

# **Examining the Design and Use of Digital Kiosks to Enhance User Experience in Smart Cities**

Ryan Oliver

MA User Experience Design  
Falmouth University  
The Games Academy

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## Abstract

Digital Kiosks can be found in different forms in smart cities across the globe. They exist to provide quick and easy access to a multitude of features, helping smart cities engage with and assist the wider community using technology. This paper examines the uses of digital kiosks within smart cities and how their hardware and aesthetic design affects user experience. A literature review examines specific uses of kiosks, including as access points for digital infrastructure and for information. A study gaining responses from the public and UX specialists was also conducted. The survey focused on opinions of the idea of digital kiosks, current usage, desired features, and the idea of kiosk vs. mobile applications for specific tasks. The results suggested that kiosk networks should focus on supplying access to information over infrastructure as this was the key driver for public interaction with digital kiosks. Additionally, a critical yet unexpected find from the survey was that covid-19 had become a deterrent for use of shared digital displays. Feedback noted that fears over the transmission of the disease through usage of public displays would lower public engagement with current interactive kiosks.

**Key Terms:** Digital Kiosk, Smart City, Public Engagement, User Experience, Interaction Design

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# 1 Introduction

Since 2015, New York City has seen the rollout of thousands of digital kiosks called LinkNYC. These interactive street-side monoliths have a plethora of features<sup>1</sup> designed to improve the lives of New York residents and visitors. LinkNYC has proven incredibly popular, with over two billion cumulative sessions to the end of 2019 (NYC OpenData 2021). LinkNYC is one of several digital kiosk networks that have been released into the wild, with cities across the globe either launching or looking into their own networks.

The idea of the digital kiosk is one of versatility, accessibility, and equality. These publicly accessible devices can be used in many different situations, providing access to general or context-specific functions and information where they are needed. Free usage and generally uncomplicated interaction designs allow people from many socio-economic groups and tiers of technological literacy to access the city's smart infrastructure. The key motivations for their deployment are access and visibility – connecting city populations with the smart digital infrastructure in city centres.

This research paper will discuss the current and potential uses for digital kiosks and issues surrounding kiosk design. The paper will look at how these concerns affect the user experience (UX) and public engagement with digital kiosks in smart cities. A study will be conducted that will assess the public opinion on such matters, gaining an insight into the real-world usage of kiosks, what features should be present to engage the public and if current hardware designs appeal to them. This research aims to reveal the key drivers for public engagement with kiosks and how the public view the designs of current kiosk networks. As the potential for kiosks is so great going forward, this study should provide a clearer path for which the future of digital kiosks could take, or for which further research can be conducted.

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<sup>1</sup> LinkNYC features: Free Superfast Wi-Fi, maps and directions, city services, free US phone calls, a quick access 911 button, USB charge ports and two public service and advertising displays. (LinkNYC 2021)

## 2 Background and Context

### 2.1 The Kiosk and the Smart City

Current digital kiosks can trace their lineage back to the 'PLATO Hotline' self-service kiosk. These early plasma-touchscreen-controlled devices allowed access to essentials such as maps, directories, and extracurricular activities (Kelsen 2012: 182). This basic concept progressed into "Multimedia Kiosks" (Ong, Subramanian and Low 1994: 461) that appeared in the early 1990s, providing access to key features such as maps and information videos across sprawling university campus buildings (Ong, Subramanian and Low 1994: 461). The basic premise has remained the same since then. Smart city digital kiosks exist to reach the population directly with the technology, information, and tools they need to enrich and simplify their experiences.

The rollout of kiosks is currently seen mainly in *Smart Cities*; however, the definition of what a smart city is can vary greatly depending on whom you ask (Falconer and Mitchell 2012: 3). Despite the focus on vast amounts of technology in smart cities, many scholars argue that the smart city's human side must take precedence. They argue that technology and IT must serve and empower the populace (Hollands 2008: 315). This definition is particularly pertinent in developing current smart cities and the potential use of digital kiosks to improve the human-smart environment UX. The kiosks should respond to the needs of the surroundings rather than introducing unnecessary and potentially problematic technology (Hosio et al. 2014: 5).

