourhood liveability	Rank	Mean	Std. deviation	5	4	3	2	1
1	Public transportation services	27	1/00	0/00	330	0	0	0	0
2	Public security	27	1/00	0/00	330	0	0	0	0
3	Public open spaces	27	1/00	0/00	330		0	0	0
4	Food services	25	1/09	0/288	300	30	0	0	0
5	Education and learning services	23/5	1/12	0/320	292	38	0	0	0
6	Internet and online services	23/5	1/12	0/330	289	41	0	0	0
7	Affordable housing	22	1/15	0/356	281	49	0	0	0
8	Leisure facilities	20	1/17	0/379	273	57	0	0	0
9	Walkability, sidewalks and cycling paths	20	1/17	0/379	273	57	0	0	0
10	Nightlife facilities and services	17	1/19	0/394	267	63	0	0	0
11	Multipurpose design and flexible buildings	17	1/19	0/394	267	63	0	0	0

Source: Cyberjaya neighbourhood areas survey and in-depth interview

Therefore, public transportation services and public security have the highest and most significant priority. Following them, public security, public open spaces, food services, education and learning services, internet and online services, affordable housing, leisure facilities, walkability, sidewalks and cycling paths, nightlife facilities and services, and multipurpose design and flexible buildings received the highest rank based on the frequency of choice by the neighbourhood residents. According to the residents' prioritisation of the indicators affecting the liveability of a residential neighbourhood, it can be concluded that their perception has been towards having a

quality life with various amenities in a neighbourhood. International residents taking part in the survey may not have a complete definition of a smart city's main infrastructure and its design criteria, but the way they prioritise effective infrastructure on neighbourhood liveability is such that they are aware of the differences between a city with a standard design and a city with the title of a technology hub.

Importance of public infrastructure and services related to city intelligence

On a scale of one to ten, the respondents were asked to rank the relevance of infrastructures connected to the city's intelligence in the questionnaire's third section (Table 4). The T-test has been used to rank the most important urban intelligence elements.

Table 4. Public infrastructure and services related to city intelligence

One-Sample Statistics T Test						
Row	**Public Infrastructure**	**N**	**Mean**	**Std. deviation**	**Std. Error Mean**	**T**
1	New digital infrastructure; e-services	328	4.9878	.10992	.00607	327.506
2	Creation of innovation; knowledge	330	4.9848	.12234	.00673	294.722
3	Better education; skills building	329	4.9878	.13470	.00743	267.675
4	Better public transportation	330	4.9788	.16403	.00903	219.152
5	Economic growth	329	4.9635	.25640	.01414	138.907
6	News skills for the citizens	328	4.9360	.25734	.01421	136.247
7	Increase of security	329	4.9027	.29677	.01636	116.294
8	Protection of the environment	327	4.9083	.29953	.01656	115.206
9	Cleaner energy	330	4.9000	.30046	.01654	114.876
10	Protection of natural resources	327	4.8991	.30168	.01668	113.833

Source: Cyberjaya neighbourhood areas survey and in-depth interview

According to the analysis, it can be concluded that the respondents believe that with the implementation of the smart city, the city's management will be improved significantly. In conclusion, the respondents largely agreed on the variable choice (better education and skill development) and the design of a smart city, and these variables have a critical effect on the intelligence of the neighbourhood area. Out of the twenty-six public infrastructures participating in this test, ten of them are very critical for the smartening of the neighbourhood. These ten infrastructures in their order of importance are: new digital infrastructure, e-services; creation of innovation, knowledge; better education, skills building; better public transportation; economic growth; new skills for the citizens; increase of security; protection of the environment; cleaner energy; and protection of natural resources. Nevertheless, the residents

mentioned that social infrastructures are more important for improving the liveability of their neighbourhoods, and the smart infrastructure that makes life easier for them can also be of high importance because the goal of choosing a city or neighbourhood for international residents is to experience a better quality of life.

Table 5 shows the effect of each of the variables on enhancing the liveability of Cyberjaya neighbourhoods, which are prioritised from the most effective to the least effective based on the effectiveness coefficient. The findings obtained from the regression test are important in order to prioritise the influence of the independent variables on neighbourhood liveability. Ranking them based on the degree of impact that they have on neighbourhood liveability can help create a better understanding of their importance in quality neighbourhood design.

