Service (eco)system in digital mapping platform

Developing a value co-creation framework and contribution of service design

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Copyright Statement

Abstract

The continuous technological improvement of digital mapping in the service economy has fundamentally altered mapmaking and its usage mechanisms. These changes have challenged the established modes of developing map-related products and services and this phenomenon appears to be increasing. While the established mapping industry has been substantially disrupted by service innovations, the latter phenomenon requires new theoretical and empirical understandings of how digital mapping is being implemented in the emerging service economy.

This dissertation develops theoretical knowledge that outlines the value system for a digital mapping service and its implementation in light of cartographic and service system theories. It further underlines service design as potentially providing meaningful tools with human-centred approaches and systemic orientations which can help realise digital mapping service opportunities. The main body of the research consists of four case studies and collaborative project with Transport for London. These identified four types of service system, which also demonstrate the challenges and opportunities in developing a mapping service in each case, furthermore their relational interaction. This study also attempts to assist participants in the service (eco)system in mapping to co-create the value through the sharing of resources, thereby maximising the value of the technology and resources generated.

This thesis extends the theoretical understanding of digital maps from a service system perspective and advocates service design as providing methods to assist its implementation while also providing a framework that not only enables participation in mapping service systems but assists practitioners to re-design service (eco)systems through collaboration approaches and value co-creation.

Keywords: Cartography, Digital Mapping, Digital Platform, Service (Eco)System, Service Design

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Author's declaration

During the period of registered study in which this thesis was prepared the author has not been registered for any other academic award or qualification.

The material included in this thesis has not been submitted wholly or in part for any academic award or qualification other than that for which it is now submitted.

Signature:

Date: 30 August 2019

Abbreviations

A2A Actor to Actor

API Application Programming Interface

B2B Business to Business

B2C Business to Consumer

G2C Government to Citizen

GUI Graphical User Interface

GDL Good Dominant Logic

GIS Geographical Information System

ICT Information Communication Technology

IoT Internet of Things

OS Ordinance Survey

OSM Open Street Map

SD Service Design

SDL Service Dominant Logic

VGI Volunteered Geographic Information

Typographic conventions

"Double quotation" denote direct quotes from literature or from interview transcripts. 'Single quote' indicates figures of speech or jargon. *Italics* are used for emphasis. CAPITAL nouns are used for organisation, brand, products, service and companies.

Chapter 1. Introduction

1.1 Context and position of research

For many centuries, maps have existed as mediators between the human mental world and the physical world. They are considered to be one of the oldest forms of human communication, consisting of almost universal visual metaphors reflecting analogical thought (Harley, 1987; Harley and Woodward, 1987). Maps as visual language have encompassed natural philosophy, people, culture, and the social implications that shape the geography of the human mind in various formats, as well as dealing with a range of subject matters. They have encapsulated a trace of how human society should be ordered and communicated at certain times and in certain spaces.

Over the past half-century, the study of cartography has focused mainly on the most productive ways to theorise cartographic production, dissemination and its use, with references to specific notions of ontology, epistemology, aesthetics, and methodology (Kitchin, Dodge and Perkins, 2011). The significance of maps has compounded a complex series of interactions between their making and usage which have required knowledge of, respectively, the real world, mapmakers, map-readers (i.e. users), and the map itself as an artefact (Harley, 1987). Our conceptual understanding of the nature of maps from the perspective of maps as artefacts and the technical process of their production has emphasised their accurate measurement and comprehensiveness as a scientific endeavour- 'map effectiveness' (Robinson, 1995; Robinson, Woodward and Edney, 2007). Indeed, this view was predominantly discussed in the early study of maps (from the 1950s). The study of the technical approach to mapping was soon recast by the cartographic communication approach as a cognitive science. Then, a substantial amount of empirical research investigated maps' capacity to transmit cartographic knowledge from mapmakers to map-readers (i.e. users), and effective ways to design maps including aiding users' ability to read various elements of maps, i.e. the 'cartographic communication model' (Kolácný, 1969), which was further articulated by 'geovisualisation' (MacEachren, 1994; Montello, 2002).

During the ontological shift in thinking about maps—from maps as the representation of truth to maps as social constructs –, cartographers problematised the dominant theory and scientific view regarding 'what maps represent' but in the end came to emphasise 'what maps do', wherein maps were seen to be potent depictions of power expression with extraordinary authoritative influence (in the 1980s). (Robinson, 1978; Harley, 1989; Wood, 1992). The exploration of scientific and cartographic knowledge production over time produced new cartographic theories, with the understanding that maps are both representational and practical, thereby interpreting the nature of maps as *processes* rather as *products*. On this view, the intrinsic dimension of maps is their constant state of *becoming* (Hanna & Del Casino, 2006; Wood & Fels, 2008a) and their status as *fluid* and *mobile objects* that are always in the process of being made (Dora, 2009). Instead of viewing maps as representing certain spaces at *particular moments*, maps transform spatial knowledge from one specific time and space to another, meaning that they produce new space and time *in the context of particular moments* (Casebeer, 2006)—therefore, given the nature of maps, they are processual and emergent rather than having the status of artefacts and products.

This was the most significant turn in cartographic theory and marked a shift from a representational to post-representational perspective, and then to a processual/emergent understanding of mapping focused primarily on the ontological underpinnings of cartography (Crampton, 2004; Pickles, 2004; Hanna and Del Casino, 2006; Kitchin and Dodge, 2007; Wood and Fels, 2008; Dora, 2009; Kitchin, Gleeson & Dodge, 2013).

The shift in ontological assumption is closely aligned with the recent development and wide use of advanced digital technology in every aspect of our lives. In addition, digital technologies in mapping and smart devices have allowed maps to become much more fluid and pervasive (as a form of information), whereas previously maps contained a static set of information frozen in time and space. Maps now fulfil collaborative mapping functions as participatory digital platforms with the capacity to collect, create, store, and process data through interactions between people, environments, and places. Maps have transcended their artificial value, which implies both a fundamental ontological and epistemological shift in their nature. In this transformation, users become co-producers of maps, as have service and technology providers, governments, and other stakeholders (Sun & Park, 2017). This shift has significantly influenced the way maps perform and the ways in which they interact with other stakeholders, inevitably altering the ways in which design is involved in mapping.

This digital transition in maps and mapping, which began a few decades ago, now dominates to a much greater extent. The increasing pace of GIS technological advances such as geo-analytics, location aware IoT devices, and integrated geospatial data are also boosting the adoption of GIS in various regional and market segments—global GIS-related market was valued at USD 5.52 billion in 2016 and is expected to reach USD 10.12 billion by 2023 (MarketsandMarkets, 2017). Many different economic sectors and service segments use various location-based applications and services that are being made available on the Web, while smartphones are one of the most prominent contributors to this market's increase.

Geospatial companies' capital is mostly produced either by advertising models, direct consumer purchases of end-product licences, or service usage either from a fixed fee, standard to premium service subscriptions, or the indirect sale of data utilised by users. The market consists of diverse ecosystem partners from large corporations such as Esri[1], who provide a range of software, services, and platforms as B2B models, to SMEs, who provide more niche specialist services (Kitchin, 2017: p.179), and other mapping platform enterprises such as Goole Maps, OSM[2], and Here[3], which are embedded in other media (platforms), sometimes invisible to users but nevertheless enabling the interconnection of different resources (data, servers) and people (stakeholders).

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[1] The Environmental Systems Research Institute, founded in 1969.
[2] OpenStreetMap (OSM) is a collaborative, volunteer-based geographic information service with a free, editable map.
[3] Here, which was previously known as Navteq, a Nokia property sold to a German carmaker in 2015 for $3.1 billion.

More specifically, Google Maps (launched in 2005) achieved huge success, reaching the most significant online mapping market share as they decided to 'open' up their data in the form of API to relatively everyone, despite the fact that they had recently decided to start charging a fee for API usage for developers (June, 2018). They allowed individuals, developers, and companies to adapt their service as a basemap, which resulted in anyone being able to develop their maps without professional knowledge. Both public and private businesses are able to promote their locations and add reviews and photos gathered from customers, which allows maps to become participatory platforms. Google as a data and platform provider can learn from users' search-queries on maps and provide better quality information to users. By simply opening up their platform to the public for 'free', they reuse this data for location-specific targeted ad-models (i.e. Adwords), thereby increasing their capital by reselling their API as data services to a number of businesses.

In a time when map-data was controlled by government agencies and large private companies, which were restrictively expensive, similarly OpenStreetMap (OSM, launched in 2004 in the UK) opened their maps up for anyone to use for any purpose, free of charge. They opened up their basemap to the public to be able to share, edit, and update geospatial data on the OSM database. The idea was similar to the Wikipedia model (see Wiki mapping. Sui, 2008), which is constantly updated through voluntary efforts, while OSM has more than two million members who use GPS tools, satellite photos, and their local area knowledge to solve geospatial-related problems by using 'open' editable maps of the world. OSM started as a 'bedrock' platform for many other location-based products using open GIS sources and software (i.e. Foursquare, Esri's ArcGIS, Mapbox etc), such that the data is owned by the users and communities, while in contrast Google owns users' contributions, which can be controlled and reused by Google themselves.

In a similar case, Bing Maps—licensed by Microsoft—is a mapping system partially powered by HERE to generate a high-precision geospatial database pulling in street, postal, and imaging data and other third-party data sources, therefore with the ability to focus on comprehensive geospatial databases for platform-enterprise-facing business models (i.e. truck-routing systems) and future autonomous vehicles.

In addition, countless consumer-facing applications integrate maps into their services. For example, Citymapper[4] offers a free-of-charge service to end users that utilises TfL's open transport API on Google Maps as its basemap platform. The service is known as an application designed to find the best routes to get around cities in real-time by providing public transport data integrated with other transportation datasets. Citymapper has brought in over $50 million in investment from venture capital by cleansing, repackaging, and connecting pre-existing open data (TfL API) in better ways, thereby delivering information needed at particular locations and times. The crowdsourced transportation service Waze provides real-time road updates from over 80 million volunteers using iOS and Android apps. Google acquired Waze for $1.1 billion (in 2013), with the idea of connecting maps with users' knowledge and experience on the road, thereby delivering substantial road and road-condition information on demand. Waze allows several million users to act as sensors (see 'citizens as sensors', Goodchild, 2007), who transmit real-time traffic data on the road as well as identifying accident locations. While Google Maps facilitates multi-layered geospatial data, Waze has integrated other party's services (i.e. Spotify[5]) as well as socially-driven user-values, either allowing users to directly submit traffic-related information or to unconsciously generate traffic-related data through its navigation service. The vast number of volunteer efforts reduce the cost of maintaining the mapping service, while also generating more financial value by expanding services through directing potential customers to other partners such as retailers, fuel stations, or restaurants as part of ad-model revenue generation.

Whilst these enterprises have operated similar monetised models such as ad-modelling and reselling their mapping data, Uber[6] has moved into the mapping industry—along with

[4] Citymapper is a public transit app and mapping service for both smartphones and computers. It integrates data for all urban modes of transport, from walking and cycling to driving, with an emphasis on public transport.

[5] Spotify is music streaming service founded in 2006. The free service offers basic features with advertisements, while the premium service offers additional features, such as improved streaming quality via paid subscriptions.

[6] Uber is a transportation network company offering services include peer-to-peer ridesharing, hailing service, food delivery, and a bicycle-sharing system that has over 110 million users worldwide (est. early 2019).

Hailo[7] and MyTaxi[8]—and radically altered how the existing industry operates, without owning physical resources and hiring employees. Instead it connects people to people (e.g. drivers to passengers) through the maps and mapping platform, whereas the conventional taxi industry requires many more steps to get a taxi to its arrival destination. Uber has attempted to develop its own mapping platform based on accumulated service-usage data, and has now extended its service into food delivery (UberEats). Deliveroo[9] was a forerunner in food-delivery service, connecting restaurants, deliverers, and users; logistics companies for organisations such as Amazon use best-routing maps to calculate delivery slots and thereby faster driving over shorter times; while the leisure industry (Booking.com[10], Tripadvisor[11]) and the property rental market (Airbnb[12]) use map platforms to connect locations with guests. Finally, Google integrates all this information and services into its platform.

These consolidation of various types of geospatial data into mapping services and platforms reshapes established practices of disseminating geospatial information in new ways, thus remapping the established mapping industry. Indeed, changing how maps work, in the form of geospatial and social interaction, reduces the gaps between the service provider and customers.

These are significant shifts in how we use maps/mapping that drive new ways of using maps and offer both significant opportunities and threats. The result is a disruption of the established mapping-platform industry and its business model in geospatial-related industries but also the emergence of new business models that result in market expansion. As more people and enterprises are empowered by new technology to create, use, and develop services in maps and mapping, this technological influence has led to the

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[7] Hailo is a British mapping technology platform founded in London in 2011. This service matches taxi drivers and passengers through its smartphone apps.

[8] Mytaxi is taxi hailing app that has been available since 2009. It offers people just two taps to a licensed taxi and provides a direct connection between passengers and drivers.

[9] Deliveroo is food delivery service founded in 2013. It connects restaurants, kitchens, and users and makes revenue by charging restaurants a commission fee, as well as by charging customers a fee per order.

[10] Booking.com is a travel fare aggregator service for lodging reservations covering 228 counties.

[11] Tripadvisor is travel and restaurant search company that offers hotel and restaurant reviews, accommodation bookings, other travel-related content, and travel forums.

[12] Airbnb is online marketplace and hospitality service company that does not own any real estate but is based on brokerage.

identification of a paradox: we see both an increasing marginalisation of cartographic practice within mapping platform enterprises (i.e. see 'GIS has killed cartography' Charlotte, 1996); 'Cartography is dead' Wood, 2003), and at the same time an increasing need to study the implications of the service perspective as influenced by digitalisation (see 'Cartography is Alive -Thank God!' Carter, 2013; Dodge, 2017).

However, to date, much research and thinking about maps/mapping has focused on understanding the medium (or artefact) itself, its use and productive ways of performing a specific task via maps. As yet, the existing literature on maps and mapping services has neither thoroughly investigated the theoretical basis on which we engage with maps/mapping or developed an empirical understanding of its effect in relation to business and economic value, which is deeply engrained in service innovation and the digital economy (Kitchin *et al.*, 2017). The question is no longer *what maps represent* or *what maps do*; rather it is more importantly *how we engage* with maps and mapping when maps become a service, an omission which represents a significant gap in our knowledge.