### 2.2 Uses for the Digital Kiosk

Digital kiosks come in various guises and can be used for various functions. The main objective of digital kiosks is to provide a valuable service to members of the public wherever they may be placed<sup>2</sup> (Feller 2018: 9). The core design of the kiosk is adaptable, allowing the functions for each kiosk to be contextual and grounded in their urban surroundings (Gómez-Carmona, Casado-Mansilla and López-De-Ipiña. 2018: 5).

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<sup>2</sup>For example - city centres, train stations, shopping malls or town halls and civic centres or public parks (Feller 2018: 9).

### 2.2.1 Access to Infrastructure

In New York City, ranked 12th in the world for smart-city capability<sup>3</sup> (IMD 2021: 92), the digital divide is seen as a significant barrier to future growth, economic opportunities, and prosperity. 18% of New Yorkers<sup>4</sup> lack a mobile connection and home broadband (NYC 2020). Access to digital devices and affordable and accessible wifi is essential in a modern smart city (Baltac 2019: 542). Digital kiosks are a way in which smart cities can push the necessary wifi access points out to the public where they are needed while also providing the equipment - screens, browsers, and charge points - to utilise it. With 21% of mobile owners in New York lacking smartphone features (De Blasio and Menin 2015: 7), the LinkNYC network is a critical player in allowing all people - regardless of wealth or background - to access vital services and infrastructure (Feller 2018: 9). Kiosks that contain infrastructure access features allow the smart city to work for all community members.

### 2.2.2 Access to Information

Digital kiosks allow interactions between the city and the public easily within city centres. This availability and visibility enables information to be seen and accessed without the need to purposefully seek it out, as would be required with a website or mobile application. Furthermore, direct access or advertising of information on kiosks allows for community members that would otherwise have missed information to be able to engage with it (Hosio et al. 2014: 5). In addition, kiosks may allow for sharing information and connectivity between mobile and kiosks<sup>5</sup>, creating a hybrid UX between large public screens and personal devices. With Kiosks potentially connected to city-wide government networks, information sharing with kiosk hubs can alert citizens of necessary information and events quickly and efficiently. At the same time, the public can add replies, questions, and data (Feller 2018: 11), creating a network of smart citizens, actively engaging with the smart city infrastructure.

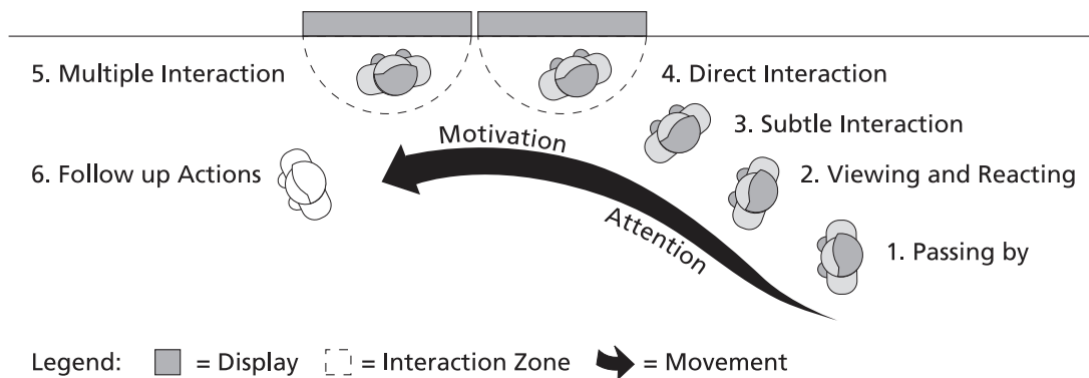
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<sup>3</sup> New York has a grading of BBB in comparison to other smart cities within the same Human Development index (HDI) Group (1) in a scale of AAA-BB based on the perceptions of residents. The ranking of 12th is out of the 118 cities measured across the globe. (IMD 2021: 11)

<sup>4</sup> This equates to around 1.5 million people (NYC 2020)

<sup>5</sup> Technology such as Bluetooth, NFC or Wifi, as well as software such as mobile apps could support this sharing of information.

