

# The Impact of Hi-Technology Navigation Systems on the Reading of the Five Elements of Urban Design, Using the Case of the Central District of Hong Kong

Hee Sun (Sunny) Choi<sup>1</sup>, Xinyi Yang<sup>2</sup>

<sup>1</sup>Urban Environments Design (MDes), The Hong Kong Polytechnic University, Hong Kong, China

<sup>2</sup>Harvard University, Cambridge, USA

Email: hee-sun.choi@polyu.edu.hk, xinyiyang@gsd.harvard.edu

**How to cite this paper:** Choi, H. S., & Yang, X. Y. (2022). The Impact of Hi-Technology Navigation Systems on the Reading of the Five Elements of Urban Design, Using the Case of the Central District of Hong Kong. *Current Urban Studies*, 10, 451-466.

<https://doi.org/10.4236/cus.2022.103027>

**Received:** July 19, 2022

**Accepted:** September 26, 2022

**Published:** September 29, 2022

Copyright © 2022 by author(s) and Scientific Research Publishing Inc. This work is licensed under the Creative Commons Attribution International License (CC BY 4.0).

<http://creativecommons.org/licenses/by/4.0/>



Open Access

## Abstract

As smartphones become an essential and ubiquitous appendage for most city dwellers, a reliance on digital mapping and navigation systems as a means to navigate the city is increasing. Taking as its starting point, this paper represents the way in which this technology and capability have changed, the way the city is read and travelled through, and whether a fundamentally different image of the city is formed by the user. The aim of the research is to discover the usage of navigation technologies in forming a city image and in relation to the five elements of urban design defined by Kevin Lynch in his book *Image of the City*. The Hong Kong district of Central is used to analyze the impact of such navigation technologies on the observer seeking to orient themselves within the built environment. The mapping apps on a smartphone and other GPS-enabled handheld devices were used as research tools to collect data as an empirical research method. In conclusion, this paper highlights how navigation technologies can extend the consistencies Lynch sought to establish with these five elements, but considered as the sixth element.

## Keywords

Place Imageability, Sense of Place, Smart City, Hyper-Reality

## 1. Introduction

### 1.1. Navigation Systems Using Digital Technology

The pervasive deployment of the e-network is a defining characteristic of contemporary cities. Just as televisions and desktop computers transformed the ci-

ties of earlier eras, mobile phones, iPads and other handheld PDAs are now more numerous than both and are beginning to subsume many of the same functions. With this, changes in our cognitive understanding of the city may be emerging, and the five key elements of this understanding defined by [Lynch \(1960\)](#) have evolved to the extent that this e-network could be regarded as the sixth key element.

When considering these developments, [Foth and Sanders \(2008\)](#) argue that it is important to depart from simple binary oppositions and compartmentalized dichotomies such as “physical place” vs “cyberspace” ([DiMaggio et al., 2001](#)) and embrace the complex hybrid nature of urban spaces ([Foth & Sanders, 2008](#)). From an urban perspective, as the use of digital networks becomes an integrated part of everyday life, a new digital layer is added to the process of cognition of the image of the city, with the GPS chip in the mobile device acting as the mediator between the physical environment of the city and the formulation of the city images, with a way to use as navigation, helping for the orientation, and operational flexibility and tailored to the user’s location.

This technological and behavioural evolution has changed the way the city is read and travelled through, and can result in a fundamentally different image of the city formed by the user. This paper *aims to discover* how has the advancement in mobile technology impacted how people read and understand these elements and use them for orientation? Has it changed the significance of these elements; have other elements gained in significance?

The paper examines these topics by first briefly exploring how academics, city planners and innovation experts have approached the issue of orientation and technological development. It then examines the urban theory of the image of the city in a literature review that seeks to shed light on how these technologies have changed the reading of the city and the applicability of this theory. In this, the arguments from two key texts, “The Image of the City” (1960) and “Rethinking Image of the City in the Information Age” ([Al-Ghamdi & Al-Harigi, 2015](#)) are counterposed. The study takes as its starting point an overlay of Al-Ghamdi and Al-Harigi’s model of the image of the city in the information age onto Lynch’s model of the perception of the city and then seeks to gain more detailed findings than previously achieved. In doing so the paper focuses on the case study city of Hong Kong, including a comparative study of navigation with and without a smartphone with the Google Maps app installed. The paper concludes by using these findings to reflect on how the integration of new technologies influences the imagining of urban form and sense of urban space, reflecting on the five key elements based on the research of the urban navigation and public space arrangement in Hong Kong.

In this way, the research focuses on the impact of the usage of mapping apps on a smartphone or other GPS-enabled handheld devices. For the research and data collection, two groups were set up to compare the differences between the people using experience and the people using GPS navigation tools when ex-

ploring the streets. One group was asked to start up their journey without their mobile phones or GPS, using physical maps and the advice of passers-by to find their route by making visual connections with landmarks and forming mental maps in the way [Lynch \(1960\)](#) described. The other groups of people have been asked to start up their journey with GPS navigation on their mobile phone, particularly Google Maps, and use this as their reference point as they navigate their journey. The data collected includes interpretations of mental maps of the journey from the interviewees, in the form of hand-drawings of the routes taken, considering very various ways of drawings from the interviewees. In this way the paper gives particular focus to the walking experience in the city, in order to assess the form of understanding of the city these tools offer, and how this experience differs from that offered with a small physical map, orientation through visual exploration and asking passers-by for directions.

## 1.2. An Evolving Image of the City

Kevin Lynch's book "Image of the City" was published in 1960 and has become one of the fundamental theories in urban design and provided urban designers with a language for how to perceive, organize and design the city in a better way. This language is based on five key elements that form the perception of cities:

- Paths: Channels such as streets, walkways, transit lines, canals, railroads.
- Edges: Boundaries such as shores, railroad cuts, edges of development, walls.
- Districts: Medium-to-large sections of the city.
- Nodes: Points such as junctions, places of a break in transportation, crossing
- Landmarks: Point-reference such as isolated towers, golden domes, great hills.