Therefore, this study builds on and extends research that has argued that there has been a fundamental re-conceptualisation of maps/mapping reflecting both an ontological and epistemological shift. Furthermore, this dissertation argues that maps and mapping have now become a value co-creation system from the service point of view. With this in mind, this thesis is shaped by a number of literatures: cartography (namely critical cartography/neo-cartography), but also service science and service design, which are of vital importance for both maps and services in the context of value creation.

The perception of value and value co-creation has been the key concept in the research on services, have focused on the advanced understanding of the value and how the value is created and exchanged. Since S-D logic in the study of service science has maintained the customers as active actors in value creation rather than isolating them from the value exchange and creation process, the latter depends on the integration of available resources such as knowledge, skill, technologies and/or anything in the service system that enables action to achieve the *specific aim of actors in a specific context* (Edvardsson, Tronvoll and Gruber, 2011). Furthermore, value creation is also relational, that is, it depends on how multiple entities or actors create value together, with purposeful and knowledge-intensive interactions between distinct entities meaning that value co-creation is a joint activity between the provider and the customer. In other words, service is at the basis of value co-creation which results from the interaction between entities/actors in a *particular context*.

This view acknowledges value co-creation in the service system, as the user takes an active role in service use, hence playing a core role in the realisation of service value (i.e. the user as prosumer and value co-creator). This means that value is created in the delivery of the service when the customer's desired purposes and goals are accomplished. This also refers to service as being *processual* in nature, referring to '*performance*', meaning that service provides customers with *activities* while an *experience* is created for the customer's benefit (Edvardsson, Gustafsson and Roos, 2005). Therefore, ultimately, user *experience* and *perception* (Woodruff and Gardial, 1996) become the critical factors in value-creation, which are in line with *value-in-use*, *value-in-context* and *value co-creation* (Vandermerwe and Rada, 1988; Ravald and Grönroos, 1996; R. Normann, 2001; Prahalad and Ramaswamy, 2004; Vargo and Lusch, 2004a, 2008a; Grönroos, 2008). That is, participation in the service system can be understood as a way to drive resource integration and value co-creation; value is created during the use of the service and this is perceived as such by users.

In light of this, the recent development of maps/mapping, altered by technology and user involvement, suggest that maps/mapping is now aligned with the definition of a service system – configuring people, technologies, information and/or organisation that create value for all involved beneficiaries as well as integrating resources, knowledge, skills and technologies, through interaction and activities to increase overall value (see Spohrer, 2007). Applying this perspective to maps/mapping services, maps fall between the spheres of service provider and consumer, wherein value is co-created by allowing users to contribute data, information and knowledge to maps/mapping space, thus allowing the facilitation of interactive *activities* and the integration of *shared resources* on mapping platforms.

Since maps/mapping has becomes *processual*, *experiential*, *relational* and *context-dependent* as shown by recent discourse (Kitchin and Dodge, 2012; Caquard, 2015, see Table 1, p. 40), they can be understood to have the status of 'becoming' rather 'fixed' or 'being', depending on how resources are integrated and operated on, in the specific contexts with specific purposes. Therefore, the nature of maps in terms of 'how maps are becoming' is derived from the outcome of resource integration and value co-creation. Elaborating on this assertion, the nature of maps/mapping and service system shares ideology in this context.

In this way, the conceptual overlap between maps/mapping and service systems supports the argument that maps/mapping are now a portrait of a service system, particularly when the user is involved and co-creates value with other stakeholders; thus maps and mapping should be understood as a way of thinking about service systems rather than being tied to cartography or specific design-object offerings. Furthermore, the design of maps and mapping means the designing of service systems, where service design in particular has the potential to contribute to the realisation of service systems with its systemic methods of confronting service offerings.

Therefore, the rationale for exploring service design in mapping lies in both theoretical and empirical explanations of service, necessitating a definition of service systems in terms of maps/mapping. In this sense, this study also argues that service design becomes a matter of offering a perspective on the human experience, ultimately providing meaningful tools and methods for interpreting the service system wherein service provider and user collaboratively create value together. On this approach, the study of maps/mapping in the emerging service economy and from a design researcher's perspective will contribute to bridging the gap between maps/mapping and the service system, where gaps in knowledge allow practitioners in both the mapping and service fields to develop service opportunities. This study will therefore extend cartography into a new space with the shifting notions of its ontological and epistemological status, where the study of service design contributes to the realisation of the service system, which in turn leads future service innovation in maps and mapping. This study is timely, appropriate, and original, and will ultimately extend the boundaries of both cartography, service systems, and service design into new territories.

1.2. Research objectives

The overarching research question of this thesis is: what does it mean for the map to be a service and, from the service (eco)system perspective, what opportunities lie in maps and mapping? Despite a number of studies in maps and mapping supported by technological advancement, there has been little focus on the theoretical or empirical understanding of maps from a service-study perspective, that is, in addition to the conceptual and practical relationship between the two roles. The focus of attention here is not on a specific actor (entities), but more on their relationships, interaction, activities, resources, and value-creation processes and practices, which result in service ecosystems in maps and mapping.

As a consequence, this thesis aims to develop both a theoretical and empirical understanding of maps from a service-system perspective as well as investigating its implications. In terms of theory, it aims to extend cartography to the service system and to identify the relationship between actors and their activities within the service ecosystem. A variety of theoretical contributions to the study of service systems have been applied to the ecosystem context (Kaartemo, Akaka and Vargo, 2016; Vargo, Wieland and Akaka, 2016), however most of these analyses have been theoretical contributions without real practical implications (Grönroos, 2011b; Grönroos and Voima, 2013). Therefore, the goal is to provide a coherent framework that can help to improve value co-creation in the mapping service (eco)system. The second goal is to develop a theoretical understanding of the way in which the realisation of value creation is driven in the mapping-service (eco)system from a service-design perspective. The study of the service system therefore extends cartography into a new space, one in which the study of service design may contribute to the realisation of the service system. This will extend the boundaries of cartography, the service system, and service design into new territories.

While existing research suggests that all actors, whether businesses or customers engaged in exchange-relationships, are resource-integrating, service-provision enterprises that have the common purpose of value (co)creation (Spohrer, 2011), research into emerging maps/mapping service systems in the digital economy is limited, hence it is not clear how value-co-creation is achieved practically, or how it can be exploited or enhanced.

Therefore, the second goal is to investigate the similarities and differences between these maps/mapping service systems across different service systems, thereby illuminating the relationships and interactions that (co)create value between them. Third, I examine how service design methods can contribute to this relational aspect. This is likely to improve the proposed systemic framework as a tool for designing better value (co)creation systems, which will enable more innovative mapping services by facilitating the sharing of resources (i.e. technology, knowledge, and skills) between multiple entities and disciplines to the benefit of practitioners.

To this end, this study investigates three research questions as follows:

1. What is nature of maps and the changing dynamics in relation to technological development?

2. How can opportunities be developed in mapping services?

3. If service design can be implemented into mapping services, what value can we thereby expect to create?

1.3. Research approach

In order to answer these questions, I conducted three research activities consisting of an analysis of maps samples, four case studies on existing map-service systems, and a separate design-practice case study in partnership with London Transport—which also received feedback from the Global Service Design Network as a means to evaluate its service-design capacity. As a qualitative research methodology that provides a flexible method for researchers to explore or describe complex phenomena using a variety of data sources (Merriam, 2009; Mayer, 2001, Stake, 1995), this allows the researcher the opportunity to explore a topic not only ‘through one lens but variety of lenses which facilitate multiple facets of the phenomenon to be understood’ (Baxter and Jack, 2008 p.

544). These methods involve the collection of data relating to personal experiences, introspection, life stories, interviews, observations, interactions, and visual or textual materials, such that the research activities eventually adopted are the most suitable for embracing both theoretical understandings and practical implications through the comparison of case findings.

This approach therefore recognises the importance of the researcher's background and subjective experience. In this approach, the researcher's background and subjective experience is important and tends to rely on the perspective on a given situation, while inductively developing patterns of meaning throughout the research process rather than beginning with theory (Creswell, 2003). Ultimately, a multiple-case design was chosen in which bounded cases are examined using multiple data-collection methods. This explores the technological context of the phenomena identified in map-sample reviews, thereby providing more description and explanation of the issues or phenomena concerned. The detailed research objectives, activities, and methods used are illustrated in Figure 1.

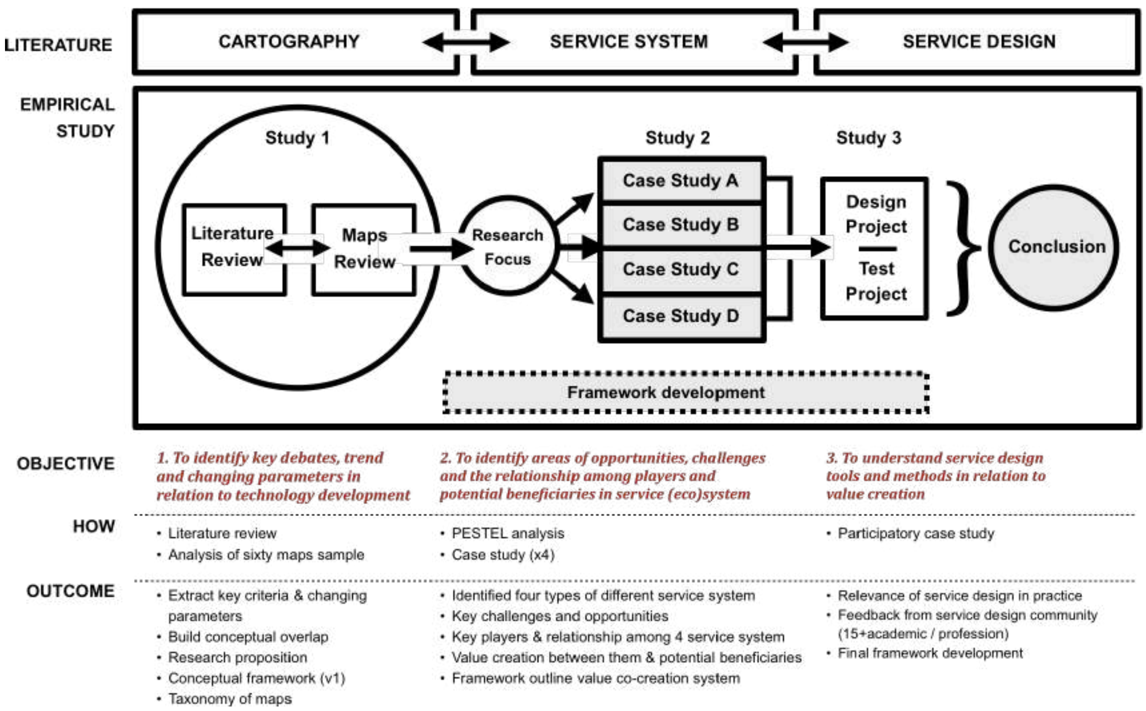


Figure 1. Research activities (September 2014–March 2018)

1.4. Thesis structure

This thesis comprises eight chapters. Following this introduction, Chapter 2 reviews four areas of literature, namely cartography, digital platforms, service systems and design. Furthermore, the focus here is on service studies in the context of digitalisation, in an attempt to understand the nature of maps and to identify key debates, and from this to derive the attributes that show the changing ontological and epistemological status of maps as influenced by technology. The chapter also reviews critical cartography theory in light of the dissertation's study of the service system, which has itself focused on value co-creation. This chapter argues that the nature of maps has transcended their artefactual value and that this change has led to a paradox in terms of the increasing marginalisation of mapping practices and the increasing need for mapping in new service provisions through value co-creation. Hence, it is necessary to consider maps/mapping from a service-design perspective when searching for service opportunities in the maps/mapping that emerge from the growth of the digital economy.

Chapter 3 outlines the research approaches taken. This consists of a mixed research strategy including analysis of map samples, four case studies, and a design project as a separate case study. The chapter details the appropriate methodological choices in order to answer the research questions and describes data generation and collection.

Chapter 4 synthesises the literature and research based on a sample analysis of sixty maps in order to gain useful knowledge and key criteria in terms of developing a mapping service. This chapter identifies how maps and development trends and changing parameters in mapping have been affected by both technology and the expanded usage of maps. The results are then synthesised into multi-level parameters, thereby formulating a map-taxonomy matrix that represents relevant maps and provides examples of maps. This chapter also develops an initial conceptual framework for further contextualisation which will be completed at a later stage. (Research activity 1: Map sample review)

Chapter 5 reports the results of the four empirical cases by identifying four types of service systems (i.e. mapping services and businesses) and investigates the challenges and opportunities for developing a service system in the geospatial industry. It also investigates how maps/mapping have been used, how each case (i.e. service system) operates, who is involved, and the relationships between participants in the service ecosystem. The chapter begins by examining the rationale behind the examination of the selected cases by discussing each business type, thereby identifying the necessary resources and describing the service opportunities.

The first case illustrates how common resources might more accessible to others in order to create value for end-users, while the second looks at increasing detail in the level of accuracy and reliability of resources, for example the accuracy of geospatial data and its tools or techniques for increasing the accuracy and stability of data. The third case then focuses on making sense of geospatial data and from this derives an understanding of the representation of the resource, which in this case includes data or physical assets on the ground, through visualising the geospatial data pattern or extracting meaningful insights for users. The final case describes the practice-based optimisation of resource integration through engaging with wider stakeholders, thereby leading to final users as well as other stakeholders' co-creation of greater value in the service ecosystem. The findings from each case are significantly dissimilar, illustrating four different service ecosystems that are useful in terms of clarifying the roles and responsibilities of each service system and improving the wider ecosystem. This chapter also argues that the logic of value co-creation in each case results in different service offerings, as well as variance in terms of the involved actors and their relation to the other resources needed when developing digital mapping services (i.e. the service system). More specifically, the case findings demonstrate that when there is increased interaction between players, more value is created from the perspective of final users (Research activity 2: Case Study).