The ease of reaching the public works for both the public and institutions such as the city councils, whereby gathering feedback through paper or web forms can easily be ignored or missed. The interest generated by interactive displays can increase the amount of feedback gathered due to its physical town centre presence (Goncalves et al. 2014: 36), which is vital for civic matters, future smart-city initiatives, and improvement.



**Figure 1: Müller et al. 2010. The Audience Funnel**

### 2.3 The Influence of Design

Modern digital kiosks have also become sculptural forms of street-side furniture. Aesthetics and hardware design all constitute part of the overall UX of the digital kiosk and can impact the experience of users and how many users the kiosk can attract. Aesthetic qualities can drive user engagement with smart displays before the functionality is known, by enhancing the surrounding public areas appearance and piquing passer-bys interest with their hardware design (Han, Lee and Leem. 2019: 1). As seen in figure 1, users usually pass through phases (1-3) before committing to use of the display (Müller et al. 2010: 1286). Because of this phenomenon, digital displays and kiosks must be eye-catching to attract attention, while suiting and enhancing the surrounding area.

Getting users to pass into the 4th stage of the diagram is a critical issue known as “interaction blindness” (Ojala et al. 2012: 47). With the lack of interactive media on city streets and few large screens used for anything other than advertisements, many people may not perceive the kiosks as interactive (Ojala et al. 2012: 47). To combat this, UI elements

should be bold and eye-catching to encourage interaction from a distance, alongside visual clues on the exterior of the kiosk<sup>6</sup>.

Where the kiosk is located within its environment is another factor influencing the usage of digital kiosks. Careful consideration must be given to the surrounding public realm, with aspects such as "lighting, sound, safety and indoor-outdoor considerations" (Kuikkaniemi et al. 2011: 44). Incorrect positioning could result in little usage and potential misuse of the device<sup>7</sup>, as well as harm or nuisance caused to the surrounding community. To correct this issue and return to technology responding to and working with its context (Hosio et al. 2014: 5), public consultation with the surrounding neighbourhood should occur before installation.

### 3 Methods

A study was conducted to gather primary data beyond the literature review that explored the development, design, and requirements of digital kiosks. This study consisted of a questionnaire sent out to members of the public and UX design specialists. The questions focused on three key areas: the previous usage of and opinions of digital kiosks, desired features within a digital kiosk, and a scenario-based section looking into digital kiosks versus a mobile application for specific tasks.

The study returned 27 responses between the 28th November 2021 and 18th December 2021. This is a smaller response than initially hoped; however, the results displayed a clear pattern and general consensus in certain areas that will provide a clear path for discussion. The participants were not directly chosen but responded to a call for answers on their own accord from group messages. This has resulted in a range of participants from various backgrounds and age groups, hopefully mimicking the makeup of a city centre and the potential users of digital kiosks.