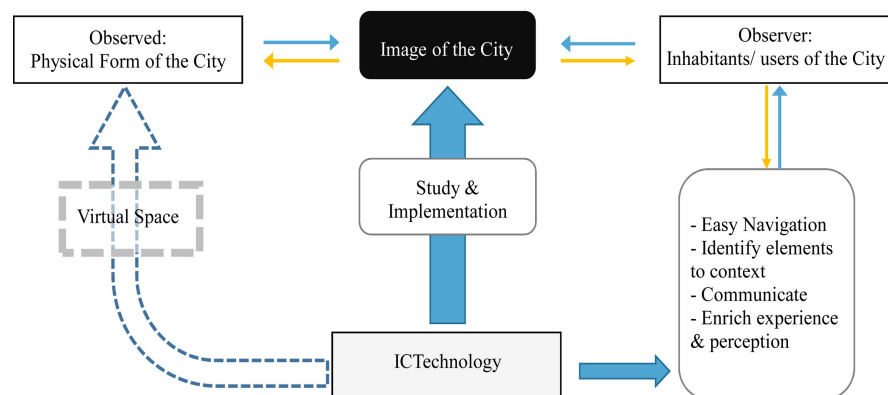
Whilst this book with those key elements and its content has become one of the tenets of urban design education, however, fifty years later now, some have argued that this theory and research lacks a scientific base upon which to build a research foundation (see [Table 1](#)).

Although [Marshall \(2012\)](#) and some scholars have argued that these key elements lack clarity, it did provide a way for urban designers to view a city in a more constructive way. When compared with quantitative forms of scientific data, qualitative research and cognitive mapping of human behavior patterns, experiences and identity are of a very different value and offer a different reading of the built environment which helped us understand and visualize users' feelings, sense, and experiences. Because the mobile phone provides a spontaneous visual and cognitive linkage between a mapped world as yet unseen, and the immediate visual perception of the physical world in front of you.

Using Lynch's Image of the City as a key theory, [Al-Ghamdi and Al-Harigi \(2015\)](#) provide a model ([Figure 1](#)) to show the effect of this technology, highlighting that the technology impacts on both the observer and the observed. They argue that there are two ways that technologies can affect the image of the city, as a tool to study and facilitate a mental image of the city, and to provide

**Table 1.** A summary of the scientific readings of “The Image of the City” (Source: Marshall, 2012).

Urban Design Theory/Key Hypothesis	Original Science Footing	Subsequent Validation	Subsequent Use (Urban Design Literature)
<p>The Image of the City.</p> <p>There is a single (or more than one) public image of the city, articulated through five elements that are suitable for using as the building blocks for urban design</p>	<ul style="list-style-type: none"> <li>- On the basis of small pilot study</li> <li>- Tentative with appropriate caveats</li> <li>- Informed by social science literature</li> <li>- “Urbanistic” precursors of five elements not reported</li> </ul>	<ul style="list-style-type: none"> <li>- Partial positive confirmation of five elements</li> <li>- Alternative elements not investigated</li> <li>- No overall testing nor validation of overall linked hypothesis</li> </ul>	<ul style="list-style-type: none"> <li>- Generally uncritical affirmation as if factually established</li> <li>- Generally not reflecting existence of subsequent testing</li> </ul>

**Figure 1.** Proposed model to understand image of the city in the information age (Source: Al-Ghamdi & Al-Harigi, 2015).

further stimulus to affect and influence the observer. The model also identifies the “virtual space” that this technology has created, but does not go further to consider the impact this new environment has on the mental image of the city. This paper and the study of Hong Kong does also not attempt to elaborate on the impact of this “virtual space”, focusing rather on the interface between users, their handheld device and the urban environment in Hong Kong.

Understanding that, the three different technologies that affect urban space can be defined as follows:

- 1) Navigation, mapping and locating: Link between GIS and LBS to collect and analysis the data about mapping and legibility.
- 2) Meaning, experience and perception of the space: Social media influence the activities happened in open space.



3) Virtual reality and visual reality: Difficult to measure due to the lack of physical sensation.

This paper focuses on the first item on this list and uses this definition to further determine the extent to which our increased reliance on mobile devices for orientation, navigation and recommendation may impact and influence the cognitive processing and understanding of the city.

### 1.3. Urban Spatial Structure and Experience with Technology in Hong Kong

- **Spatial Structure**

Although GPS and sensors are not stable and limited in Hong Kong because of the high-rise buildings and their density in the central districts, the experience of the city with and without GPS was conducted in an external urban environment and consisted of two phases; an initial learning phase, and a testing phase where participants were asked to provide orientation, Euclidean and route distance estimates. The results show that there are differences in the spatial knowledge acquired, and that mobile map users performed worse than map users on route distance estimation. Also, only mobile map users showed differences in cognition between different types of locations. These findings indicate that mobile map users acquire a more fragmented and regionalised spatial knowledge based on strong connections between locally clustered landmarks along the route. This can be attributed both to the piecemeal presentation of views during navigation and to increased requirement on users' attention to be split between the physical environment and the journey as depicted on their phone.