Chapter 6 reports the processes and results of a service design project produced as a participatory case study in partnership with Transport for London. The chapter demonstrates how service design and its methods can be implemented in support of value co-creation, with maps becoming a service, thereby developing a new service and demonstrating what value we can expected to create. Along with the knowledge synthesised in Chapters 2 and 4, this chapter details the procedures of the design project alongside the tools and methods used, thereafter suggesting a business service model and outlining the project's outcomes. In order to evaluate the case findings, this project received the feedback from professionals and academics who had more than a decade of experience in the field of business and (service) design. (Research activity 3: Service design case study)

Chapter 7 compiles the findings from the three research activities presented in Chapters 4, 5, and 6 under three research questions and objectives, namely: service opportunities, the service ecosystem, and practice perspectives. This chapter not only discusses the research questions proposed in Chapter 3, but also delineates the outline of a framework for a value co-creation system in maps/mapping that would be useful for practitioners both in mapping platform enterprises and service design fields, both of which are involved in the service ecosystem. It specifically discusses the challenges and opportunities within each service system in line with the four business categories identified in Chapter 5.

This chapter also suggests that a service ecosystem allows all players to co-create value by sharing resources, such that the value of a given resource (i.e. technology, skills, knowledge and so on) can be maximised. By considering the important role of value co-creation in light of service science and service design in the geospatial industry, the chapter further examines how the relationship between players co-creates value through the way in which the ecosystem is co-created and shared while delivering value to its final users. It also discusses what value we can expect to create when service design is involved, so that value creation can be maximised in the service ecosystem. Finally, this chapter details the implications of the dissertation's theoretical and empirical contributions to the service (eco)system in digital mapping research.

Chapter 8 concludes the thesis, outlining the contributions to theory, method, and practice as well as delineating its limitations and pointing to directions for future research.

Chapter 2. Literature Review

2.1. Introduction

This chapter clarifies the nature of maps, while considering the digitalisation of maps and mapmaking. It offers insights based on a review of critical cartography and service studies that have informed current debates and gaps in knowledge. The chapter reviews four areas of literature, namely cartography, digital mapping, service systems, and service design. Furthermore, the focus here is on service study in the context of digitalisation, in an attempt to understand the nature of maps and to identify key debates – and from this examination to illuminate the changing ontological and epistemological status of maps as influenced by technology. The chapter also reviews critical cartography theory in light of digitalisation and the rise of service systems that focus on value co-creation. I argue that the nature of maps has transcended their artefactual value and that this change has led to a paradox in terms of the increasing marginalisation of mapping practices and the need for mapping in new service provisions through value co-creation. Hence, it is necessary to consider maps/mapping from service-system and service-design perspectives when we attempt to identify mapping service opportunities emerging from the growth of the digital economy.

These points indicate three distinct bodies of existing literature: cartography, digital mapping, and service study. This leads us to further discussion of the relevance of service design by reviewing:

(1) The critical cartography and neo-cartography literature, to understand the epistemological and ontological shift in the nature of maps in the context of digitalisation and technological enhancements;

(2) The service system literature in relation to maps and mapping, service (eco)systems and value-creation;

(3) Service design in order to understand its competence as a tool for interpreting current service systems in mapping and to engage with value co-creation practices.

In summary, the following section details how maps have been theorised, first from the perspective of representation, followed by a review of the ontological and epistemological conceptualisation of maps/mapping as influenced by technology to date. Also considered are other fields of study and disciplines in order to explore how service-system thinking may be used to address new value-creation in mapping services. The definition of conceptual overlaps here helps to inform the position of the research within the current discussion. It is suggested that service design, with its human-centred approach and systemic orientation, is especially relevant in context of the service economy.

2.2. Understanding the nature of maps

For many centuries, people have been making maps to relate to other people, the places and spaces they have observed, experienced, and even thoughts they believe. Maps have been the primary medium for transmitting ideas and knowledge about spaces and places (Theerman, Harley and Woodward, 2006), and have acted as ‘graphic representations that facilitate a spatial understanding of things, concepts, conditions, processes or event in the human world’ (Harley and Woodward, 1987, xvi). Indeed, they help us to organise the changing world and to navigate space, sometimes becoming even more real to people than the reality they claim to represent. Maps have had an immense influence, evoking beliefs, delivering complex meaning, and documenting more than factual information on particular phenomena and places, thus communicating the concept of space.

Mapping technologies have enabled the rapid growth of spatial knowledge production and dissemination with the capacity to collect, create, store and process spatial data, and this technology has also changed the way people involved in mapmaking have interacted with other stakeholders. This change implies that the map has been more than a just static image of space but has transcended its value as an artefact, reflecting its significance on both maps as mediums and physical objects, as well as the way they are used to communicate spatial understanding.

This section therefore consists of three parts: the first looks at the way maps have represented and communicated concepts and facts that have a spatial dimension (mapmaking). It will show how the traditional communication models of cartography have contributed to its form and content between the mapmaker (provider) and map reader (user). Second, moving beyond the recognition of the primary function of cartography, its power rather than representational aspects are reviewed in terms of how maps have been read. Lastly, the significant shift in both ontological and epistemological perspectives on maps and mapping is discussed.

Image 1. Hereford Mappa Mundi [13] (Mappa Mundi Trust, 2014).

Image has been redacted.

Hereford Cathedral, 2014. Hereford's Mappa Mundi Maps [Online]. Mappa Mundi Trust, [Accesses 10 Nov 2014]. Available from: https://www.themappamundi.co.uk/

Image 2. Medieval depiction of the Ecumene (Johannes Schnitzer, 1482).[14]

Image has been redacted.

Schnitzer, 1482. A Ptolemaic world map from the *Geography* [Online]. Wikipedia website, [Accesses 11 November 2014]. Available from: https://en.wikipedia.org/wiki/Ecumene#/media/File:Claudius_Ptolemy-_The_World.jpg

2.2.1. Cartography as true representation and a mode of communication

Maps have been understood as powerful graphical artefacts that visually represent a geographical landscape. They frame our understanding of the world, shaping our image of places, constructing our sense of spatial relations at a reduced scale, given that the visual form of artefacts is very diverse. They demonstrate the value of practical utility, which is the most important when it comes to organising spatial knowledge in a systemic way while facilitating navigation.

[13] One of the most famous medieval maps in existence, dates from around 1300 and is kept at Hereford Cathedral in England. It was drawn on calfskin and depicts Jerusalem as being at the centre of the world. Great Britain and Ireland are squeezed into the bottom left hand corner.

[14] A medieval depiction of the Ecumene (1482, Johannes Schnitzer, engraver), constructed after the coordinates in Ptolemy's Geography and using his second map projection.

In early modern cartography (1950s), the fundamental aspect of cartography was to present objective information in terms of spatial relations and was originally planned to deliver a single purpose, namely the truth in terms of the world as an object, as faithfully as possible and using scientific techniques that captured and displayed spatial information in a scaled abstraction of the world – through maps as an artefactual medium (Kitchin, Perkins and Dodge, 1994). This discourse then started to concern itself with how best to represent and communicate truthful information for map readers. Robinson (1995) has emphasised 'map effectiveness', whereby maps' design principles are aligned with the mindsets of maps users. The aim was to increase the effectiveness of maps and to reduce signal distortion in the communication of data to users through good cartographic design (Kitchin, Perkins & Dodge, 1994).

On this view, the cartographer creates a scientific perspective of cartography that enables maps to capture relevant information in a way that facilitates map readers' analysis and interpretation of the arrangement of the spatial data that the cartographer has put into the map (Robinson & Petchenik, 1976).

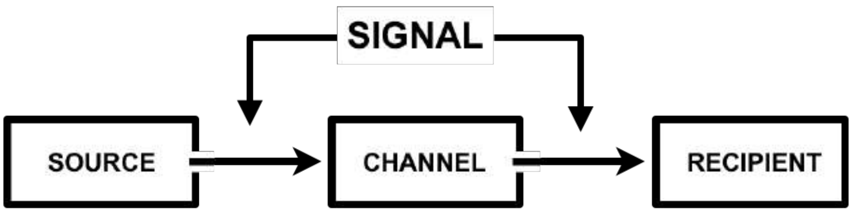


Figure 2. Simple framework for a communication model (adopted from Robinson & Petchenik, 1976).

It was critical that the cartographer understood how their design choice affected map users' minds in terms of evaluating the relevancy and efficiency of cartographic language through the medium of the map, as shown in Figure 3. This view placed great emphasis on issues such as maps' readability and an accurate correspondence between physical objects and their graphical representation. These related, for example, to maps' interpretability, use of colour, scale, projection, data categorisation, and symbology.

Since cartographical theory emphasised the effectiveness of maps and mapping, this was a significant epistemological shift that focused on how individuals engaged with maps in order to improve cartographic design (MacEachren, 1995; Montello, 2002; Lloyd, 2011), including how map representation communicates spatial information to users through psychological experiment, in order to build files for the most appropriate cartographic design decisions (i.e. shapes, sizes, edges, orientation, position colour range, classification, and so on) in relation to maps users' capacity to read a map. This approach is often associated with 'cognitive map design' (MacEachren, 1995) and the 'visualisation principles' (Antle and Klinkenberg, 1999) of the dominant theoretical paradigm of the 1960s–1990s, namely the 'map communication model'. This was conceptualised by Board (1967) and Koláčný (1969) in the 'maps as communication' model. Cartographers in the early-modern period negotiated information from both the physical object and its graphical representation and were therefore able to draw maps with scientific methods of execution, thus creating an effective representation of physical places as a mirrored world.

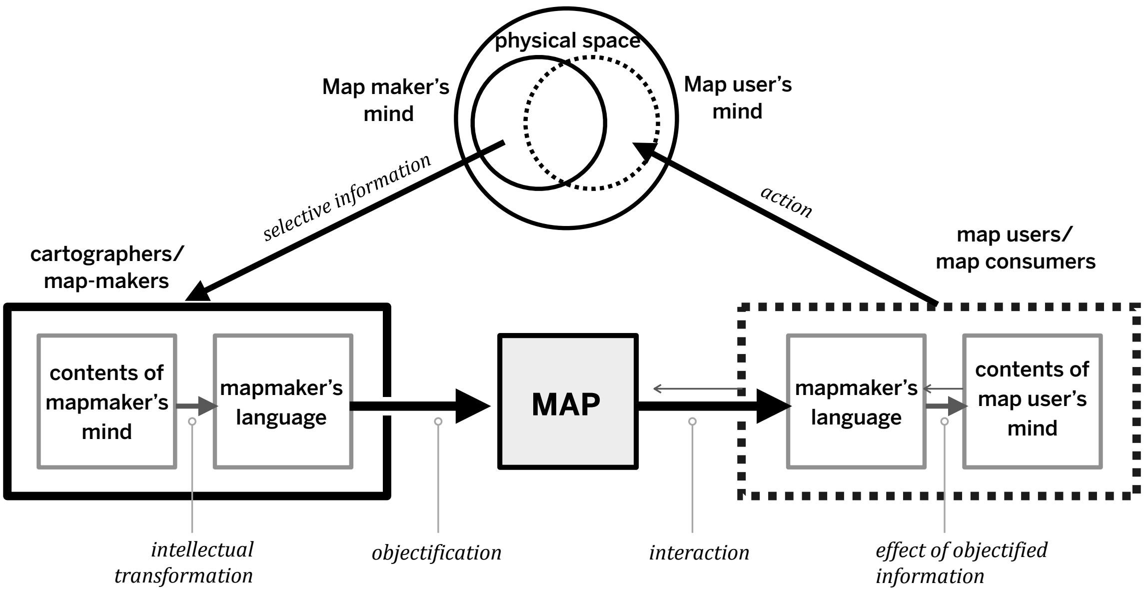


Figure 3. Cartographic communication model (elaborated from Koláčný, 1969)

This early model was intended to look beyond a functional analysis of map design and portrays the map as a *channel* that transmits information from a source to a recipient (Montello, 2009), which manifests itself in a linear flow or a one-way process between distinct entities (Figure 3).

Modern cartography requires us to present information as faithful and objectively as possible regarding reality in the spatial context. The map is expected to portray reality in much more detail or truthfulness than the map user can perceive. This depends on the cartographer (mapmakers) ability to obtain information about reality and to generalise and transfer initial information into cartographic information on maps. The role of the cartographer in this model is to transmit spatial data and apply 'scientific' rules in order to communicate information visually. This is a fundamental and intrinsic requirement of mapmakers, which can secure efficiency in meeting users' (map reader) needs and interest, namely for a map to be easily readable, understandable, and aesthetical (Koláčný, 1969). In this practice, these points are a prerequisite for mapping practice, thereby understanding the internal minds of users and also level of their knowledge, ability to use maps, and knowledge of ways to use maps, which are principal factors in the process of implementing the cartographic communication model; but also taking into account the external conditions of those who use the cartographers creation. This means that users previously played a relatively passive role as receivers, decoding cartographic information which the cartographer had encoded via a particular process (Morrison, 2011). Moreover, there is a clear distinction between the mapmaker and the map user, with the map as the representation of a physical space located in-between, the map itself an essentially neutral medium—as illustrated in Figure 3.

Image 3. Robinson's map projection (Arthur H. Robinson, 1952).

Image has been redacted. Robinson,1952. Robinson's map projection [Online]. Robinson projection Wikipedia website, [Accesses 11 November 2014] Available from: https://en.wikipedia.org/wiki/Robinson_projection

Image 4. Harry Beck's London Underground Map (Harry Beck, 1931).[15]

Image has been redacted.
Harry Beck, 1931. Harry Beck's Tube Map [Online]. Transport for London website, [Accesses 13 November 2014] Available from: https://tfl.gov.uk/corporate/about-tfl/culture-and-heritage/art-and-design/harry-becks-tube-map

[15] The idea of creating a full system map in colour. Beck believed that Underground passengers were not concerned with geographical accuracy and were more interested in how to get from one station to another and where to change trains. While drawing an electrical circuit diagram, he applied new idea for a map that was based upon concept rather a geographic map on which all stations were more or less equally spaced.