Table 5. Coefficients for independent variables in the regression model (subscales of social, physical, environmental aspects)

	Model	Unstandardised Coefficients		Standardised Coefficients	*t*	*Sig.*
		B	*Std. Error*	*Beta*		
1	(Constant)	1.444	1.173		1.231	.219
	Social relationship	-.079	.119	-.053	-.668	.504
	Safety	.005	.079	.004	.063	.949
	Education	-.074	.300	-.015	-.246	.806
	Health	-.002	.055	-.002	-.034	.973
	International relationship and culture	.101	.074	.105	1.365	.173
	Welfare facilities	.061	.189	.026	.322	.748
	Equity in services	.170	.067	.187	2.533	.012
	Vitality of the place	-.066	.095	-.049	-.696	.487
	Public spaces	.023	.063	.026	.365	.716
	Technology and smartness in design	.100	.100	.075	1.004	.316
2	(Constant)	1.025	.523		1.962	.051
	Accessibility	.264	.082	.189	3.228	.001
	Affordability	.004	.083	.003	.044	.965
	Connectivity	.076	.051	.082	1.491	.137
	Mobility	.026	.077	.019	.335	.738
	Beautification	.087	.078	.065	1.121	.263
	Walkability	.050	.055	.053	.908	.365
	Flexibility of design	-.090	.035	-.144	-2.545	.011
3	(Constant)	1.970	.430		4.579	.000
	Climate design	-.017	.041	-.025	-.423	.673
	Clean and renewable energy	-.008	.085	-.007	-.099	.921
	Environmentally friendly design	.106	.079	.084	1.333	.183

Source: Cyberjaya neighbourhood areas survey and in-depth interview

Discussion

The study of smart city liveability, particularly in Indian and Malaysian cities, has gained attention in recent years (Bunnell 2015, Macke et al. 2018, Yap 2021). Most studies suggest that the effectiveness of smart cities relies on the presence of information and communication technology (ICT) infrastructure. Additional factors that contribute to a city being considered smart include human capital and education, social and relational capital, and the environmental concern. These factors are recognised as important drivers of urban expansion. Most experts agree that human involvement and effective communication are essential for the success of a smart city in terms of liveability and vitality.

Technology hub towns prioritise two essential elements: hard and soft infrastructure. The term "hard" in the context of urban infrastructure generally pertains to the physical construction of the city. In addition to the physical aspects, the development of a city necessitates the establishment of soft infrastructure, encompassing the human and social sectors. Smart cities, knowledge capitals, and technological centres are subcategories of contemporary intellectual cities that prioritise knowledge availability, communication quality, and social infrastructure provision for their residents and users (Caragliu et al. 2011, Angelidou 2017a, Angelidou 2017b). The focus of their interest extends beyond the ICT infrastructure to encompass the significant contributions of individuals and education in urban development. The primary objective of technology hub cities is to educate the residents, thereby cultivating a skilled workforce that can contribute to the city's economy and overall success (Berry and Glaeser 2005, Glaeser and Berry 2006). The presence of comprehensive neighbourhood infrastructure improves the connectivity, aesthetics, and overall quality of life in an area (Aldegheishem 2023).

The results of the analysis revealed a significant association between the public social infrastructure and neighbourhood liveability. The provision of public infrastructure can have a positive impact on the quality of life. As a result, the improvement of public infrastructure in Cyberjaya is expected to contribute to the enhancement of liveability, which in turn may lead to an increase in satisfaction levels among the international community residing in the area. The analysis of the sampled population indicates that the utilisation of social infrastructure is a key determinant in fostering a sense of vibrancy within individuals. So, the establishment of a scenario that fosters a sense of interconnectedness among individuals, their surroundings, and the communal amenities contributes to their contentment with residing in a superior locality.

Based on the study findings, it can be concluded that Tamarind Square stands out as the most vibrant locality owing to its diverse range of amenities, recreational facilities, entertainment options, and public transportation links that effectively interconnect the

urban fabric. However, it is imperative to acknowledge the crucial role played by the physical and environmental infrastructures in this regard, which cannot be discounted. After analysing the factors that have a significant impact on the liveability of a city, it can be inferred that an equitable allocation of public infrastructure is imperative for all neighbourhoods (Carballo et al. 2022) within the city. According to Gómez-Varo et al. (2022), this is crucial for sustaining the liveability of the city, as the availability of public spaces and opportunities for social interaction can contribute to the vitality of the city and its neighbourhoods. This is particularly important in a multicultural city that accommodates diverse populations with varying backgrounds (Alizadeh and Sharifi 2023, Karmaker et al. 2023).