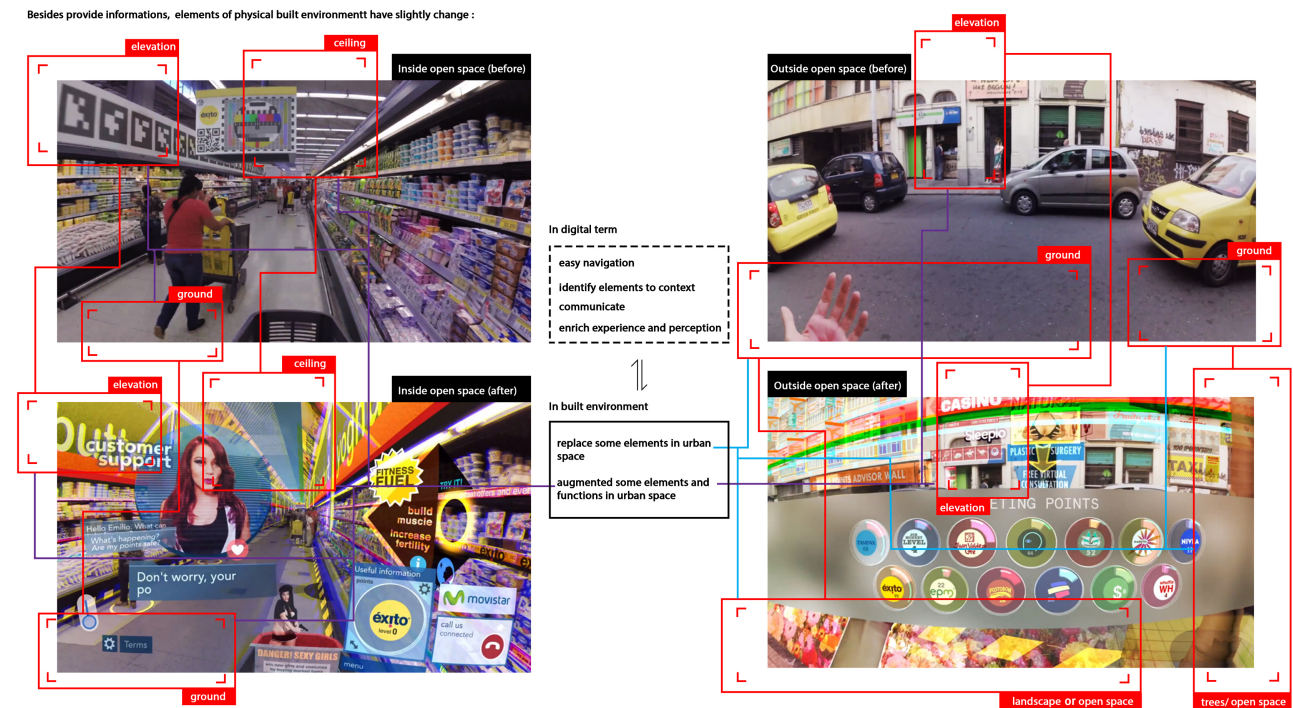
To consider this at a diagrammatic level, a cognitive map is used as a representative expression of an individual's cognitive map knowledge, an individual's knowledge about the spatial and environmental relations of geographic space (Tolman, 1948). It provides the construction and accumulation of the spatial knowledge, reflecting images after recalling and learning of information (Kitchin, 1994) (see Figure 2).

Regarding how information communication technology influences the significance of the five elements of the image of the city that Lynch argues were so pivotal to the reading and design of the city, the case study site of the Central district of Hong Kong includes a cognitive model (see Figure 3) to assess this and further consider how this augmentation of experience and impact on the reading of these elements.

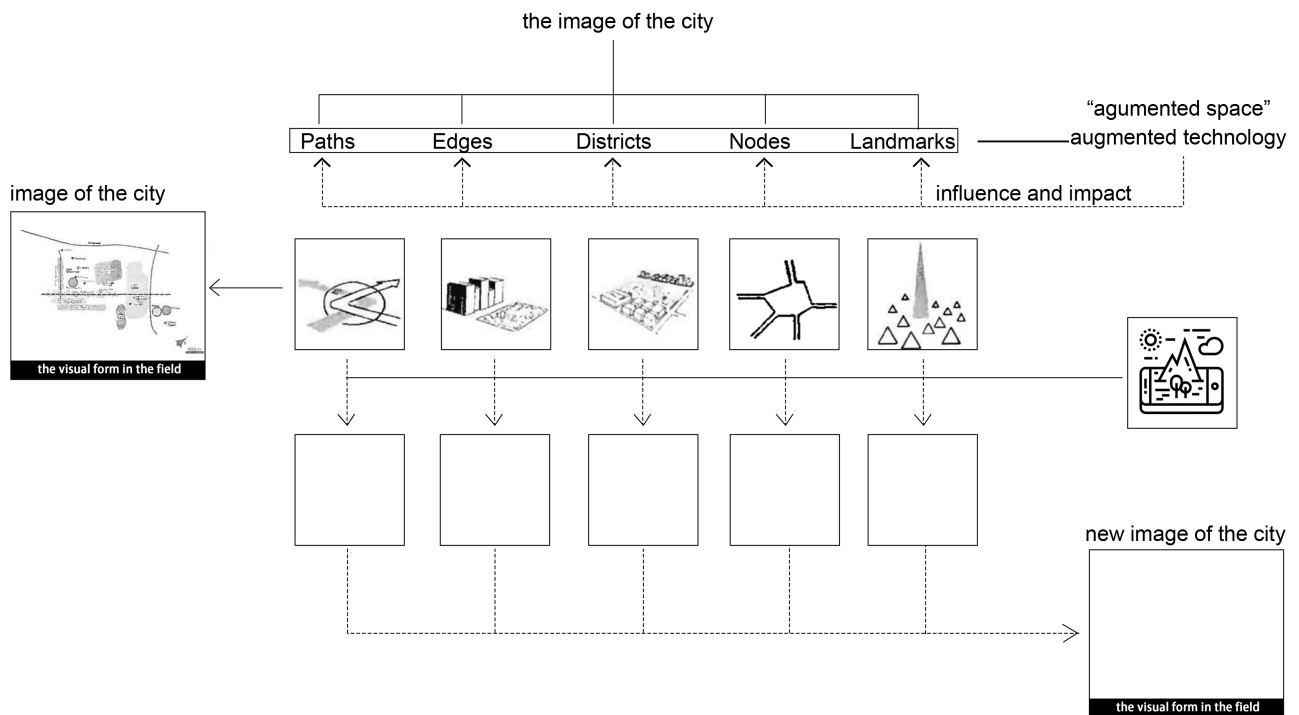
Reviewing many different forms of technologies affecting the form of city and people's life, this paper synthesises and concludes the five important technologies as shown in Table 2.