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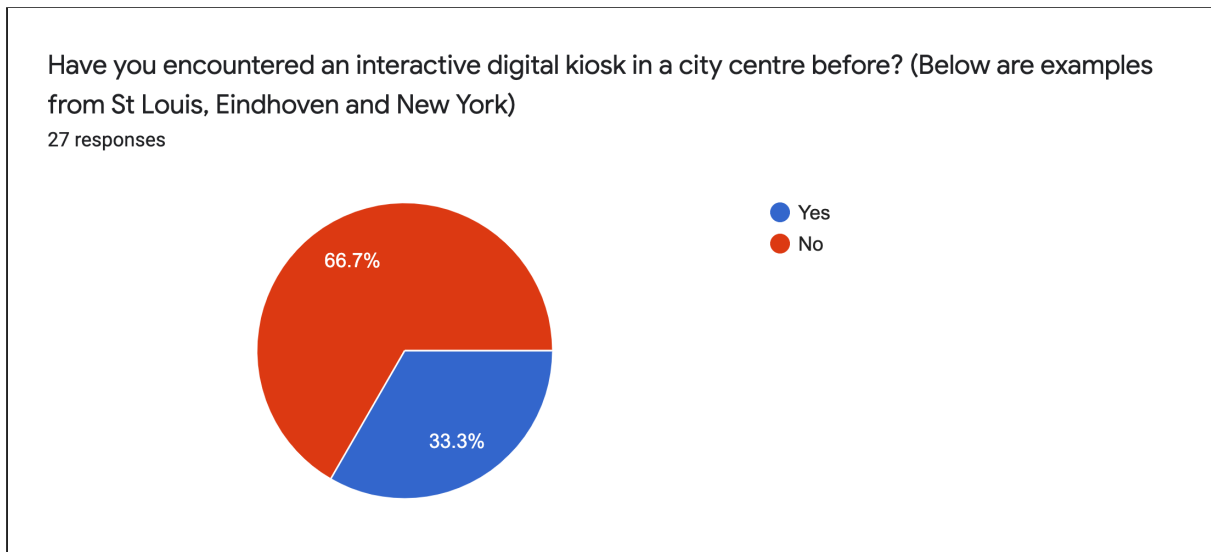
<sup>6</sup> Potential visual clues could be, for example: stickers/banners, floor markings/paving, lighting and canopies amongst others. The design should fit with and enhance the surrounding public realm.

<sup>7</sup> Passive surveillance is provided by the public in high-traffic areas such as city centres, shopping malls and tourist hotspots. Fewer incidents of anti-social behaviour and device misuse would occur in these areas compared to quiet back streets or in public parks.



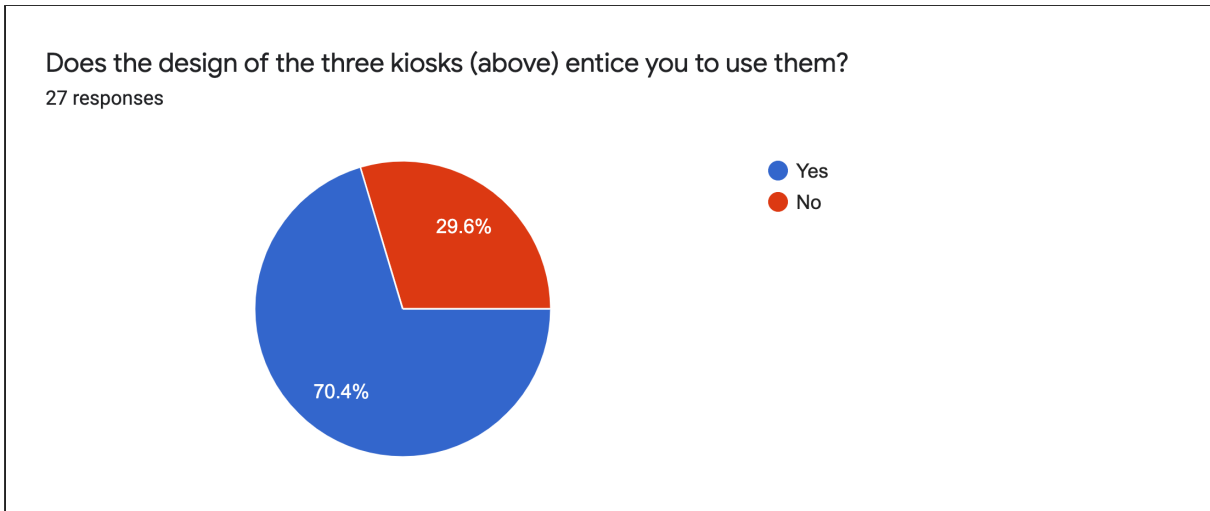
## 4 Research Results

The results gathered from this questionnaire will help understand how the public currently uses digital kiosks and how they can be developed and adapted to better suit the public's needs and desires going forward.