According to the theory of neighbourhood design quality (Mumford 1989, Richards et al. 2014, Mkandawire et al. 2018), the quality of a neighbourhood is influenced by three key variables, namely social, physical, and environmental factors (Siordia and Saenz 2013, Ribeiro 2018). The study centred on the pivotal function of public infrastructure in augmenting the quality of life in residential areas.

The present research confirms the findings of prior studies that have established a positive correlation between the standard of public infrastructure provision and the quality and liveability of the neighbourhood (Li et al. 2019, Kim et al. 2020). The results of the study suggest that the liveability of Cyberjaya's neighbourhoods is suboptimal. After conducting thorough investigations, it has been concluded that the problem of neighbourhood liveability is closely linked to the absence of crucial public infrastructure that is necessary for neighbourhoods to fulfil the expectations of their residents (Xiao et al. 2023). The proliferation of neighbourhood issues has resulted in a decrease in demand for residential properties, leading to a lack of vitality in the urban environment and a perceived sense of stagnation (Konduri and Lee 2023). Therefore, in order to enhance the habitability of urban regions, it is imperative to effectively cater to the public infrastructure requirements of the locality.

The provision of amenities and services in specific neighbourhoods has a positive impact on the satisfaction of residents and it promotes their retention in those areas especially in the Asian developing cities context (Zhang et al. 2022). Numerous scholarly articles have been published regarding this topic, including those by Costamagna et al. (2019) and Kasim et al. (2020). Therefore, it offers a firmly established theoretical and practical structure. The use of this tool has the potential to aid urban designers, specialists, and authorities in making informed decisions regarding future actions aimed at enhancing urban areas.

The study conducted an analysis of the social, physical, and environmental dimensions in order to enhance the scientific and practical frameworks of future projects. This was done to better understand the implications of the study's results and their contributions to theoretical and practical frameworks. It is noteworthy that the outcomes of this

study were solely derived from the perspectives of the expatriate inhabitants of Cyberjaya. These viewpoints were further authenticated by means of discussions with regional officials and specialists. It is important to note that the responses gathered are exclusive to individuals who are international residents and that they are influenced by their perceptions, emotions, and personal subjective connections with their surroundings. Additionally, the needs of an international migrant differ from those of a native individual, resulting in distinct expectations of a location (Chen et al. 2022). The results of this study may vary significantly if the survey were conducted through random sampling or by selecting individuals from the local population as participants. This study focused on the international residents of Cyberjaya, as it is a technology hub that initially attracted foreign investors and later developed into an educational centre with notable institutions catering to international students.

The previous research on urban planning has not adequately addressed the matter of ensuring a high quality of life for non-native residents (Valero-Escandell et al. 2023). However, it is important to note that a smart city's definition includes a focus on its human dimension (Allam et al. 2022), which necessitates special attention to the needs of all residents. The research did not centre on smart city designs. Instead, it aimed to assess the readiness of Cyberjaya, in light of its characteristics and global introduction, to cater to the needs of its residents who have migrated to the Asian tech hub city (Yasin et al. 2022).

The study's results suggest that nine specific types of public infrastructure have a significant impact on improving the liveability of a neighbourhood. The public infrastructure comprises various services and facilities such as social relationship and communication infrastructure, public safety infrastructure, education infrastructure, public health and healthcare services, international relationship and culture, welfare facility infrastructure, equity in service provision, vitality of the place, public spaces, technology, and smart infrastructures and services.