2.2.2. Cartography as a form of power and knowledge production

Moving away from the scientific perspective on mapping, critical cartographers (Harley, Wood, Harvey, and others since the 1990s) largely established a critical social theory and began to question the rationale and principles of cartography alongside how mapping operated, thereby challenging the scientific cartographic approach. They argued that maps are never completely translatable, and nor is the process of mapping neutral. Whilst maps pursue objective truth, they in fact construct power in the process of their creation (Kitchin, Perkins and Dodge, 1994). Each map is created as a dramatic reduction of the world that consists of an extensive set of facts, namely partial and selective images that suppress certain truths and from which unquantifiable information is abstracted, symbolised, and accentuated as a representative outcome of the mapmaker's decisions regarding how to serve the particular map's purpose (Wood, 1992; Pickles, 2004; Dodge and Kitchin, 2006; Wood and Fels, 2008; Perkins, 2011). In particular, Harley (1989) drew upon the ideas of Foucault in redefining the nature of maps as a *representation of power.* Thus, maps fall into the social and political dimension, which means that maps are a system is created through the process of many subjective decisions and provides a set of rules for the representation of knowledge embodied in the image (e.g. what goes into maps, how the map will look, and what the map is seeking to communicate).

Image 5. Satirical maps of the world (Fred Rose, 1877).

Image has been redacted.

Fred Rose, 1877. Satirical maps of the world [Online]. British Library website, [Accesses 13 Feburary 2015] Available from: https://www.bl.uk/maps/articles/satirical-maps

In this process, cartographers manufacture power and emphasise the underlying notion of maps as ways of knowing about the world (Harley, 1989). Pickles (2004) has further shown that maps do not merely describe or mirror the world, but instead act as producers of nature. In this view, maps works as a form of power that formalises knowledge and simultaneously tends to produce certain kinds of knowledge about the world, rather than simply revealing power–knowledge, which means that they act as the products of power while also producing power (Kitchin, Perkins and Dodge, 1994).

2.2.3. Cartography as processual and emergent nature

Yet the view of cartography as producing maps that act as 'representation' and 'social construction' has moved away from the 'rules' of map design, cartographic production techniques, and the deconstruction of maps' underlying agendas, and developed into a processual perspective. According to Kitchin, Perkins and Dodge (2009), maps should be understood 'as always in a state of *becoming*; as always *mapping*; as simultaneously being *produced* and *consumed*, authored and read, designed and used, serving as a representation and practice; as mutually constituting map/space in a dyadic relationship' (Kitchin et al. 2009:17).

This approach argues for the *performative* nature of maps as the act of mapping. As such, maps are never fully formed, and thus their work is never completed. They are always *mappings*: spatial practices enacted to solve relational problems, for example, how the best to represent the space, how to get from A to B, and so on, and *context-dependent*, always representing *particular moments* – in other words they are always *in the process of mapping* and *becoming* (Kitchin and Dodge, 2007; Crampton, 2009b). This shift in our idea of maps, from 'how things are' to 'how things become' is significant as it reframes maps as *processes* as opposed to *products/artefacts*, while also imagining a reciprocal relationship between mapmakers and map readers.

This means that the important question is not what a map is, nor what a map does, but 'how the map emerges through contingent, relational, context-embedded practices to solve related problems (their ability to make a difference to the world); to move from essentialist and constructivist cartography to what we term emergent cartography' (Kitchin and Dodge, 2007: p.342). Therefore, both the practice of cartography and the theoretical analysis of cartography are *processual* rather than representational in nature. In this way, 'maps are of-the-moment, context-dependent and they are always mapping', and hence 'cartography shifts from being ontical in status, wherein the ontological assumptions about how the world can be known and measured are implicitly secure, to an ontological project that questions more fully the work maps do in the world' (p. 343), which suggest that cartography can be understood as existence (becoming), rather than essence (fixed ontology) (Crampton, 2009b; Sun and Park, 2017).

This post-representational and processual/emergent view of cartography has questioned scientific approaches to the understanding of mapping and mapmaking and argued for a *mobile subject* perspective (Del Casino and Hanna, 2006). This means maps are not fixed but in a state of constant modification, where each encounter with the map produces *maps that are both representations and practices simultaneously* (Caquard, 2015). Theorists of this view argue that maps are not simply visual objects for deconstruction. Kitchin and Dodge (2007) have further suggested that the theoretical perspective on maps needs to shift in perspective from seeking to understand the nature of maps – namely, 'how maps are' – to examining the practices implied by 'how maps become'.

As summarised in table 1, the shift in ontological assumptions toward an emergent cartography means that there have been significant challenges to what we know about maps and how maps are now related to our everyday lives. If the question is no longer *what a map is* nor *what a map does*, but rather *how a map emerges* through the process of mapping, this suggests a significant gap in our knowledge and addressing this gap will be one of key contributions of this study.

	EARLY STAGE	REPRESENTATIONAL		POST-REPRESENTATIONAL	PROCESSUAL	NEXT
		MODERN	POSTMODERN			
		Robinson (1952)	Harley (1989)	Pickles (2004) Del Casino & Hanna (2006) Wood & Fels (2008)	Kitchin & Dodge (2007) Kitchin, Gleeson, Dodge ('12) Caquard (2015)	?
	Maps as wayfinding & order of society	**Maps as true representation**	**Maps as social construction**	**Maps as system of proposition**	**Mapping practices, processual**	?
Episteme	Imagination of the knowledge, culture, speculation	Scientific effectiveness (accuracy, readability)	Expression of power/ knowledge	Produce world (linking present information with past knowledge)	Context dependent of the moment	?
Focus	Natural history Man, resemblance	Essentialist Objective truth; Neutral communication focus	Constructed	Constructed Not representation but inscription	Emergent Processual	?
Represent-ation	Translation, picture	Time, differentiation, Statistics, Grids	Space, Complexity Networks, Simulations	Mobile subject, Immutable Re-territorialisation	Relational to context, Mutable, Practice	?

Table 1. Key concept of different cartographic epistemologies and ontologies by historical period and authors

2.3. Digitalisation and maps as digital platform

As with the movement away from manuscript to mass-print production, from printed paper to digital publishing and three-dimensional printing, maps and mapmaking have entered a similar moment of transformation via technological and social changes. Moving beyond representational cartography (e.g. the Robinsonian approach**)** and power construction (e.g. the Harleian approach) in the study of cartography, recent scholarship has asserted that maps/mapping need to be understood as much more of a process than they have been in previous map-communication models (MacEachren and Kraak, 1997; Kitchin, Perkins and Dodge, 2009). The latter emphasises a primarily uni-directional mode of information delivery to map-readers and reflects map-makers' perspectives.

The rapid growth of ICT (Information and Communication Technology) and its convergence with spatial data-mapping technologies such as GIS (Geographic Information Systems), SatNav, GPS (Global Positioning Systems), and the capacity of automated data rendering as applied in many geospatial-related services or applications has changed mapping in fundamental ways. As a consequence, ways of understanding maps and the people who are involved in mapmaking has been reshaped by the collection of data and the production and dissemination of cartographic information and knowledge, thereby altering the whole mechanism of mapmaking and its uses. This change implies that maps have become more than static images of space but have also transcended their artefactual value, the significance of which is reflected in both maps' physical capacity to transmit ideas and knowledge about space as well as conveying more than information about particular situations and places.

This suggests that, first, these digital mapping technologies can convey incredible accuracy in terms of geospatial data, coverage, and the capacity to store big datasets, which also emphasises the ability to facilitate data interpretation. Second, users have become involved mapmaking as a dominant mode of geospatial knowledge creation, which reshapes the way geospatial knowledge is disseminated. Third, the form of maps has become much more fluid, such that information interfaces are transferred between data providers and users via the creation of different platforms. Last, the usage of maps has dramatically expanded, so that the business model of cartographic production and location-based service has changed in fundamental ways.

These changes mean that the nature of maps in the digital era becomes much more evident if we consider maps and mapping as facilitators of digital platform services, whereas maps are currently treated as containers/mediums of geospatial data and knowledge. In light of this, the next section outlines how technological advances in digital mapping have opened up new opportunities, while at the same time suggest mapping service possibilities.

Image 6. Social media map (BBC Facebook connection map the world, 2010).

Image has been redacted.

Facebook, 2010. Facebook connection map the world [Online]. BBC website, [Accesses 10 January 2014] Available from: https://www.bbc.co.uk/news/science-environment-11989723

2.3.1. GIS, digital mapmaking and the dissemination of knowledge

The technological convergence mentioned above has applies particularly to mapping practices and their application in recent years. This change began with the creation of the Geographic Information System (GIS), which is a technological tool for comprehending geography and making intelligent geographically-based data decisions. Modern GIS is a computer system in which information is derived from the interpretation of data, thereby enabling a user to read a map, for example allowing a cartographer or urban planner to select the data necessary for a specific project or task. This geospatial database management system is designed to capture, store, manipulate, analyse, manage, and present any kind of automated geographic data while processing it in an objective fashion (Pickles, 1995; Keenan, 2006). In GIS, a thematic map has a table of contents that allows the reader to add layers of the desired information on to a base map of real-world locations (Esri, 2011). This enables the processing of geographic data from a variety of sources while integrating it into a map project (Goodchild, 1995).

GIS represents all earth-based spatial and temporal data in one interpretation, conveying 'real' location with 'god-like' positionality in a naturalistic manner as if seen from space (Cosgrove, 2001; Kitchin and Dodge, 2007). It focuses on cartographic displays of complex information intended to help end-users solve and discover spatial issues (Goodchild, 1995). The significant benefits over traditional cartographic methods is that this system allows us to bypass many of the technical aspects of cartographic production. This system commonly transfers hard copy maps or Ordnance Survey[16] location map data into a digital medium and integrates many forms of spatially-related data (cartographic, photographic, digital, or spreadsheet data). For instance, the wide range of digital imagery from, for example, satellites, aircraft, heads-up digitalisation, balloons, and drones is interpreted and extracted as geographic data and is overlaid on top of a map. These work as base-maps while also incorporating all of the geographic data-layers through web/internet-based platforms at a low cost.

Moreover, these technological capabilities enable GIS to associate itself with transportation, urban planning, logistics, telecommunications, and engineering-related operations and applications. These mapping applications reveal deeper insights concerning space and identify problems, patterns, relationships, situations, and contexts, and increasingly document qualitative information when data is well-mapped (Wang *et al.*, 2013). With the support of this data, the user creates interactive queries and analyses spatial information, editing and manipulating the data in the maps and presenting the result of all these operations via database-derived visualisation and knowledge discovery, thereby enabling informed decision-making (Maceachren *et al.*, 1999; Crampton, 2001). Maps and GIS are also used in exploratory data-mining and pattern-seeking (Nemec and Raudsepp-Hearne, 2013; Moosavi, 2017), thus users can manage geospatial data in an effective way.

[16] Ordnance Survey (OS) is the national mapping agency for Great Britain. They produce paper maps, digital map data, online route planning and sharing services, and mobile apps, plus many other location-based products for business, government, and consumers.

As these technological advances have complicated any single authoritative view of the world and almost replaced traditional cartographic production and methods, this technological shift has been labelled a ‘digital transition’ (Goodchild, 1999; Pickles, 2000). Significantly, the transition is not transient but continuing apace. For this reason, GIS is understood as a foundational and critical component for many map/location-based applications and services that rely on geospatial analysis and visualisation.

Image 7. GIS system (Esri, 2017).

Image has been redacted.

Esri, 2017. ArcGIS [Online]. Esri website, [Accesses 19 April 2017] Available from: https://www.esri.com/arcgis-blog/products/analytics/analytics/three-themes-of-arcgis-enterprise-10-5-analytics-automation-and-distributed-gis/

2.3.2. Users as the dominant mode of geospatial knowledge-creation in mapping

The digitalisation of cartographic information processes, production, and map design has shown how the effort required for the creation of high-quality products can be reduced while new ways of cartographic distribution make accessing and participating in geospatial information far easier. The internet and GPS have further enabled smart devices and mobile phones, which have already redefined how maps are used. Web 2.0 has primarily utilised the World Wide Web as a platform upon which diverse datasets and services can be combined in flexible and creative ways (O’Reilly, 2007). The key characteristic of Web 2.0 is its inclusion of *Read* and *Write* media, where the web’s scalability, collective intelligence through user participation, dynamic connectivity, openness, and freedom comes into its own at an effective cost. This technological shift mainly applies to maps/mapping, which has opened the process of mapmaking to everyone by inviting a vast number of users to participate as collaborative mapmakers.

The internet and web not only support the distribution of traditional products but provide a platform for cartographic web applications and the publishing of geo-information as service-oriented mapping (Hardy and Watkins, 2012). In particular, Google Maps (2005) has introduced new online mapping tools with incredibly comprehensive digital-mapping capabilities, which aims at more realistic interactive streetview where the user's context-related geospatial data is transferred to the individual through a web-service mapping model. Furthermore, the Map API (Application Programming Interface) allows maps to be easily embedded into third-party websites and applications for particular needs, thus customising its usage. Various types of data from different sources can be layered and integrated into many location-enabled services that rely on geospatial data analysis and visualisation. This movement has been termed 'Web Mapping 2.0' (Gartner, 2009), suggesting that Web 2.0 provides a suitable platform for dynamic and interactive maps while allowing everyone to produce their own individual maps on their own terms.

As democratic approaches to mapmaking and mapping, the concept of 'neogeography' or 'neocartography' consists of a set of techniques and tools that fall outside of traditional GIS, where traditionally a professional cartographer use ArcGIS, while a neo-cartographer uses Google Maps API and geotags on social media feeds (Turner, 2006; Haklay, Singleton and Parker, 2008; Haklay, 2013) In fact, this collaborative and social aspect of the mapping experience allows anyone to contribute and analyse the geospatial database and available information, which is no longer reserved for professionally trained individuals who build maps. Neogeography/neocartography is about a new mode of generating geospatial data with the data increasingly being generated by ordinary citizens (Crampton *et al.*, 2013). Indeed, this notion has been repackaged to emphasise the role of maps and mapmaking (Kraak, 2011), in particular taking into account the heavy influence of Google Maps, API, location-aware apps in iOS/Android mobile devices, and other geospatial media (Kelley, 2013), i.e. geo-tagging feeds in social media.