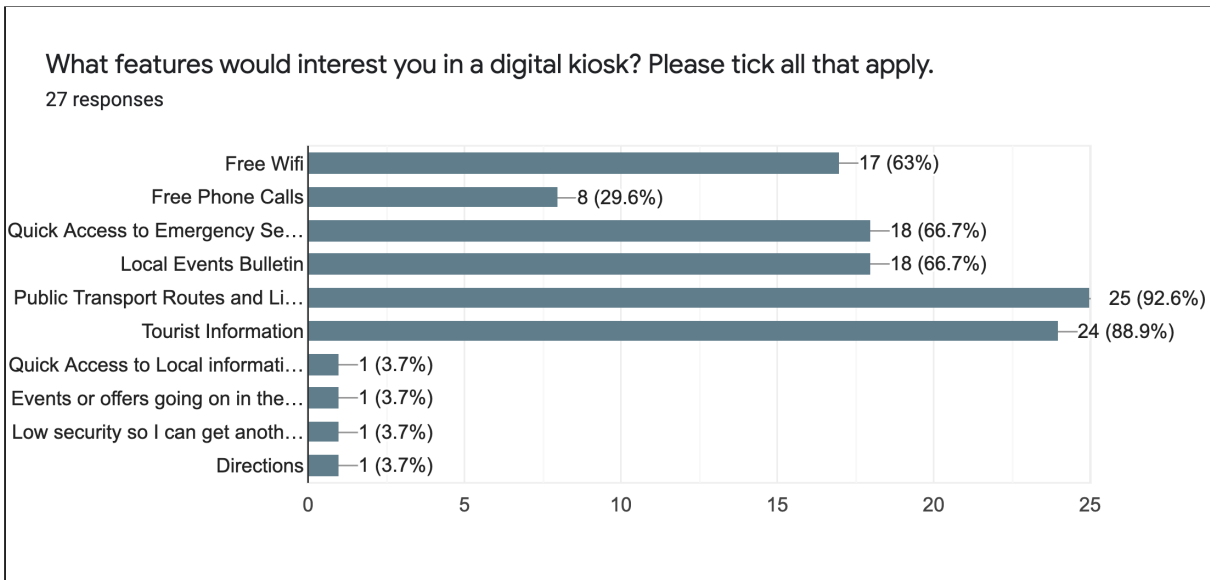
**Figure 2: Responses to Question 1**

To gauge the respondents' prior experience and potential knowledge about digital kiosks, they were asked if they encountered a kiosk and, if so, what it was used for. Only a third (33.3%) of the respondents had used a kiosk (Figure 2), and uses were quite similar across the board, with 5 participants stating they used kiosks for maps, directions, and shopping mall/street plans.