- **Experience**

The study site of Central is a district where the five elements of the city are clearly evident, including paths edges nodes and landmarks, in an area that can be understood to be one of the culturally and social hearts of the contemporary



**Figure 2.** How people form the perception of the city (Source: Drawn by the author).



**Figure 3.** The concept model of the overall research (Source: Drawn by the author).

city and thus “heavily trafficked” on social media. The walking route selected for navigation commences from the Central Mass Transit Rail (MTR) station to Tim Ma Park, through the entertainment district of LanKwai Fong, to a final destination

**Table 2.** Summary of technology on urban space (Source: Drawn by the author, 2018).

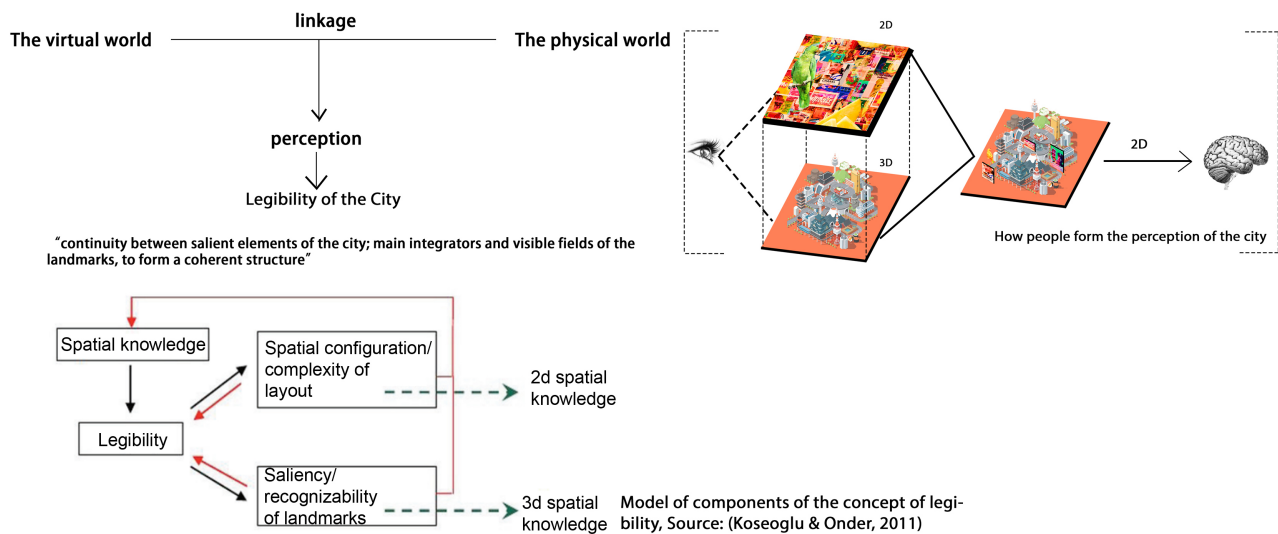
Technology	Description	Implementation
Navigation system	Navigation systems such as Google maps, Baidu Maps providing a satellite imagery, street maps, 360 panoramic views of streets (Street View), real-time traffic conditions (Google Traffic), and route planning for traveling by foot, car, bicycle (in beta), or public transportation	Real time reflecting the location and the destination where people want to go
Searching system based on navigation system	Apps such as Open rice and Four Square provide the information of the public facilitates and entertainment location surrounding people	Give people more social knowledge about the location
Searching system based on augmented reality	Searching system can not only provide the information of the shops and retails but also lead people to explore with the virtual guidance in reality	Real time reflecting the information about space
Game based on augmented reality and navigation system	Game and space integrated with each other	Add interest and entertainment when explore the streets and urban space
Regular web pages: newsfeeds and social media	Topical or targeting articles for each user in relation to the city	May offer person or location-related or more random feeds and information

at a restaurant; Lan Fong Yuen (see **Figure 4**).

The journey of this route offers the chance to experience different and distinctive urban fabrics and details, memorable places and pocket parks, the waterfront as a clear edge, and numerous landmarks including many distinctive skyscrapers and other local landmarks.

As mentioned earlier, two groups were set up to compare the differences between the people using experience and the people using GPS navigation tools when exploring the streets. The group was in the 20 - 30 years old age range. All of them were students recently arrived in Hong Kong from overseas, with a preliminary understanding of the orientation of the city consistent with a relative newcomer, and all capable of reading both physical maps and Map applications on a phone. One group was asked to commence the route given and during this journey they could only explore the route by foot without GPS or any mobile device. The group of people was taking the journey individually, and the individual interviewees had permitted the use of physical maps and questions to passers-by on the street only to assist with orientation. The other group of people were also oversee students who are not familiar the orientation of the Hong Kong central district, and they were asked to commence the route given and were permitted to use Google Map with their mobile devices only to navigate their route.

After finishing the journey, all of the interviewees from both groups were asked to respond to a questionnaire to recall what they saw along the routes, including



**Figure 4.** The case study route (Source: Author, 2018).

what they felt to be important elements in their orientation. Each person was asked to draw a mental map of how they remember the streets, district, and landmarks. The mental maps produced by two of the participants are shown below (see **Figures 5-7**).

From the research outcomes gained from the interview survey and the drawing of mental maps, it was possible to summarise findings from both user groups.