In turn, the availability of such information has fundamentally altered the way in which geospatial data are generated, collected, manipulated, and utilised (Leszczynski and Wilson, 2013). Maps and the mapping experience have begun to function as participatory and social spaces, while mapping platforms have also become more democratised than ever before, such that users can become authors while the they construct and consume geospatial knowledge collaboratively. This indicates new relationships and practices of map production and consumption in the form of ‘crowdsourcing’, wherein thousands of people collectively act as geographically distributed sensors (Goodchild, 2007): they voluntarily generate, collect, clean, and correct geospatial information, contribute data and are also connected to platforms socially, thereby communicating meaningfully and contributing collectively.

We now have the concepts of Cybercartography (Fraser Taylor, 2005), Mapping Hack (Erle, Gibson and Walsh, 2005),Volunteered Geographical Information (VGI) (Goodchild, 2007), Ubiquitous Cartography (Gartner, Bennett and Morita, 2007), Wiki Mapping (Sui, 2008), Maps 2.0 (Crampton, 2009), Citizen Cartography (Graham & Zook, 2013), Crowdsourced Cartography (Dodge and Kitchin, 2013), Critical Cartography 2.0 (Kim, 2015) – where all these definitions reflect this shift and can be understood as forms of crowdsourcing and participatory mapping.

This implies that the nature of the mapping experience and the practice of knowledge-creation has changed, reflecting what Barthes (1978) termed the ‘death of the author’. The boundaries between producers and consumers are not distinct when users act as consumers but also producers of cartographic knowledge products, as an extended notion of ‘Prosumption’ or ‘Prosumers’ (Ritzer and Jurgenson, 2010), instead of relying on experts’ cartographic products. Rather, users create customised maps on demand (Dodge & Kitchin, 2013). For example, in head-based wearable devices that track in real-time how users’ ride, as well as how their movements and locations engage with their minds, giving new insights into a rider’s experience without a user’s direct participation – which is understood as explicit volunteering geospatial data. This indicates that the production of cartographic knowledge is in the hands of the public rather than in those of trained professionals (Wilson and Graham, 2013).

The shift from map-user to mapmaker (Graham and Zook, 2011) is not only about blurring boundaries by letting users contribute cartographic information and knowledge production, but also about counter-mapping and counter-knowledge activities (Harris and Hazen, 2006). While some have questioned the quality and value of mass amateur efforts and whether these can actually create maps of sufficient quality (Haklay, 2013), as well as querying their ability to communicate as effectively as professionals working in more conventional ways, the future of cartography and new representations of cartographic expression and knowledge will continue to be influenced by the outcomes of explorations of the available geospatial data alongside the creation of innovative technological enhancement and delivered products (Jelfs, Cartwright and Pupedis, 2014). The new possible opportunities based on VGI and neocartography (Cartwright, 2012), along with the acknowledgement that 'cartography is dead' (Wood, 2003b), mean the end of traditional cartography and mapmaking, whereby professionalism has been sidestepped by 'by-passing' experts.

This view further leads to discussion of either a de-professionalisation or a re-professionalisation of cartographic knowledge production and mapping (Crampton, 2009) while opening up more fundamental ontological and epistemological questions about the nature of maps and mapping.

Image 8. Crowdsourced map (Progress Map Wordpress Plugin WPMeta, 2015).

Image has been redacted.

WP Meta, 2015. Progress Map Wordpress Plugin [Online]. WPMeta Website, [Accesses 12 June 2015]. Available from: http://www.wpmeta.org/plugins/cc-progress-map-wordpress-plugin/

2.3.3. Maps as digital platform surfaces: Complexity of geospatial data

More recently—and supported by the ubiquity of computing—, technology enhancement (machine learning, IoT technology with cloud storage and connected devices, iOS/Android mobile platforms with embedded GPS, convergences in geospatial media such as text, images, maps, audio, video, etc., and government-initiated Open Data, whose geospatial data contains geographical references regarding location) has enabled new types of data creation, where these new data contain location references. This massive volume of location-embedded data is continuously being generated and can be used to generate new assets for and through digital maps. Massive volumes of location-aware data are harvested from smartphones, geo-tagging social media feeds, and sensors embedded in the built environment such as digitally controlled utility services and transport infrastructures, building management systems, and so on. These geospatial data are now ubiquitous, fluid, and dramatically increased in terms of their complexity, given the type and amount of data available for mapping. Indeed, these data are now automatically generated in the form of 'Big Data' (Crampton, 2009a; Graham and Shelton, 2013; Stefanidis, Crooks and Radzikowski, 2013; Kitchin, 2014; Leszczynski, 2014), where IoT and GIS may be coupled together to provide an even better understanding of geospatial data patterns, with significant value and emerging opportunities for individuals, communities, governments, and businesses (Stefanidis, Crooks and Radzikowski, 2013).

The growing amount of available geospatial data is repackaged and customised in the form of maps that fulfil users' specific tasks on demand. For example, such data supports the government in transparent and evidence-based decision making through the use of crowdsourced information for dedicated public services, in order to solve social and civic problems such as housing policy, emergency services, safety, transportation, and so on (e.g., traffic management for public events, predictable policing). The Open Data Initiative has led to increased public participation and engagement with government, which aims to enhance service innovations, reduce costs, and promote the shared economy as a means of achieving efficiency (i.e. the Open Data initiative).

This shift suggests that the data generated, such as users' locations, personal opinions, reviews, photos, places they have visited, and their social network contacts, as well as free and open geospatial data are a vital asset for many people and businesses, providing them with rich insights, allowing them access to the insights of prosumers in terms of where their users actually go, for what purpose, and how they rate the experience (Bollier, 2010). These data invisible to users and are also collected passively and unconsciously in the form of an implicit contribution of geospatial data. I use the term 'implicit contribution' in distinction to explicit volunteering, which involves reporting particular interests that users want to address and share with a given purpose in mind. Together, implicit and explicit contributions from different systems are transferred into maps, and thus visualised through various cartographic representations. These various forms of cartographic knowledge-production and expression has increased the complexity of the types and amounts of data available for mapping.

Image 9. Implicit contribution: Multi Maps (Macrì, 2019).

Image has been redacted.

Macrì, 2019. Kepler.gl + Dropbox = Map Save & Share. [Online]. Giuseppe Macrì Blog, [Accesses 22 April 2019]. Available from: https://medium.com/vis-gl/kepler-gl-dropbox-map-save-share-b4a41a75715b

2.3.4. New form of geospatial data and social interaction through mapping

Each type of map utilises a specific portrayal or presentation as well as suitable data in the form of a 'basemap'. Maps and forms of cartographic expression have become a system that represents our physical evidence of the experience of physical place. This means that maps become interfaces that fundamentally transmute from being an end-product (finished product) to displaying ubiquitous evidence, rather than a mere mode of communication (Wood, 1992; Elwood and Leszczynski, 2013). From this perspective, maps can be understood as platforms that act as qualitative interfaces facilitating engagement between providers, users, and other third-party stakeholders to create, access, and share information and communication channels, which themselves express many relations and meanings. Previous studies concerning neocartography and VGI have provided solid introductions for the technological development of new kinds of knowledge-sharing (Gartner, 2009), thereby offering explanations of the consequences of these technological developments, particularly in relation to how maps/mapping work.

As the previous section described, the rise of the sharing economy and 'prosumption', wherein the user trades and co-creates resources without physical connection, means that the prosumer who acts as both consumer and producer is changing established mapping experiences, especially in GIS-related products and services. Online mapping platforms enable the user to become a cartographic information/knowledge creator, an innovator deploying new products and services on open innovation platforms, which is changing the nature of the mapping experience. This both challenges the traditional cartographic product and requires a new approach in order to survive.

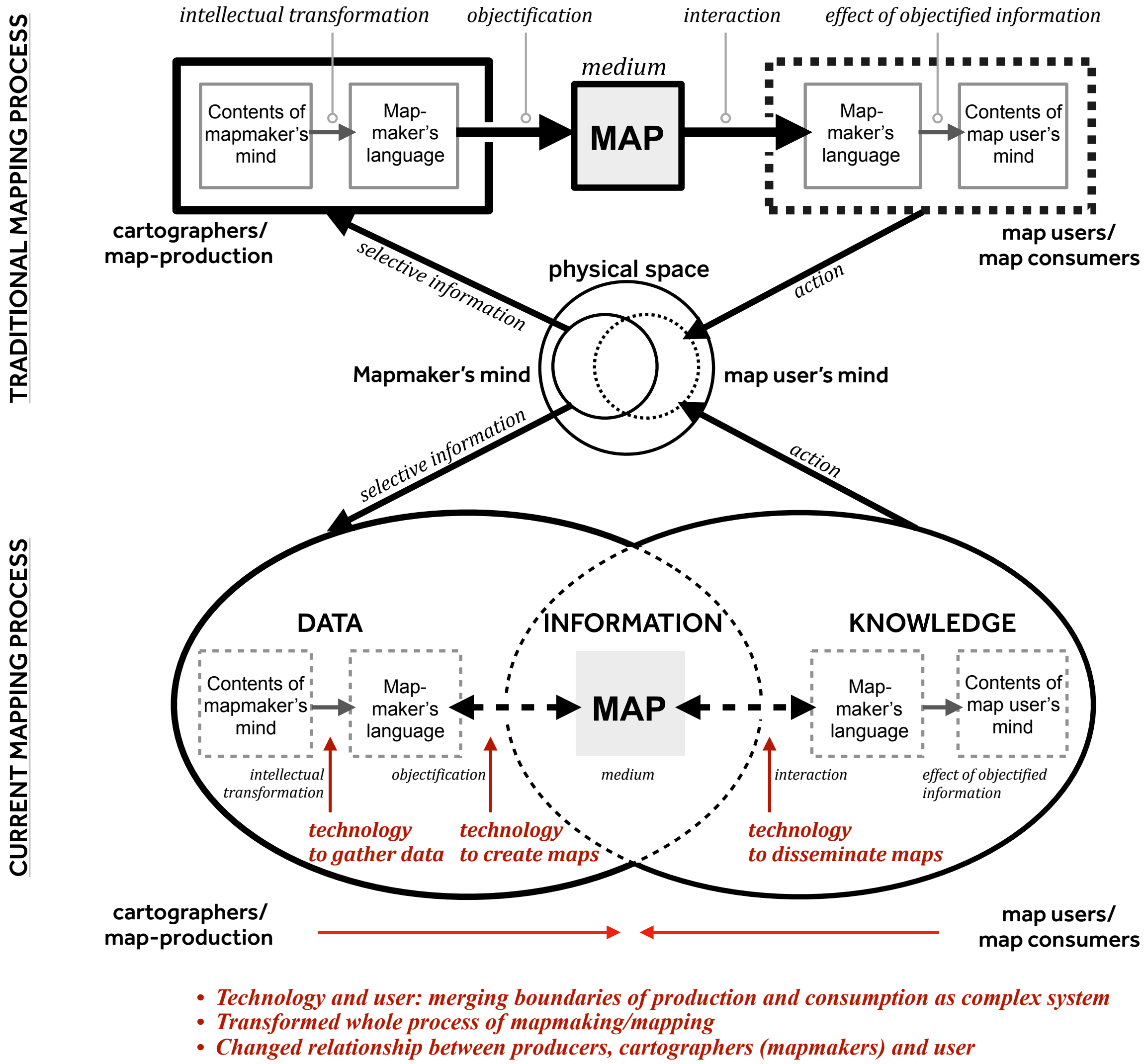


Figure 4. Complexity of the mapping process and changing dynamics.

In light of the shifting nature of maps identified, Figure 4 demonstrates the complexity of the mapping process and its changing dynamics. Conventionally, several distinctive steps took place before users would perceive cartographic information. These are, a. the intellectual transformation of mapping contents in the cartographer's mind; b. the objectified information being processed from geospatial data into something useful; c. its representation on a map (artefact/form) as represented information; d. the interaction between maps and map-user through an understanding of objectified information on a map; and finally d. users reacting based on an appropriate collection of information read from the map as knowledge.

This process is linear and is thus similar to the Data–Information–Knowledge–Wisdom (DIKW) hierarchy of information management (Ackoff, 1999) and the cartographic communication model concerning the efficiency of cartographic information production; whereas technology and the direct involvement of users have transformed whole process of mapping, this earlier cartographic communication model attempted to develop effective cartographic production for map users (readers).

First, the geospatial data and mapping process becomes much more complex and ubiquitous through the development of technology, which also replaced the previous linear steps with simpler steps, for example gathering geospatial data, creating maps, and disseminating geospatial information effectively.

Second, there are no longer distinctive boundaries between mapmakers (map providers) and map users (map consumers), as the role of user has become much more democratised in mapping, such that mapping has become participatory, collaborative, and performative in nature. In this sense, the fundamental role of the user's becomes that of a free resource or free labour by generating useful data at point of use, as they consume a given service or product, namely maps.

Third, maps not only have a physical existence in the form of goods or products, but have become a participatory platform or a complex system that creates a surface from the complexity of geospatial data and is based on an interaction between providers and users.

Lastly, the delivery of cartographic knowledge to users has become much more pervasive and comprehensive considering the transformational impact of technology and our current usage of maps.

However, these studies are limited in their discussion of maps' functionality, usability and, simplicity of application development, especially considering new kinds of geographical information production and dissemination of knowledge. The literature also has little to say on the direction in which these shifts will lead, particularly in terms of clear implications and practices in the context of potential opportunities in the service economy (Kitchin *et al.*, 2017). It seems that cartography has started to take a different direction rather than questioning the ability to interpret various types of information, processes, and usage – as these data do not speak for themselves. However, it is acknowledged that there will be new ways to utilise the opportunities arising from this shifting idea of the nature of maps.