**Figure 3: Responses to question 3**

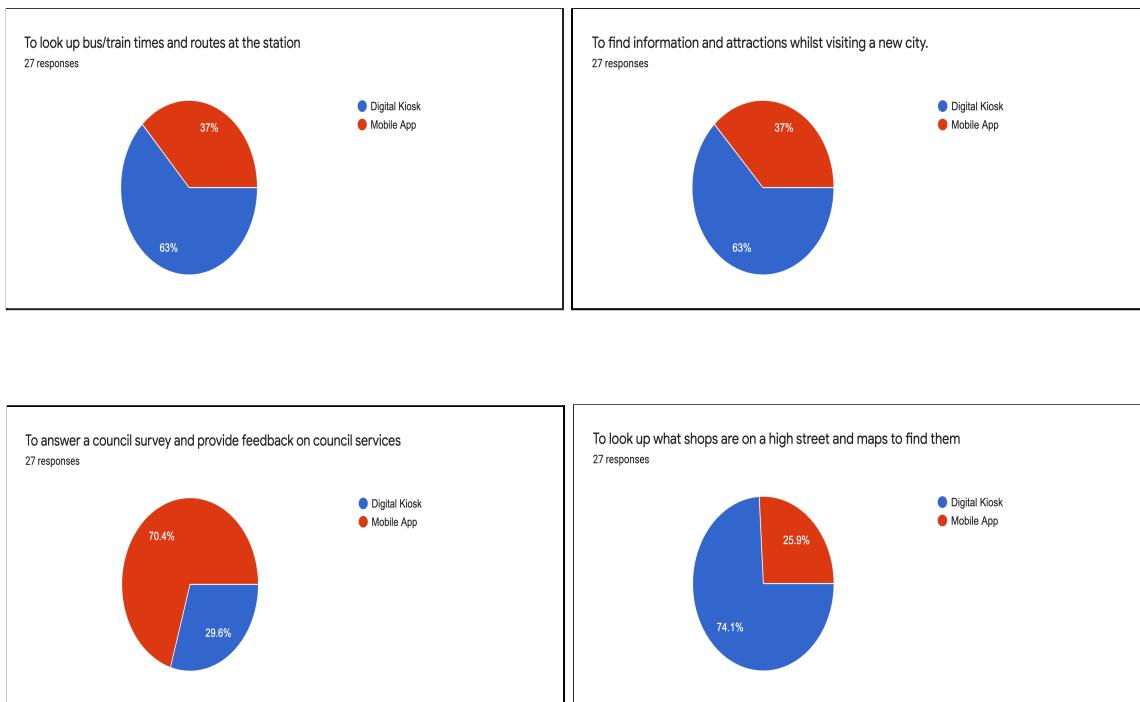
A very similar split in numbers (figure 3) resulted from the question on design and the appeal of the aesthetics of the three example kiosks. The reasons they did not appeal included; not wanting to use a public touchscreen, especially in the current covid situation (2 responses), that they looked static and too much like advertisements, or not obviously interactive (3 responses).



**Figure 4: Responses to Question 5**

The clear favourite for desired features was 'Public transport routes and Live times,' with 92.6% of respondents choosing this feature(Figure 4). A close second was 'Tourist Information' at 88.9%, followed by 'Quick access to emergency services' and 'Local events

bulletin' both with 66.7%. Three out of the four most popular choices are information rather than infrastructure based.



**Figure 5: The responses to the 4 task-based questions**

The final section of the questionnaire set four scenarios and asked the respondents which they thought would be more useful to carry out the tasks between a digital kiosk and a mobile application. For 3 out of the 4 scenarios, the digital kiosk was chosen over the mobile application (figure 5). The mobile app was preferred for the task 'To answer a council survey and provide feedback on council services at 70.4%.

## 5 Discussion

One of the key points that could be inferred from the data gathered from this research is that the recent shift to infrastructure access in digital kiosks - features such as those in the LinkNYC Kiosks<sup>8</sup> - is not the leading interest for members of the public. Instead, information is the key driver for public interaction with digital kiosks. With smart city technology responding to the needs and wants of the city populace (Hosio et al. 2014:5), this result

<sup>8</sup> Infrastructure access - Free Wifi, web browsers, phone calls, touchscreen tablets etc.

could suggest that the future of digital kiosks rests as information points to help guide and inform citizens rather than provide tools. However, this skew to information over infrastructure access could be due to how the research was conducted, as all participants had access to broadband and a personal digital device to receive and answer the questionnaire. Gathering responses from those without access to these tools in the future would provide a more balanced and true picture as to the usefulness of infrastructure functions.

As for public opinion on the current hardware design of digital kiosks, the results of this research possibly suggest that current design trends<sup>9</sup> - namely rectangular monoliths akin to advertisement boards are suitable, or at least tolerated by the majority of the public. The feedback from some of those who were not attracted to the kiosks noted issues similar to 'interaction blindness' (Ojala et al. 2012: 47). The sculpted, cylindrical shaped kiosk was the only exception of the three, noted as "interesting" and less like an advertisement board. Kiosk aesthetics may need to move away from the current slab-sided designs to attract new users in the future, yet currently, their rarity<sup>10</sup> seems to be enough to make them enticing to use.