The research data collected in different conditions and according to the method used in this study may have limitations that will eventually cause the results to have a percentage of error. The data collection period of this research coincided with the peak of the restrictions of the first phase of the pandemic, and for this reason, it was not easy to access the statistical community selected to participate in the survey. On the one hand, numerous questionnaires were completed and sent back by the online response system, as a result, there was a possibility that due to the limited physical presence of the surveyor, the participants did not give complete and decisive answers to some questions, and this is while the mental conditions of participants were also considered due to long-term quarantines and nationwide lockdown which made them more isolated and disconnected from the social life (Tran et al. 2020). On the other hand, in the conducted interviews, due to the limited time of the interview and the observance of social distance, as well as the limitation of the interviewed city officials in providing

detailed information on future urban planning, it was not possible to access detailed data. However, the review of existing government documents and blueprints has greatly contributed to the collection of qualitative data. As a result, the generalisation of the results of this research as a comprehensive framework in the implementation of new urban neighbourhood design policies or practical implementation has limitations because different neighbourhoods of a city also have differences in conditions and characters (Málovics et al. 2019), but still, the problem of the liveability of residential neighbourhoods of Cyberjaya has shown many similarities.

Among the other limitations of generalising the research results to urban studies on a general scale, we can mention the special branding of Cyberjaya as a technology centre because the residents and users of such cities have different perceptions and expectations of the standards and quality of urban life, which is different from the quality of life in other cities. Finally, this research has come to a conclusion by emphasising the public social, physical, and environmental infrastructures and their impact on urban liveability with a focus on neighbourhood areas, while the effects of other groups of infrastructures, especially economic infrastructures, should be studied because only in this case an excellent theoretical and practical framework can be presented to deal with the problem of the liveability of smart and sometimes neoliberal cities and their neighbourhood areas where the human capital of the cities live.

Conclusions

Rapid urbanisation, privatisation of public spaces, and technocratic infrastructure planning in Asia has led to urban sprawl, socio-economic segregation, and failure to meet the residents' needs. Public infrastructure, both hard and soft, can improve urban liveability. However, there is a lack of information on the influence of quality public infrastructure on the liveability of residential areas and the urban satisfaction among international residents in smart cities.

The Asian Development Bank predicts that developing Asia and the Pacific will require over $22.6 trillion in hard infrastructure by 2030, with much of this required in urban areas. The level of investment required in soft infrastructure remains unknown. Governments and policymakers must prioritise connectivity and achieve the optimal balance of hard and soft infrastructure. Developing connectivity indexes can help identify the most effective mix for economic and social development. However, the focus on local economy and welfare services is crucial for city liveability and dynamism in Southeast Asia (Arfanuzzaman and Dahiya 2019, Le and Nicolaisen 2021).

First and foremost, this study investigates the liveability of neighbourhoods in Cyberjaya, Malaysia's IT super corridor. It fills the gap between smart city liveability and the critical need of urban infrastructures. The study systematically unpacks how multiple infrastructures shape the liveability of urban neighbourhoods, revealing that

social factors affect liveability the most, whereas environmental elements impact it the least. Social factors include equity in services, international relationships and culture, technology and smart design, public spaces and welfare facilities, safety, social relationships, place vitality, and health.

Developing liveable, and equitable cities is a major policy aim especially in the regional context for the Asian cities development (Kamiński 2023, Quang Giai and Kim Hai 2023, Susantono et al. 2023). However, liveability criteria are broad, emphasising different dimensions. Secondly, this study develops a novel data-driven approach by directly surveying the perception of urban international residents, alongside satisfaction with key social-physical-environmental infrastructure urban correlates to indicate liveability criteria and influential priorities. According to Brown et al. (2023), the importance of paying attention to social and cultural communication and collective decision-making on a larger scale than the regional scale has been pointed out and its importance has been examined in the position of global cities.

Additionally, the study highlights the importance of providing soft public infrastructure in residential neighbourhoods, which is crucial to urban neighbourhoods' liveability and citizens' satisfaction. It also highlights the need for a practical framework for future designs focusing on the human dimension of cities and their expectations of global cities design standards. This approach can enhance the liveability situation in smart cities in regional scale, particularly in Southeast Asia and Pacific countries. According to Chen (2023), some Asian cities are evaluated as smart but with a lower subjective well-being and while technical products are playing the main role in the smart city, the quality of the urban infrastructure is more vital for increasing the resident's well-being. Finally, the study has several advantages for policy making, such as showing how diverse infrastructures affect the urban neighbourhood liveability, and as providing a practical framework for future designs focusing on the human dimension of cities. Future studies should test this approach in other cities to highlight their needs and to prove its efficacy in new cities especially in the Southeast Asia developing countries.

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