2.4. Maps and mapping in service systems

Advanced digital technology and smart devices allow maps to function as participatory platforms with the capacity to collect, create, store, and process data through people's interaction with others as well as their environments and cities. These technological developments have allowed for collaborative mapping actives. Users have become co-producers of maps (prosumers), as have service and technology providers, governments, and other stakeholders. These changes have challenged previous cartographic models while also focussing on increasing functionality, geospatial data accuracy, coverage, and ease of application development. In addition, exploring how maps emerge and create added value as well as how different stakeholders perceive value in different ways at particular times, spaces, situations, and in what sequence is also highly important. Since the nature of maps has changed, maps/mapping has an extended artifactual value, implying that both the ontological and epistemological value of maps has been impacted by technology. This transformation has significantly impacted the way in which maps perform specific tasks and interact with users and other stakeholders; thereby maps and map-related service development has also fundamentally altered the way in which the value of maps is created today.

While there has been intensive discussion about the changing nature of maps and mapping in relation to the impact of technological innovation, it is essential to explore the relevant practices and disciplines concerning this transformation in order to fully utilise potential opportunities in the sector of digital mapping. The following section reviews maps/mapping from a service science perspective in order to develop a new understanding of mapping's relationship with value (co)creation.

2.4.1. Definitions of service

Traditionally, the concept of service was often non-physical in nature as opposed to tangible goods or products which were beyond touch (Ramaswamy, Shahabi and Deck, 1996). Intangibility and the interaction between the producer and consumer are a key way to distinguish a service from a product. Service has been identified in the IHIP framework, which suggests that it has four aspects, namely *inseparability*, *heterogeneity*, *intangibility*, and *perishability* (of production and consumption) (Zeithaml, Parasuraman and Berry, 1985). However, some have claimed that that these characteristics are not unique to services (Lovelock and Gummesson, 2004; Vargo and Lusch, 2004b).

Many scholars have developed the idea of service in recent decades, for example with the concept of a 'moment of truth' (Carlzon, 1989), which defines crucial moments in the interaction between providers and consumers that determine customer satisfaction and the 'service encounter' (Bitner, Booms and Tetreault, 1990), thereby emphasising the customer's point of view – especially in terms of the period of *time* when the customer interacts directly the with provider (Bitner, 1990). Some commentators have also referred to service as *processual in nature*, referring to a '*performance*,' meaning that service is to provide customers with *activities* while an *experience* is created for the customer's benefit (Edvardsson, Gustafsson and Roos, 2005). Moreover, service is at the basis of value-creation, suggesting that economic value results from interactions between agents or actors at a *particular place* and *time* (Maglio, 2015). These definitions and ideas are *outcome*-related as well as focusing on the *value* that services create for customers (i.e. users).

More recently, studies of the 'service system' (Spohrer *et al.*, 2007; Lusch, Vargo and Wessels, 2008; Maglio and Spohrer, 2008; Maglio *et al.*, 2009; Vargo, Lusch and Akaka, 2010) and the 'service ecosystem' (Vargo and Akaka, 2012; Wieland *et al.*, 2012; Vargo, Wieland and Akaka, 2015; Barile *et al.*, 2016) have focused on how multiple entities or actors create value together, meaning that the nature of service relates to value co-creation as a joint activity between the provider and the customer. It also suggests that other actors in the value network are important participants in the service system, who also facilitate value co-creation. In addition, Spohrer (2007) has argued that service systems are 'configures of people, technologies, organisation, and information that create value for all involved, achieving positive economic, social, and environmental outcomes' (Spohrer *et al.*, 2007). The service system integrates resources, knowledge, skills, and technologies throughout the system to increase overall value using different components, which are complex in nature (Vargo and Lusch, 2004a; Vargo, Maglio and Akaka, 2008; Maglio *et al.*, 2009).

It is because value emerges from the interactions between different stakeholders and resources that this process requires precise coordination from providers, customers, and others to transform resources within the service system (Vargo, Lusch and Akaka, 2010; Briscoe, Keränen and Parry, 2012; Agarwal *et al.*, 2015), such that customer value-creation is significant in the study of service and also a central concept in service science and service systems.

2.4.2. Value-creation in service systems

The notion of value and value-creation was originally developed by Smith (1776) as a perspective on the efficiency of labour – not only physical labour but specialised *knowledge* and *skills* that could be applied for customer benefit and used in exchange.

Recent studies have focused on the implications and potential of the value-creation paradigm shift away from a good-dominant (G-D) logic to a service-dominant (S-D) logic (Vargo and Lusch, 2008a). The fundamental difference between these two states has been described in different ways in terms of the perception of value, from being embedded within goods and exchanged at the point of delivery, to being co-created with the customer in their context of use, implying that value is determined through the use and integration of these resources as a 'resource constellation' rather than as a chain (Normann and Ramírez, 1993).

Additionally, Edvardsson (2005) has suggested the 'service is a perspective on value-creation rather than a category of market offerings; the focus is on value through the lens of the customer; and co-creation of value with customers is key and the interactive, processual, experiential, and relational nature form the basis for characterizing service' (Edvardsson, Gustafsson and Roos, 2005 p.118).

This notion has been further articulated as 'value-in-use' or 'value-in-context' (Chandler and Lusch, 2015; Vargo and Lusch, 2016) as well as 'value co-creation' (R. A. Normann, 2001; Prahalad and Ramaswamy, 2004; Vargo and Lusch, 2004a; Grönroos, 2008; Michel, Vargo and Lusch, 2008; Bettencourt, Lusch and Vargo, 2014). These are the central aspects of S-D logic, which suggests value is always co-created through the combined efforts of providers, customers, government agencies, and other entities, such that value is always determined by the beneficiaries (i.e. customers/users) (Vargo, Maglio and Akaka, 2008).

From this perspective, Vargo and Lusch (2006) have also suggested that 'there is no value until an offering is used – *experience* and *perception* are essential to value determination' (Vargo and Lusch, 2006: p. 44). If value is perceived in the customer's experience, this means that value is created in the delivery of the service when the customer's desired purposes and goals are accomplished. Therefore, users' *experience* and *perceptions* (Woodruff and Gardial, 1996) ultimately become the critical factors in value-creation, which evolve in line with *value-in-use*. That is, value is created during the use of the service.

Vargo and Akaka (2012) have outlined the key foundational premises of the service system from the S-D logic perspective as: (1) service is the basis of exchange (FP1 – see below); (2) value is always co-created (FP6); (3) all social and economic actors are resource integrators (FP9); and (4) value is always phenomenologically determined by a service beneficiary (FP10) in general (for a detailed illustration see Table 2).

	Premise	Key emphasis
FP1	**Service is the fundamental basis of exchange.**	Operant resources (knowledge and skills), 'service' is the basis for all exchange. **Service is exchanged for service.**
FP2	Indirect exchange masks the fundamental basis of exchange.	Goods, money, and institutions mask the **service-for-service.**
FP3	Goods are distribution mechanisms for service provision.	Goods (both durable and non-durable) derive their value through use – the service they provide.
FP4	Operant resources are the fundamental source of strategic benefit.	The comparative ability to cause desired change drives competition.
FP5	All economies are service economies.	Service (singular) is only now becoming more apparent with increased specialization and outsourcing.
FP6	The customer is always a co-creator of value →**Value is co-created by multiple actors, always including the beneficiary.**	Implies value-creation is interactional.
FP7	The enterprise cannot deliver value, but only offer value propositions. →**Actors cannot deliver value but can participate in the creation and offering of value propositions.**	The firm can offer its applied resources and collaboratively (interactively) create value following acceptance but cannot create/deliver value alone.
FP8	A service-centred view is inherently customer oriented and relational → **A service-centred view is inherently beneficiary-oriented and relational.**	Service is customer-determined and co-created; thus, it is inherently customer-oriented and relational.
FP9	**All economic and social actors are resource integrators.**	Implies the context of value-creation is networks of networks (resource-integrators).
FP10	**Value is always uniquely and phenomenological determined by the beneficiary.**	Value is idiosyncratic, experiential, contextual, and meaning laden.

Table 2. Foundational premises of service-dominant logic clarifying value-creation in the contemporary service economy (Vargh & Lusch, 2006, 2008, 2016).

As a consequence – and particularly in the light of service science – value-creation in relation to the customer is becomes significant, both in theory and practice (Smith et al., 2012). A number of scholars have discussed value from a customer's perspective (e.g. Christopher, 1982; Zeithaml, 1988, De Rose, 1991; Anderson et al., 1993; Ravald and Grönroos, 1996; Woodruff and Gardial, 1996). In particular, Woodruff (1997) has argued that value is created in the use and consumption experience; thus customer value is not what the provider objectively determines, but the what customer perceives subjectively (Heinonen *et al.*, 2010).

Figure 5. Value-creation as the customer's creation of value-in-use (Grönroos & Voima, 2013).

Figure has been redacted.

Grönroos & Voima, 2013. Critical service logic: Making sense of value creation and co-creation. Academy of Marketing Science, 41(2), p. 137 [Accesses 11 March 2015]

If we consider customer value in this way, this means that the provider only offers the potential value of service to the customer, as a realisation of value can only be determined by the customer. In this sense, the realisation of value depends on the customer's use experience and their judgement of the service and experience. This indicates that when the provider proposes the value offering, they cannot deliver value to customers without considering the customer's experience (Vargo and Lusch, 2004a, 2008b). This means that the perception of value is dynamic and context-dependent as it depends on how customers process the use of the service as they evaluate the service experience (Smith, Ng and Maull, 2012).

Similarly, Grönroos and Voima (2013) have suggested that the service value-creation process can be grouped in three different value-creation spheres that describe how value is actually created and by whom. They argue that service providers have the opportunity to engage with their customers and co-create value with them. As illustrated in Figure 7, the provider sphere produces no *real value* but merely *potential value*, which is transformed into real value when customers later become involved and the resource is consumed by a customer's purposeful *activities*, which parallel the meaning of *value-in-use.* Therefore, the provider is fundamentally performed as a value facilitator (Grönroos and Voima, 2013). On the customer side, the user or customer is in charge of value-creation in the joint sphere. The service provider and customer interact directly, during which the provider engages with the customer and the value co-creation process. In this arena, which is closed to the provider in the sense that customers independently create value with resources obtained from the providers, customers are directly creating *real value* (prosumers) without directly interacting with the providers, whereas providers create value indirectly as value-facilitators in the customer sphere (Heinonen *et al.*, 2010). This indicates that the joint sphere can be defined as *experiential*, wherein *value-in-use* emerges through the user's accumulated experience over time in multiple temporal, spatial, physical, and/or social contexts (Grönroos and Voima 2013, p. 142). This view can be articulated as different spheres corresponding to the value-creation process, which can be conceptualised as a model of value-creation in service in the following way:

> **a provider sphere** that is closed to customers, where the service provider compiles resources, including potential value-in-use, to be offered to the customers to facilitate their value creation; **a joint sphere** in which the service provider and customers interact directly, which enables the provider to engage with the customers' value creation and co-create with them; and **a customer sphere**, which is closed to the provider and where the customers independently create value and may socially co-create value with actors in their eco-system. [Grönroos and Gummerus, 2014: p218]

In this view, the distinction between producers and customers is blurred, which means that all participants contribute to value-creation both for themselves and others. Therefore, *value is always co-created*, given the multiple reciprocal interactions, while being determined between providers and beneficiaries (i.e. users/customers) through the integration of resources at an individual as well as broader system level (Vargo, Maglio and Akaka, 2008; Vargo and Akaka, 2012). This statement is in line with the 'becoming' ontology (Zimmermann, 1951), whereby resources realise a service through interaction between the provider and the user, as 'resource integration' (Vargo & Lusch 2004, 2008).

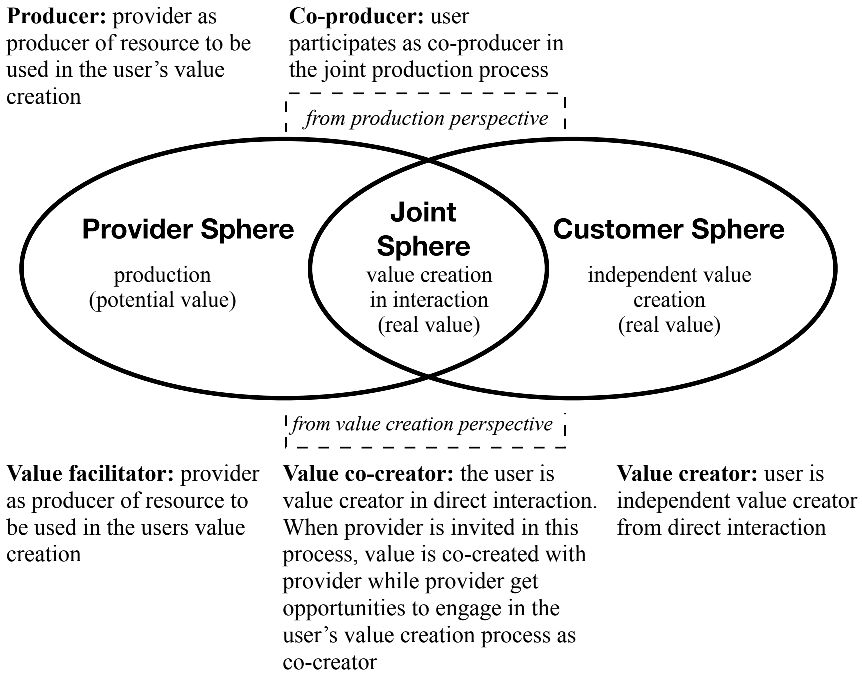


Figure 6. Value-creation sphere (adapted from Grönroos and Voima, 2013)

While the concept of value (co)creation presented above provides a high level of abstraction at a scale that can be understood at a glance, it has been challenged in terms of both the consumption and provision process of value co-creation and thought to be impractical.

A more practical framework has been suggested by (Grönroos, 2011; Grönroos and Voima, 2013—and see FP6 in table 2), who questioned the meaning of value co-creation, and explored what it includeds as well as the process of value co-creation itself. Their alternative framework explains who is involved in value co-creation (service provider–customer) and how they interact each other to create real value together (Figure 7).

They suggest that value (co-)creation can be controlled by the customer (Heinonen *et al.*, 2010; Grönroos and Ravald, 2011), which implies that 'value can be seen as embedded in the customer's subjective life, accumulated reality and ecosystem context' (Heinonen, Strandvik and Voima, 2013; Heinonen and Strandvik, 2015).This view emphasises the crucial role of interaction in the nature of value (co)creation, meaning that service is *relational* (Grönroos and Gummerus, 2014). Lusch and Vargo (2014) have further explored the ‘service ecosystem' in terms of its implications in a broader, holistic, and dynamic perspective on value-creation, which supports identifying the particular interactions and flows between actors and the environment, and thus looking at mutual value-creation and service exchange from a wider viewpoint (Lusch and Vargo, 2014).