Feedback exposed a side of kiosk interaction not considered before in the literature review, which was the Coronavirus pandemic's impact on kiosk usage. Covid-19 presents a novel issue with the design of digital kiosks, with the potential for transmission through shared use of the public displays noted as a deterrent for use. As the sample size of the research was relatively small, only 2 people noted this. Were the study to continue and collect a more significant number of responses, especially in city centres, this concern would likely be a commonly observed barrier to usage in a post-covid world. Research in this area, specific to covid-safe interaction with shared screens, has already started - such as using a mobile web app to control kiosk functions<sup>11</sup> (Vosinakis and Anastassakis 2021: 2). However, additional research is needed in this area to develop the correct response that can work for people of all age groups, socio-economic classes and abilities.

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<sup>9</sup> Images of the LinkNYC kiosk, St Louis (STL) digital Kiosk (both similar in design) and Citybeacon Eindhoven were shown to the participants of the questionnaire. (Appendix B - Research Methods and results - Questionnaire)

<sup>10</sup> As only 1/3 of participants have seen and/or used a kiosk, the kiosks are not commonplace and so are possibly interesting in design due to their uniqueness to those participants.

<sup>11</sup> This method requires the use of a mobile, thus rendering kiosks potentially useless for those without one, cutting off some members of the public that may need the kiosks most.

Finally, in the kiosk versus mobile scenarios, the mobile app was most popular in the one task that would potentially require more information to be input and potentially require more time and effort on the part of the participant. Therefore, it can be inferred that tasks carried out on a kiosk should be quick and relatively simple, requiring few steps with simple UIs to complete in order to entice participation.

## 5.1 Further Work

As this survey was online, participants responded based on images as examples rather than physical devices. Future research should move to an ethnographic study to provide a broader sample of participants. This research will provide the basis for future projects looking into the newly revealed critical area of modes of interaction with kiosks in a post-covid world. Touchless interfaces are the future of kiosk design. Further study should research alternative Natural User Interfaces (NUI) such as gesture and voice control for kiosks in post-pandemic city centres.

## 6 Conclusion

Digital kiosks are incredibly flexible and powerful tools that can be utilised in various ways to improve life within smart cities. From the start of this research, the question area was broad, with many potential avenues for discussion. The research study has whittled this question down to three main branches that may provide direction for the future of kiosk design and implementation. Firstly, information seems to be the key driver behind public interaction with digital kiosks, and features within multipurpose kiosks should aim to provide helpful information instead of, or at least alongside, tools. Adding additional features such as browsers, phone calls, and wifi is unnecessary to entice users, although additional research within this area would be beneficial to capture a more comprehensive sample of opinions. Secondly, due potentially to the current rarity of city centre kiosks, the aesthetics are generally enticing to use. In the future, should they become commonplace, kiosk design may need to adapt to become more noticeable and interesting to overcome “interaction blindness” (Ojala et al. 2012: 47) that some members of the public are already exhibiting. Finally, touchless gesture control and other novel kiosk NUI must be researched and implemented. These modes of interaction will combat users' potential hesitation to engage

with shared displays during the covid pandemic and beyond. Acting on and further researching these key points will ensure that digital kiosks continue to enhance human-smart city interaction, complimenting or providing valuable alternatives to mobile and other personal digital devices within smart cities.

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## List of Figures

Figure 1: Müller et al. 2010. *The Audience Funnel [adapted from 39]* From: MÜLLER, Jörg, Florian ALT, Daniel MICHELIS and Albrecht SCHMIDT. 2010. 'Requirements and Design Space for Interactive Public Displays' (p.1286) In *Proceedings of the 18th ACM International Conference on Multimedia*. 1285–94.[online] Available at: <https://doi.org/10.1145/1873951.1874203> [accessed 30th Nov 2021]



## Appendix A - Research Proposal

### **Utilising Digital Kiosks to Enhance Citizen Engagement in Smart Cities**

Ryan Oliver

Tutors: Liz Coulter Smith and LJ Hazzard

MA User Experience Design  
Falmouth University  
The Games Academy

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## Introduction

Since 2015, New York City has seen the rollout of thousands of digital kiosks called LinkNYC. These interactive street-side monoliths have a plethora of features designed to improve the lives of New York residents and visitors. Users have access to: Free Superfast Wi-Fi, maps and directions, city services, free US phone calls, a quick access 911 button, USB charge ports and two public service and advertising displays (LinkNYC 2021). LinkNYC has proven incredibly popular with over two billion cumulative sessions to the end of 2019 (NYC OpenData 2021).