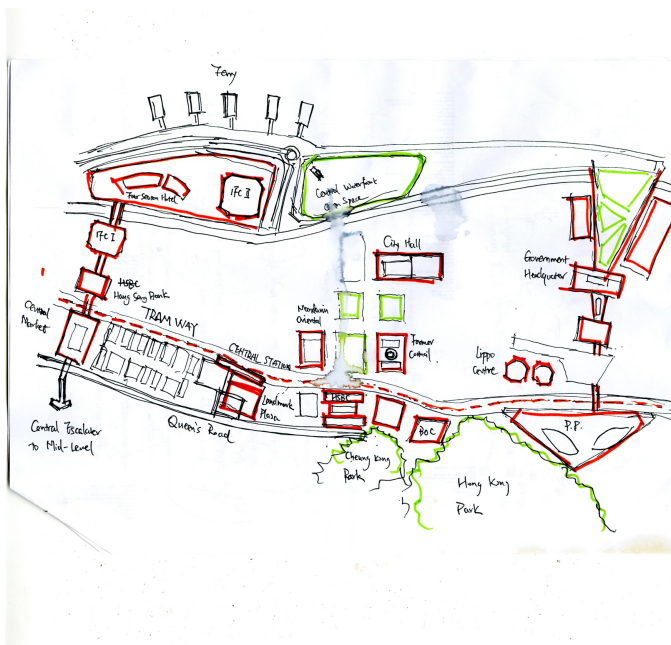
From those users *not using mobile devices and GPS*, some common messages that appeared more than five times are summarized below:

- Landmarks: "I remembered there were a lot of delicious restaurants over there, such as..." "After getting to that... Shops, we can find our way to..." "In that corner of the street, I could find a convenience store..."
- Nodes: "There are some people who are willing to stay in the sun in that part during the hot days." "Many people will stay in these stairs when it is a holiday." "This place is better than the park over there."
- Districts: "If we go through these fancy shops, we can find the way to the frontage" "There are so many restaurants and bars in these small blocks" "It is so difficult to cross these tall buildings if we want to go to the destination."
- Edges: "The water frontage is so beautiful at night and we can see that the sun set a little bit later." "The highway is so terrible, every time I have to go down to the tunnel to get through these districts." "The LKF is on the top of this mountain."
- Paths: "If we are in Hong Kong, whatever destination you want to go, you should go upstairs on the footbridges first because it is always easy to find our ways." "It is more comfortable to go to this way as outside this place it is so hot to walk under the sun outdoors." "It will not take too long to go to... From this place."

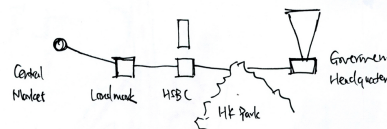




**Figure 5.** A mental map and questionnaire from one interviewee who navigated using physical map and his own experience (Source: Drawn by the interviewer, data collection by the author).

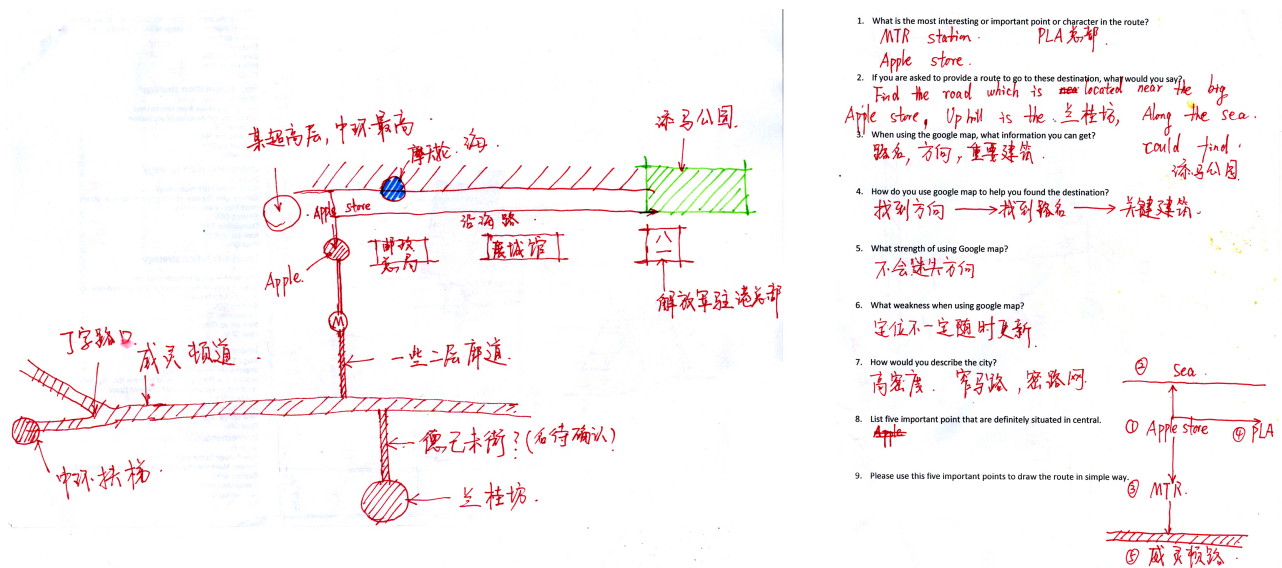


1. What is the most interesting or important point or character in the route?  
*The changing view from train, diverse urban context and atmosphere along a continuous way (tramway)*
2. If you are asked to provide a route to go to these destination, what would you say?  
*Get on a train you can have a continuous experience along the route*
3. Where information you can get along the route?  
*Building style and its period, Block size and scale, Urban atmosphere*
4. What difficulty in finding the route?  
*Interrupted by motorways and other large facilities*
5. How would you describe the city?  
*Fragmented, ~~the~~ Futuristic, Extreme, Contrast between urban & nature, local & international*
6. List five important point that are definitely situated in central.  
*Central Market (The Start Point of Escalator), Landmark Plaza, HSBC Building, HK Park, Government Headquarter and its open space*
7. Please use this five important points to draw the route in simple way.



**Figure 6.** A mental map and questionnaire from one interviewee who navigated using physical map and his own experience (Source: Drawn by the interviewer, data collection by the author).

From those *using mobile devices and GPS* to orientate themselves and navigate their journey, some common messages that appeared more than five times are summarized below (see **Figure 8** and **Figure 9**).