In this respect, value-creation in service is more than an *action* or *activity* but depends on the abilities of the service system to integrate, sustain, and expand beyond its surrounding environment as well as the *relationships* associated with each service system. In this way, the given service (eco)system is maintained by the constant effort of each actor to create value for themselves and others in the system (Vargo, Maglio and Akaka, 2008; Vargo and Akaka, 2012)

2.4.3. Digital mapping and the move towards ‘smart’ service system

Continuous ‘smart’ technological improvements in relation to various devices and service systems, such as AI, Deep learning, Big Data, and its automation, mean that all actors involved in the service system are anticipated to derive benefits.

As technology plays a crucial role in value co-creation, there is a need for interdisciplinary approaches to service science to enable the innovation of more systemic and sustainable practices of real-world value co-creation (Spohrer *et al.*, 2007). Service can be defined as value co-creation, while service systems can be understood as configurations of technologies, people, information, resources, and actors that together create value as result of realised purposeful action and activities for all the actors involved, through interdisciplinary efforts (Edvardsson, Skålén and Tronvoll, 2012).

In addition to the direct service provision, the service provides platforms for meeting customer needs, referred to as ‘The product, in fact, is no more than artifact[s] around which customers have experiences’ (Prahalad and Ramaswamy, 2000: p84), while customer experience can be stimulated by the advanced level of digitalisation, blurring the boundaries between providers and customers and between material objects and services they are able to perform – which could result in new markets and often disruptive business models (Ng, 2014). Moreover, digital platforms allow users to explore their needs in a non-liner way, weaving several levels of information and activities together through linking entities – whether artefacts, individuals, or services – where users can influence a supplier's service provision but also the customer's usage process. For example, highly technological firms such as Google or Uber – which are industry leaders, though other mainstreaming studies term them 'platform leaders' (Gawer and Cusumano, 2014), 'innovation ecosystems' (Adner and Kapoor, 2010) or 'network centric innovation' (Nambisan and Sawhney, 2011) – are not only technology platform providers, but develop a platform-based service and strategies that support others in building upon their product or service. Their products, services, and technologies either enhance value or enable others to create entire service ecosystems for interconnected activities through the service provider, by opening up new paths and new markets, such that we see both specific relations and interdependency among the firms (service providers).

Although existing work in the diverse range of studies on service – including marketing, economics, and technology platforms – there is a need for interdisciplinarity towards gaining a systemic understanding of service – not only focusing on the technology, but also on the broader context of the service ecosystem, including how service opportunities unfold in this changing context. As studies of service science aim to draw various disciplinary threads into a comprehensive and coherent study of service phenomena (Maglio, Kwan and Spohrer, 2015), this discipline enables us to revisit the alignment of the service system with 'smartness', offering a systemic exploration of resource configurations (Brynjolfsson and McAfee, 2012) in order to improve existing value offerings, allowing the creation of new ones and/or reconfiguring ecosystem partners across different sectors (Maglio and Spohrer, 2013).

Given the increasingly important role of service innovation, the quality of the user experience could depend on a continuous improvement of the service system. This includes the quality of the service experience, the flexibility of the service system, and its adoption of other service-system components, as well as the costs incurred by service providers and users.

In this respect, Medina-Borja (2015) has claimed that ‘a *smart* service system is a system capable of learning, dynamic adaptation, and decision making based upon data received, transmitted, and/or processed to improve its response to a future situation’ (Medina-Borja, 2015, ii). Likewise, Maglio and Spohrer (2013) have suggested that the key to enhancing the smart service system’s development/design is aligning value propositions and appropriate resources that are mutually beneficial for all actors involved in the service system. The main focus of the smart service system is automation and support for the complex service system. This also involves ‘self-detection, self-diagnosing, self-correcting, self-monitoring, self-organising, self-replicating, or self-controlled functions’ (Medina-Borja, 2015: ii), that is to say, innovation in the service system will depending in large measure on how the system itself turns into a ‘smart’ system through an effective understanding and use of data, information, and technology, resulting in a blurring of both the distinct boundaries between providers and users and those between physical and dematerialised objects (e.g. intangible objects and services) (R. Normann, 2001).

From this perspective, the transformation of the service system into a ‘smart’ system requires new approaches as well as new theoretical and empirical understandings that incorporate collaborative interdisciplinary approaches along with design, engineering, and social science disciplines, which will help us understand the service system and the relationships among system components. These are comprised of technologies, people, and information, which potentially drive disruptive service innovations and business models as well as facilitating new value-offerings in established markets (Ng, 2014; Maglio, Kwan and Spohrer, 2015)

While scholars studying service systems highlight that these systems are ready to adopt radical transformation (Maglio and Maglio, 2014; Carsten *et al.*, 2018), some argue that there is still a general lack of research, and thus that the study of the service system still faces challenges generated both by constraints and by an incompatibility between *how technology functions* and *how human beings behave* (Larson, 2016). Furthermore, adaptations of technology to fix or improve a given service are not always the appropriate way forward, as adopting technology blindly can degrade a system even further. This means that the implementation of smart service systems relies on the capacity to adopt multidisciplinary approaches to understanding the interaction between technologies, people, resources, information, and other service system components, thereby encouraging value co-creation. From this perspective, the 'smart' service system should be a re-configuration of resources from human-centred interactions between different stakeholders (providers, customers, and other actors) and resources rather than being goods- or technology-centred.

In the case of maps and mapping, the latest digital technologies in mapping and smart devices have allowed maps to become much more fluid and pervasive (forms of information), whereas previously they were a static set of information with frozen contents fixed at particular moments in time and space. The shift in ontological assumptions regarding maps and mapping (e.g. geospatial data to mapping platform and mapping-related services) is closely aligned with the emergence of smart technology and its widespread usage in every aspect of our lives, thereby enhancing our standard of living.

With the continuous technological improvement of digital mapping affecting service systems in the service economy, maps and mapping are now situated in a joint sphere where users are in charge of value-creation through direct interaction on a kind of *platform* for joint value co-creation. This means that maps/mapping play a critical role in the act of *value co-creation*, wherein the integration of shared technology, resources, and actors together create value for all the actors involved in the given map/mapping service. For example, according to the accepted definitions of value-in-use, value co-creation, and value in context, value in maps/mapping is co-created over time through the service experience that the provider offers. That is, maps now constitute collaborative mapping *activities* and function as participatory digital platforms with the capacity to collect, create, store, and process data through interaction between people, physical objects, information, and the surrounding environment.

Existing work in service science and other streams of literature provide a comprehensive understanding of value (co-)creation, not only from a theoretical perspective but also from the perspective of practical realisation or real world implications. This study does not focus on technology, the service supply chain, or actors on various platforms, but instead focuses on value co-creation (service provider–user interaction), quality of interactions, and broader interdependencies in the wider service (eco)system in maps and mapping; thereby unfolding the how service opportunities are developed in such a context, especially when the nature of maps and mapping are closely aligned with nature of service.

In this sense, maps/mapping nowadays should be seen from a service-system perspective which allows providers and users to engage with each other by sharing and transferring their resources (e.g. technology, knowledge, skills) during the use of mapping services. This view is in line with a complex value co-creation system, where users play active roles in service delivery, thus playing a critical role in value co-creation and the *realisation of value* as value co-creators (for users as prosumers see: Kotler, 1986; Ritzer and Jurgenson, 2010; Grönroos and Voima, 2013). In this way, maps/mapping paint a portrait of the service system from a design researcher's perspective. As such, we can conclude that maps and mapping services can be understood as a way to think about and develop service systems rather than being tied to cartography or specific design object offerings, which we can then relate to the problematisation of value-creation in mapping services.

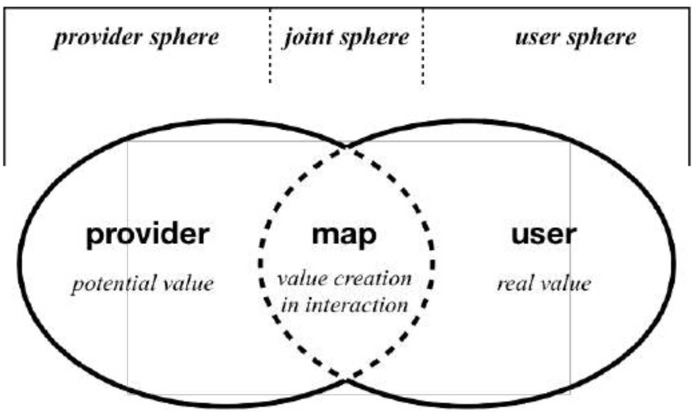


Figure 7. Value creation sphere in mapping

2.5. Service Design when maps become a service

In service systems users integrate knowledge and resources/capabilities in a form of value co-creation; the conceptual position of users is as active co-creators of value, in a move away from their former passivity. Works in this field also discuss how and when to involve users in the process of service development as active co-creators of value (Ostrom et al., 2010; Grönroos, 2011a). In the service system framework, Service Dominant Logic (S-D logic) is highly conceptual, and its focus has mainly on offering a different perspective on the ways that the service provider can understand the value-creation process. This perspective requires other approaches, methods, or tools to facilitate the value co-creation process, but also realises value co-creation and its implications in the development of maps and mapping from a designer's perspective. However, there is limited knowledge regarding how the value co-creation view in service system studies can be actually applied in practice in accordance with the value-(co)creation perspective (Edman, 2011). This view neglects to take up the tools and methods necessary for understanding the actors/stakeholders involved or the question of how to realise service systems in accordance with their features (i.e. SD logic) in practice. This section will bring service design into relation with value-creation activities, especially when viewing maps as aligned with the service system.

2.5.1. Service design and value co-creation

Many scholars have tried to depict services as activities, processes, or performances and interactions which contribute the fundamental concepts to service design (Solomon *et al.*, 1985; Edvardsson, 1997; Grönroos, 2011a). Accordingly, it is widely accepted that service is a *process* of creating *real value* in the process of interaction between two entities by exchanging services and building relationships (Vargo and Lusch, 2008b), such that these exchanges benefit both; service concepts (Edvardsson, 2011**;** Gustafson et al., 2000), value propositions (McColl-Kennedy et al., 2014), and service encounters are ways to value co-creation when an associated set of value co-creation opportunities are initiated (Katzan, 2008 ; Tung & Yuan, 2008). This aligns with a parallel discussion that states that service acts as a co-productive process in which ‘the service value is produced in a customer’s process where the customer, company, and subcontractors play as actors’ (Edvardsson, 1997, p. 31).

While this concept is further developed in the ‘service system’ (Lusch, Vargo and Wessels, 2008; Spohrer and Maglio, 2008) and ‘service ecosystem’ (Vargo and Akaka, 2012; Maglio and Spohrer, 2013; Lusch and Nambisan, 2015; Vargo and Lusch, 2017), the concept in service science also provides a clear theoretical understanding of value co-creation, especially in terms of its usefulness for understanding maps and mapping services; however it is not yet clear how s theoretical understanding of value-creation dynamics would transformable into actual practice in maps/mapping. Therefore, an exploration of service design is necessary in order to build both theoretical and empirical explanations of design in maps and mapping service systems.

Underpinned by the fundamental concepts of the service system, service design is comprehensively understood as multidisciplinary in nature (Joly *et al.*, 2018), and is framed as an application of design practice and principles to service innovation, thereby acting as a new integration of resources that enables a new form of value co-creation (Lusch and Nambisan, 2015), value networks (Ng *et al.*, 2012), and service ecosystems (Vargo, Wieland and Akaka, 2015; Barile *et al.*, 2016).

Since service design has been widely accepted as a human-centred discipline, with an iterative and holistic approach to service innovation (Segelstrom, 2013), the practice of service design is particularly focused on value-creation in its experiential dimension, that is, service is often performed and realised—meaning that value is intangible and is often associated with the design of the system, with processes and experience rather than tangible media and products for end users. This means that at the practice level, service design results in a holistic service experience that is comprehensive, empathic with regard to customer needs, but also supports service provider in delivering useful, usable, efficient, effective, and desirable service offerings (Stickdorn and Schneider, 2011).

In doing so, service design weaves interdisciplinary efforts together in various fields, supporting complementary perspectives—for example marketing in order to focus service concepts, propositions, and value-offerings to the customer (Grönroos, 2011a) ; information systems to enable new technology and service delivery (Zimmermann, 1951); operation management that stretches to organisational transformation processes (Sangiorgi, 2011); design of interactive service interfaces that exemplify service provision (Holmlid, 2007; Secomandi and Snelders, 2011; Secomandi, 2012); and so on.

In addition, service design is an integral part of the service-system concept, one that attempts to apply a scientific understanding of service to design practice while focusing on the experience of people with a human-centred, iterative, and holistic approach and set of tools (Stickdorn and Schneider, 2011), which can potentially develop new and/or improved services and customer experiences (Maffei, Mager and Sangiorgi, 2005; Moritz, 2005), translate and scale service systems to achieve feasible solutions that drive business efficiency, effectiveness, and sustainability (Spohrer *et al.*, 2007), and help organisations to implement these through transformation processes at an organisational level (Junginger, 2009; Kimbell, 2011; Sangiorgi and Junginger, 2015).

In this sense, service design involves a collaborative, complex, and holistic approach to the whole service design and production experience that requires the integration of cross-disciplinary contributions in a systemic solution. This perspective is in line with the idea that service design involves 'the orchestration of clues, places, processes, and interactions that together create holistic service experience for customers, client, employee, business partner or citizen' (Ostrom *et al.*, 2010: p. 17). In this way, service design is relevant to value-creation because it bridges the gaps between service and design, such that the debate about the changing dynamic of mapping and the role of service design in this dynamic is highly relevant to this study.