The idea of the digital kiosk is one of versatility, accessibility and equality. These publicly accessible devices can be used in many different situations, providing access to general or context-specific functions where they're needed. Whilst the usually simple designs and free usage allows people from many socio-economic groups and tiers of technological literacy to access the city's smart infrastructure. The key motivations to their deployment are access and visibility – connecting city populations with the smart digital infrastructure in city centres without the need for personal devices.

The aim of this research paper is to analyse the use case for digital kiosks and other interactive displays within city centres – such as the LinkNYC installations. The paper will investigate how digital kiosks can be used to enhance user experience and citizen engagement in smart cities. Alongside this, additional research will be undertaken to identify the key uses of this situated technology, by gaining public opinion on the idea of digital kiosks and insights into currently used and desired features.

### Problem Statement and Research Relevance

Smart cities are blossoming across the world, with 118 cities being collected in the IMD 2021 world smart city ranking (IMD 2021: 11). This number will continue to increase, and as it does, the need to create simple, functional and truly helpful interfaces between the city and the citizens will become more important.

With this development, the interface between the smart city and their citizens is often pushed to mobile apps and web portals. This is often seen as the most convenient method however, digital kiosks and interactive displays can pull this isolated form of interaction back into the city itself, creating a more connected and usable city centre that allows people of all socio-economic groups to access these city functions.

This research paper will look at the digital kiosk and how they can be utilised and further developed to enhance the user experience in city centres and connect all residents with the smart city infrastructure.

## Research Question(s)

- **How can digital kiosks be used to enhance user experience and citizen engagement within a smart city?** - Do the current kiosk networks appeal to the public through features and design and what could be added or developed to improve appeal and increase public usage?
- How can digital kiosks and interactive displays be developed and further utilised within cities to improve access to smart city infrastructure and features? – How do/would they compare to an app for desirability and perceived usefulness – What is the public view on these Kiosks, their designs, and desired features?

## Research Methods

The research for this paper will be carried out in two key stages. The first stage will consist of a literature review, whereby key texts shall be selected from the following libraries: Falmouth University Library, Google Scholar, ACM Digital Library, IEEE Xplore, Science Direct (Elsevier) and ResearchGate. The literature collected will look at past and current uses of - and research around – digital kiosks and interactive displays in cities and public engagement with smart environments.

The second phase of research will consist of the collection of primary quantitative and qualitative data through a questionnaire that will be created using Google Forms. This method will allow for the collection of responses to occur remotely online in-line with the MA course. The questionnaire will be open to a wide range of individuals, aiming to collect responses from at least 20 members of the public aged 18+ and from differing backgrounds. This wide sample group will mimic the potential users of street side kiosks as they are open to all individuals within the city. The questions will investigate the public use of digital kiosks, features they find or would find most useful, opinions of current kiosks (with images) and finally what they would find most useful between a kiosk and a mobile app in certain situations. The responses will provide a base for future research into the design and utilisation of digital kiosks, and human-smart environment development.

-Questionnaire to gauge public desire for digital kiosks and to understand what they have been/are currently used for and how they can be improved with additional features.

-Mix of qualitative and Quantitative data

-The responses will support the future development of digital kiosk design and human-smart environment research. By outlining what the public would want out of a digital kiosk, how they would use them and how the current crop of networks appeals to the public.

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## Appendix B - Research Methods and Results

### Questionnaire

Access to the original questionnaire that was sent out to participants can be accessed here: <https://forms.gle/U9D8CZgGHtbvtq5T9>

### Research Results

The raw research results can be viewed as a sheets document here:

<https://docs.google.com/spreadsheets/d/17xrAMobXkQ0OIYHjJJ8yVTyxWsfHYQD9FksO9NVu0bM/edit?usp=sharing>