**Figure 7.** A mental map and questionnaire from one interviewee who navigated using Google Maps (Source: Drawn by the interviewer, data collection by the author).

- Landmarks: “The China Bank is over there!” “There are so many small shops on the roadsides which make me feel confused about the whole area.” “This large park is so comfortable”.
- Nodes: “I cannot find the crossing shown on the google map, as the location shown on the map is not precise.” “There are so many people in that crossing.” “How can we get to crossing there?”
- Districts: “So many people in this area” “It is getting busier in this area than the one we saw just now.”
- Edges: “The pedestrian at street level I could see the road I need to cross, but the interior public realms was so confusing when and where I should go in order to cross one building to the other building even though I was using GPS...”
- Paths: “If we follow this direction shown on the Google map, maybe we can find the Ferris wheel next to the riverside.” “The route shown on the Google map is so strange. I cannot find my way very well.”

These outcomes indicate in general terms that, when compared with the group of people who used a mobile device app for navigation, the interviewees who didn't use the mobile device app seemed to gain a clearer sense of the five elements of the city based on using them to help orientate themselves.

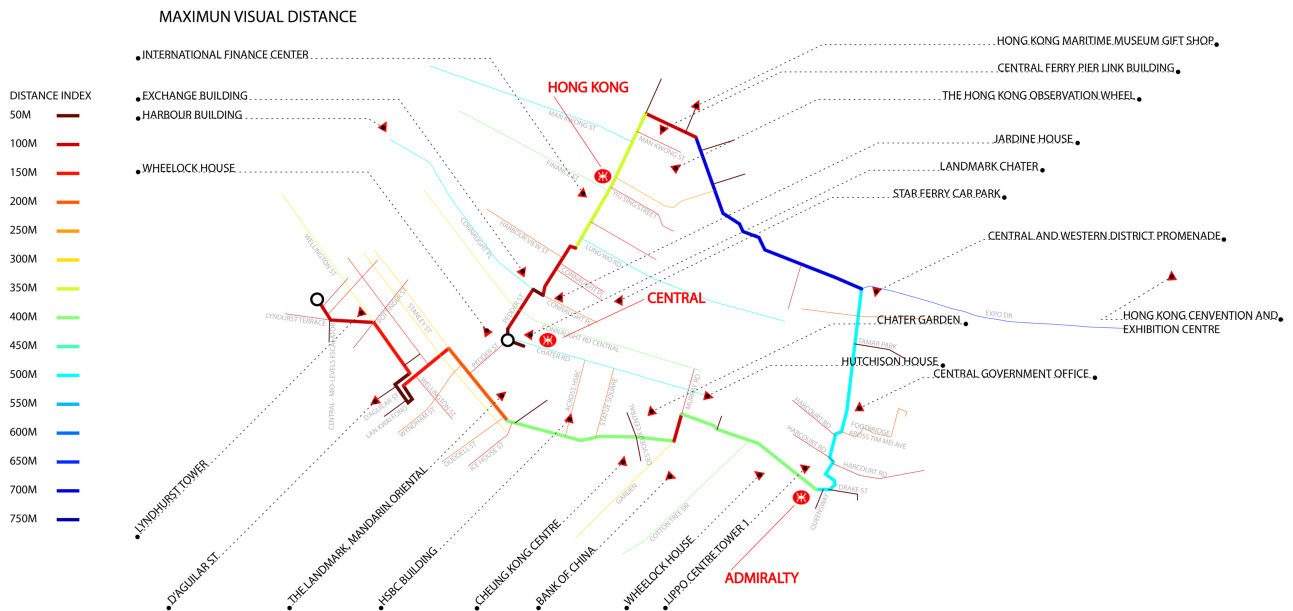
#### Findings:

##### • GPS and Its Impact on City Image

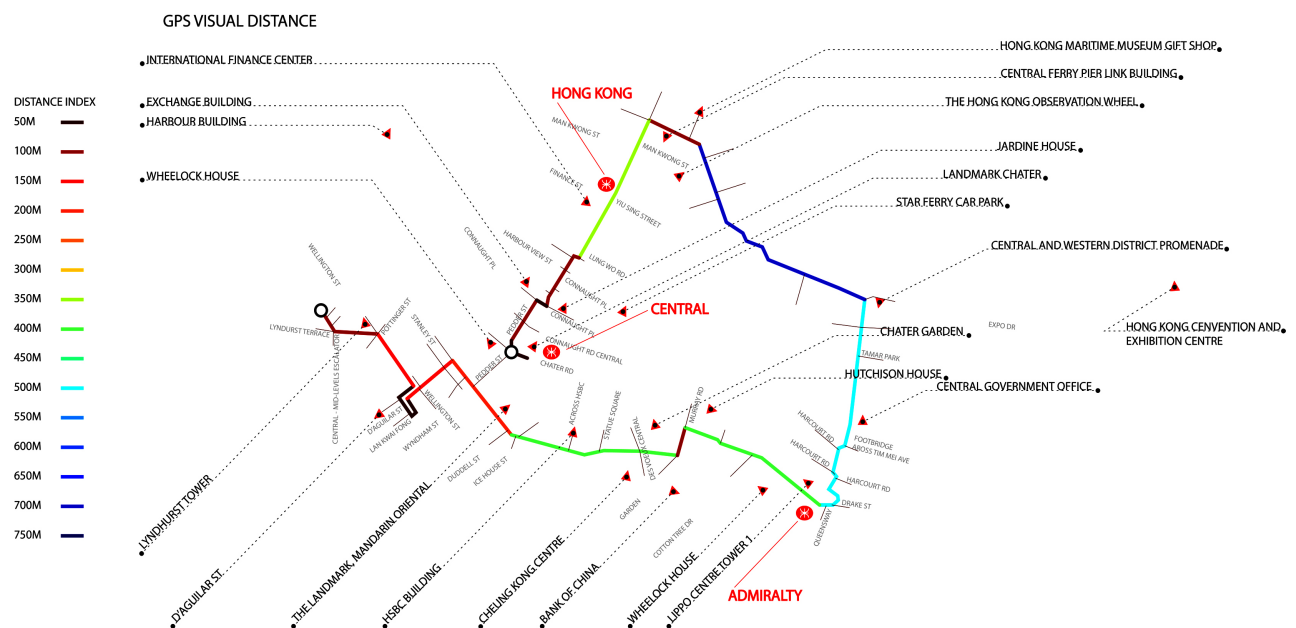
The results from the analysis of the narrative experience of the city can indicate the role and value of five elements highlighted by Kevin Lynch still stand, but the way of sensing/understanding them has changed as noted below:

##### • Landmarks and Nodes

If there are no navigation tools and the search engines on the Internet, people



**Figure 8.** Summary of maximum visual distance when the group of people who didn't used a mobile device app for the navigation system (Source: Drawn by Author, 2022).



**Figure 9.** Summary of GPS visual distance when the group of people who used a mobile device app for the navigation system (Source: Drawn by Author, 2022).

tend to be more exploratory and will go to each place following their instinct and sense of direction. But after a while, people will have their preference or will be recommended to some place where shops or landmarks, and nodes to a certain extent, will cluster with more people, while places without these characteristics become less popular.

With the navigation tools and the searching systems available, people tend to



have “goals” when exploring the street. People will search for what they want to do and the exact location of the place before going outside. Consequently, there are more and more people going to one place while some places will receive less and less human traffic. It can be argued that the commercially influenced logorhythms of Google Maps are supporting the traditional notion of the “richer getting richer” and “poor getting poorer” by influence of foot traffic through the city streets.

- *Paths*

Without the navigation systems, people tend to explore the street with their own preference, towards some aspect of the streetscape, and the hope of a short-cut or quieter route will attract people to divert to smaller roads, thereby assisting in gaining a more detailed understanding of how the city is arranged.

With the navigation systems, people have two ways to choose their routes when they have the destination in their mind: follow the route recommended by Google Map, or stay on the main roads and pick up directions and landmarks from Google Map along the way.

- *Districts*

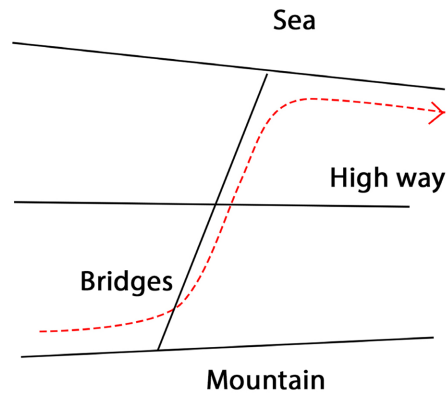
Without the navigation tools, Lynch’s argument was that people gain a sense of “clusters” and “districts”. In this particular study, in their drawing and descriptions the participants describe how they pass “some fancy shops” “the tall building clusters”, “wine bars streets” and so on. They will separate different districts of the site and overlay their routes on top.

With the navigation systems, people have less awareness for “clusters” and “districts” and more concern about simple dots and points they notice when exploring the streets with their phone.

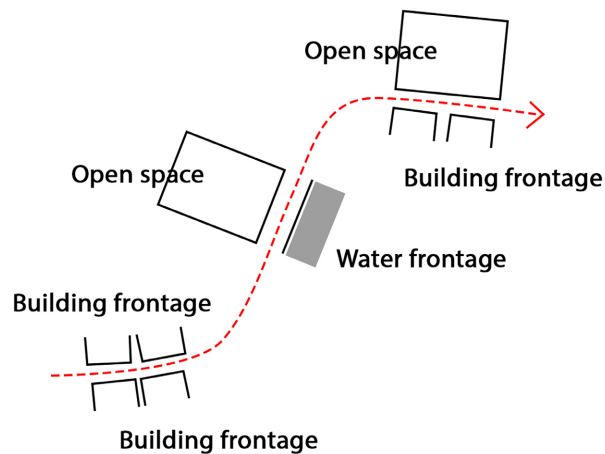
- *Edges*

Without navigation tools, people notice more the “edges” as one of the signals of reaching the destination and form their own concept of the whole area. The edges mostly show the structure of the site (see **Figure 10**). With navigation tools, people have a different concept of edges. They consider more about the edges of “buildings” and symbolic crossing and transitions of different clusters. They notice more about the edges when “crossing” and “going through” some important nodes (see **Figure 11**).

The illustration of mental maps from both user groups highlight a clear distinction and difference in the way the image of the city and its elements are illustrated, but interestingly the way in which the cognitive image of the city was formulated and processed appear to be different. The participants who didn’t use the mobile device gained a better sense of this particular city district from an eye-level, users perspective, with a clearer understanding of the 2D street orientation and edges. Whilst the participants who used the mobile devices gained less understanding from this perspective, they gained a better understanding and overview of the complexity and three dimensional nature of Hong Kong’s public realm, and how they were positioned within it.



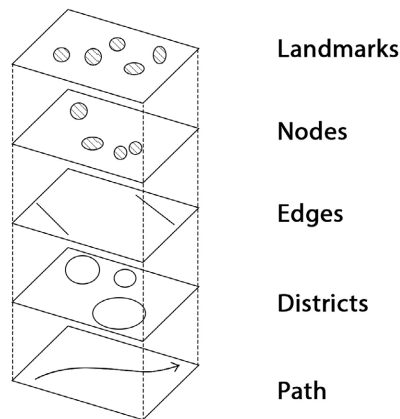
**Figure 10.** Edges concept diagram of the mental map which shows the situation of the map with Google map (right) (Source: Drawn by the author, 2018).



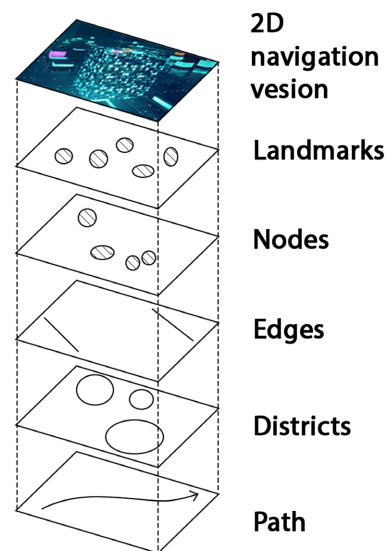
**Figure 11.** Edges concept diagram of the mental map which shows the situation of the map without Google map (left) (Source: Drawn by the author, 2018).

These findings raise the question ‘How has the advancement in mobile technology impacted on how people understand these elements and use them for orientation?’ Has it changed the significance of these elements; have other elements gained in significance? The research indicates that this advancement does lead to a new way of sensing and formulating an Image of the City. Using a case study of Hong Kong’s Central District, this empirical study shows how a GPS-enabled device as a tool and platform can assist people in their reading and understanding of the city. Overall, people had a clearer but shallower structure of the mental map when using the Google Maps, and the places people remember are mostly based on the routes assigned by Google Maps. Again, based on their own experience people had additional imaginations and descriptions about places that are not located nearby or have some distance from the routes (see **Figure 12** and **Figure 13**).

Importantly, the impact of this technology on the urban environment can be



**Figure 12.** Original elements of city image (left) (Source: Drawn by the author, 2018).



**Figure 13.** New elements of city image (right) (Source: Drawn by the author, 2018).

understood as a recursive process, unfolding over lengthy periods of time, in which network infrastructures and patterns of usage evolve by continually responding to one another. In his book *ME++*, Mitchell (2003) comments on how the networked city affects the relationship between users and the city. He argues that a user is no longer a form of Vitruvian Man, “enclosed within a single perfect circle”; rather, he or she is connected and linked to the surrounding city via the handheld device they are carrying. Mitchell refers to the networked user in the city as being a spatially extended cyborg, so less a Vitruvian Man, more an Inspector Gadget, as a means to show how the device changes the relationship between human and city. In relation to the five key elements that Lynch identified, their significance remains but the way that they are sensed and related to

have changed.

## 2. Conclusion

People often consider that technological advances can offer increases in the efficiency and convenience of urban life. However, the impact of technology as a plug-in system in urban space is more complicated than that. GPS- and social media-enabled technologies create a virtual, personalised overlay on physical space that influences the orientation and understanding of each individual in varying ways, and once activated these overlays created a variety of different usages and impact the cognitive readings of public space in the contemporary city.

Considering that, this paper has shown that there can be drawbacks when users rely too heavily on mobile technologies to assist with their reading and navigation through the city. Whilst GPS is undoubtedly useful in assisting users in getting where they need to go, the research found that the city image becomes linear, fragmented and limited when using GPS, rather than something more expansive, varied and open-ended without it. For those using their phone, they continue to use the visible landmarks of the city, but would be more concerned with the landmark that is the cellular network signal tower that ensures their continued connectivity and orientation via the device. If we assume that mobile apps will continue to develop in sophistication and reach in terms of augmenting reality with virtual layers of geo-referenced information, it is possible that physical landmarks will become yet more obscured. For instance, *hyper reality* created by Keiichi Matsuda in 2011, a computer scientist, envisions an inability of consciousness to distinguish reality from a simulation of reality, especially in technologically advanced postmodern societies. *Hyper reality* is seen as a condition in which what is real and what is fiction are seamlessly blended together so that there is no clear distinction between where one ends and the other begins. Although not covered in detail in this paper, this hybrid of locational and augmented layers of information in a physical context could be a fruitful line of future enquiry.

In the theory of the Image of the City, Lynch makes the assumption that although cities are inhabited by different urban societies, which understand and interpret the urban environment differently, there is never-the-less some commonality in the cognitional mechanism used to orient oneself within complex urban areas. This paper has explored that the advent of mobile devices with GPS capability creates a distinction in the cognitive processing between those who are using the device for navigation, and those who are not, thereby removing the similarity. In this way, and at least for the time being, wayfinding systems might need to be two-tiered based on the assumption that those who chose and chose not to use their mobile phone and app-based navigation systems are co-existing. If we can adapt our traditional approach to urban design to embrace technology then we have the opportunity to add value and increase usage of public space by making it more accessible.

## Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

## References

- Al-Ghamdi, S. A., & Al-Harigi, F. (2015). Rethinking Image of the City in the Information Age. *Procedia Computer Science*, 65, 734-743.  
<https://doi.org/10.1016/j.procs.2015.09.018>
- DiMaggio, P., Hargittai, E., Russell Neuman, W., & Robinson, J. P. (2001). Social Implications of the Internet. *Annual Review of Sociology*, 27, 307-336.  
<https://doi.org/10.1146/annurev.soc.27.1.307>
- Foth, M., & Sanders, P. (2008). Impacts of Social Computing on the Architecture of Urban Spaces. In: *Augmented Urban Spaces: Articulating the Physical and Electronic City* (pp. 73-91). Ashgate Publishing Limited.
- Kitchin, R. M. (1994). Cognitive Maps: What Are They and Why Study Them? *Journal of Environmental Psychology*, 14, 1-19. [https://doi.org/10.1016/S0272-4944\(05\)80194-X](https://doi.org/10.1016/S0272-4944(05)80194-X)
- Lynch, K. (1960). *The Image of the City*. MIT Press.
- Marshall, S. (2012). Science, Pseudo-Science and Urban Design. *Urban Design International*, 17, 257-271. <https://doi.org/10.1057/udi.2012.22>
- Mitchell, W. (2003). *ME++: The Cyborg Self and the Networked City*. MIT Press.  
<https://doi.org/10.7551/mitpress/4512.001.0001>
- Tolman, E. C. (1948). Cognitive Maps in Rats and Men. *Psychological Review*, 55, 189-208.  
<https://doi.org/10.1037/h0061626>