2.5.2. Service design competence in terms of capturing the dynamic of service processes and experience

As mentioned above, in viewing service design as a creative process that bridges gaps between service and design we see that the debate on the changing dynamics of mapping and the role of service design is highly relevant. Service design may facilitate collaborative activities using its unique and multidisciplinary set of tools and methods, while its methods are also concerned with design and the description and visualisation of users' experiences (Katzan, Jr., 2015).

These tools are mainly useful within four sets; for example, video diaries and sketching, user observation, contextual interviews, personas (i.e. fictional potential user profiles), and stakeholder mapping, the latter being useful for collecting evidence. These techniques can be applied in the early stages of design research (i.e. the discovery and define stages), thereby identifying problems and the user's sequence when using the service process; the visualisation of the user's experience is an example. In addition, user-journey mapping, narratives, and storyboarding are examples of service ideas based on a hypothetical service process in a cinematographic representation that shows every touchpoint and relationship wherein service providers and users interact in the creation of a service experience. These tools effectively illustrate how the service will unfold in a narrative sequence. Blueprint and Touchpoint matrices support the representation of complexity of service in a systemic way, in particular the 'Service Blueprint' (Shostack, 1982, 1984), which is a flow chart that captures all the Touchpoints and the front and back end processes that are aligned with the user experience. This tool visualises where the service provider and users interact as well as their actions, thereby identifying constituent service components that are visible to users, and also identifies what runs behind the scenes that supports service providers. In addition to this, the prototype helps to catch supplementary activities that are tested by groups of users, which is essential in order for the service to be sustainable.

These tools and techniques are useful for generating and testing collaborative ideas regarding service development. The significance of these sets of tools is that they are open, transparent, and interactive, while also effectively capturing the combination (or dynamics) of the integrated service processes, people, skills, and resources that should be planned in advance (Goldstein, Johnston, Duffy & Rao, 2002), particularly when compared to conventional design methods that focus on the single discipline of a given design application (i.e. an interface design or product design). Using service design methods in designing services allows for a holistic approach and facilitates a systemic perspective on multiple stakeholders' needs, all of whom are involved in a particular time, space, and sequence. In this way, service design facilitates user participation alongside interdisciplinary and collaborative teamwork and creative collaboration across disciplines and stakeholders.

To summarise, the following tables present service-design tools' characteristics and dimensions in the many ways in which they can be combined and incorporated into service innovations in actual practice.

Service Design dimension	**Principle and description**
User-centred	Service should be experienced, and a certain degree of customer participation is necessary. The inherent intention of service is to satisfy customer needs and their purpose through interaction between the service provider and a customer using a given service.
Co-creative	All stakeholders should be included in the service design process, including customers and other stakeholders who might collaborate in creating, exploring, and defining service proposition.
Sequencing	The service should be visualised as a sequence of interrelated actions. All services are dynamic processes and the state of the participants takes a certain period of time and space.
Evidencing	Intangible services should be visualised in terms of physical artefacts. The value of both tangible and intangible services should be clearly evidenced as part of the service design experience, which can explained as certain aspects of a service touchpoint or process. These can be captured as a snapshot of front- and backstage processes, and we can explore how they are interrelated through the service blueprint.
Holistic	As service is intangible, it take place in the physical environment at the level of individual touchpoints and service moments. These are entire environments where a service take place. These services should be considered the bigger picture, as customers perceive this environment with their senses. Thus, a good service designer should be culturally ambidextrous.

Table 3. Five principles of service design dimensions (elaborated from Stickdorn and Schneider, 2011).

2.5.3. Service design in mapping as a collaborative activity

Service design approaches combined with the above five principles contribute to the development of a service concept, focusing on creating service forms, outcomes, and experiences (Mager and Evenson, 2008), thereby designing the service touchpoint in which the overall interaction and service experience so that it can be more useful, usable, and desirable from a service user's perspective . A design application that incorporates these principles results in a good service design through a combination of holistic design, interdisciplinary integration, useful and usable service delivery, effective and efficient service processes, and an approach accounting for stakeholders' mutual benefit, which has the potential to create a good customer experience (Stickdorn and Schneider, 2011).

While many designers have continued to design service interfaces and interactions aimed at touch-point innovation, thereby enhancing service features and experiences (Clatworthy, 2011), they have been critiqued for their weakness in relation to service implementation and lack of attention to economics – namely, ensuring that ideas are cost effective and applicable to organisational issues and cultures in the development of a service (Mulgan, 2014). In contrast with the conventional focus on design practice and methods, service design expertise may make these practices more accessible and communicable through its own approach, such as the ability to be engaged and empathise with all stakeholders, thus deepening the connection with service providers and users.

The designer co-creates, meaning that designers work as facilitators of collaborative design processes and activities, such that design is collaborative and co-creative within a team including users, providers, and others. The value of these working practices is not simply the following of protocol but collaborative work, which implies applying thought to action while considering the overall service system – a process that is difficult to replicate easily in other service design work (Fayard, Stigliani and Bechky, 2017). This participatory approach and service design competence is considered 'not simply a method or set of methodologies [but] a mindset and an attitude about people' (B.-N.Sanders and

Rim, 2002: p. 1). Therefore, service design should be understood as the ‘process and mindset of designing with people [rather than] skillsets of designing for people’ (ibid.).

Image 10. Service design session

2.5.4. Exploration of mapping as a new form of value co-creation

Service concepts include how the service is delivered and experienced by users and the value provided by both service providers and users, where the user interface is the prime determinant of the user’s experience. It is important to understand the influences on this new form of value co-creation through forms of resource integration that occur alongside the service delivery process (Bitner, Ostrom and Morgan, 2008), as well as new approaches to the use of technology (technological innovation) to enable the service (Edvardsson and Olsson, 1996; Patrício *et al.*, 2011).

In the context of maps and mapping, the central challenge has been how to exploit the opportunities provided by the adaptation of technological innovation in mapping services. As stated, the relentless march of recent technological developments has allowed maps to become collaborative mapping activities. Thereby, users have become co-producers of maps and mapping (i.e. prosumers), as have service and technology providers, governments, and other stakeholders. In this space, the role of the producer (in this case service providers) and consumers (users) are not distinct, which means that value is co-created when mapping space through interactions between entities and through resource integration. On this view, contemporary maps and mapping should be seen as another facet of service systems and examined from an integrative perspective in terms of service design’s potential to enable service innovation.

As the nature of maps and mapping has changed, the role of design and the designer in this space has also adapted. Service design is therefore a central discipline when exploring the potential of opportunities for new mapping service systems and experiences, which is particularly evident in the reformation of mapping service systems and the adoption of more collaborative service models in mapping. In this approach, the relation between mapping service systems and service design's competence is complementary, particularly regarding its methods and tools for user involvement alongside facilitating co-creation; thus the relationships and value generated are mutually productive. Service design becomes a matter of offering perspectives on the interactive space where providers and customers co-create value together, in which people's experiences are central (Arvola and Holmlid, 2016).

In this sense, service design contributes to the bridging of gaps between design and service; so far the debate has concerned itself with the changing dynamics and the role of service design in this transformation, particularly in relation to its role in providing multidisciplinary support to service innovation by envisioning new forms of resource integration within value networks (Vargo and Akaka, 2012), and at the service ecosystem level by facilitating institutional chance based on new forms of service interactions between actors (Vargo and Lusch, 2016).

Therefore, the rationale for exploring service design in mapping lies in the theoretical explanation of service and the meanings shared between mapping service platforms and service (eco)systems. In this sense, service design in maps/mapping falls in line with design and the service (eco)system by putting the human at the centre of service system design.

2.6. Summary

Chapter 2 of this thesis has identified the theoretical knowledge that has informed the shifting ontological and epistemological status of maps, particularly as influenced by digitalisation in the context of the service economy. This chapter has also suggested new perspectives based on a review of cartographic and service studies that inform current debate and knowledge gaps between the theoretical and empirical contexts. The examination of service design explored whether its approach could potentially provide useful methods for the development of maps/mapping services.

This chapter also argued that the nature of maps now transcends their artefactual value, significantly impacting the way maps perform specific tasks, given their interaction with users and other stakeholders. Thereby, maps now facilitate collaborative mapping activities and function as participatory digital platforms with the capacity to collect, create, store, and process data through interaction between people, devices, environments, and places. The chapter suggested that cartography now points in a different future direction, however the ability to interpret various types of geospatial data sources and the holistic integration of information, processes, and mapping-service usage has become an important topic of study. As yet there is comparatively little theoretical or empirical understanding of how these changes should be understood, including in relation to the emergence of the service economy to date.

The review of service-system studies identified that value is always co-created when the service is used and experienced by users at the point of service delivery. This means that value-creation in mapping is more than an action or activity but is dependent on the abilities of service systems to integrate, sustain, and interact with their surrounding contexts as well as influencing relationships with associated service-system components. Therefore, the capture and usage of data in the service system, the involvement of the efforts of each actor, and the integration of resources (i.e. experience, skills, and knowledge) should be addressed in order to further value-creation in mapping-service development. Although service-dominant logic provides a clear theoretical understanding of service value-creation dynamics, reflection on its wider implications is still lacking.

Despite the absence of empirical context regarding the practical principles of value-creation in mapping service systems, service design has been framed as the application of design practice and disciplines to the development and design of service systems in maps/mapping with a focus on people's experience, particularly in relation to user involvement and stakeholder co-creation using service design's tools and methods. Therefore, service design supports relations between actors and helps these to become mutually productive; that is, service design offers a perspective on the interaction of (joint) spheres where providers and users create value together.

Therefore, the rationale for exploring service design in mapping lies in the theoretical explanation of service while also defining service systems in terms of maps/mapping. Furthermore, the service design provides a highly appropriate way to utilise the resources and facilitate engagement with stakeholders, thereby involving them in the value co-creation process. In this way, this chapter asserts that service design can potentially contribute to the bridging of gaps between design and service, thereby adding to the debate in terms of the changing dynamics and role of service design, especially when the nature of maps aligns with the service system. Based on this assumption, the next chapter will present a detailed picture of the research setting and methodological approaches used to conduct the research activities.

Chapter 3. Research Approach

3.1 Introduction

This chapter outlines the methodological process of the research activity conducted. It details the methodological approach chosen in order to answer the research questions, addresses the research process, and describes the rationale behind the data generation and collection undertaken. This research aimed to develop an understanding of the opportunities in digital map services that have emerged from the growing digital economy. The study focuses on the development of a theoretical understanding of digital maps/mapping from a service design perspective, as well as its implications. The following research questions were proposed:

1. *What is nature of maps and their changing dynamics in relation to technological development?*
2. *How can opportunities be developed in mapping services?*
3. *If service design can be implemented into mapping services, what value can we thereby expect to create?*

In order to answer these questions, three research activities were conducted, including an analysis of map samples, four case studies of existing map services, and a service design project as a separate case study in partnership with Transport for London. These research activities were built up from a methodological basis, one that embraced both theoretical understandings and practical implications through iterative comparison. The following three sections describe the research approach as well as developing a framework for a theoretical understanding with corresponding implications from the perspective of a service (eco)system.

Section 3.2 introduces the research strategy and explains the fundamental guidelines of its methodological grounding.

Section 3.3 introduces the methodological approach adopted in this research. The case-study research approach has been tailored based on the research aim and objectives. This section presents the research stages and the methods that were adopted in conducting the research activities. It also provides information regarding detailed research activities, thereby illustrating how the research plan was carried out.

Section 3.4 describes the data collection and analysis methods.

3.1.1 Research purpose and enquires

In order to achieve the proposed objectives (Table 4) and answer the research questions, this chapter/section defines the research methodology, research settings, and methods used to collect and analyse the relevant data. The aim of the research was to offer systemic exploration guided by a series of decisions in relation to the research objectives, posing questions and using strategies to collect and interpret data; thus my decisions depended on the research objectives. Whilst Robson (2002) classifies the purpose of such enquiries as explaining, describing, exploring, and emancipating in a flexible form of research (or qualitative) design—as presented in figure 3.1—Yin (1994) suggests that if research questions focus on the 'what' question, it is justifiable for an *exploratory* study to follow one of five different research strategies—for example, an exploratory survey, an exploratory experiment, an exploratory case study about prevalence—such as survey strategies or the analysis of archival records. In the case of 'how' and 'why' questions, it is likely that these will lead to the use of case studies, experiments, and histories (ibid. p. 6)

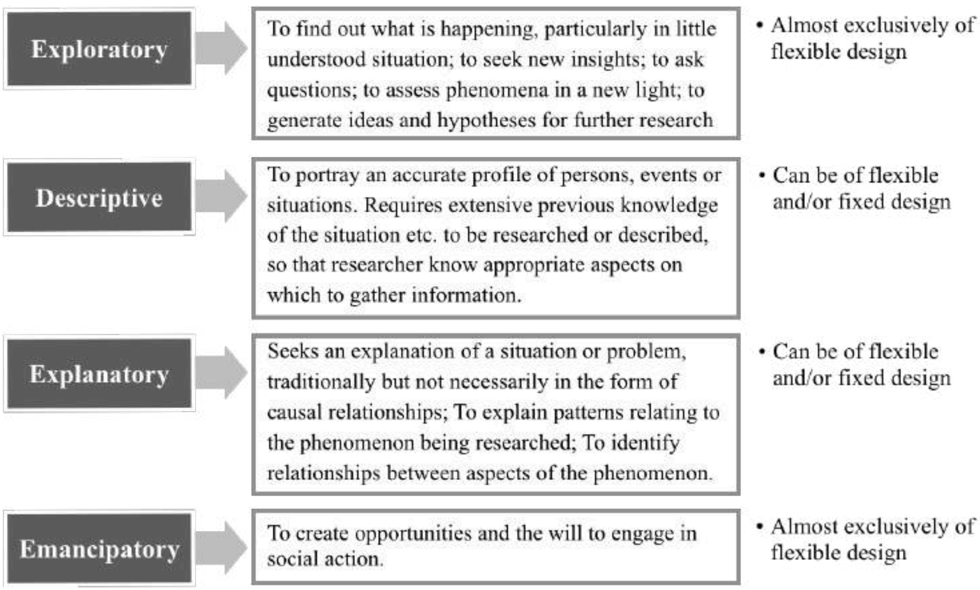


Figure 8. Classification of the purpose enquires (Robson, 2002: p.59)

Since the research aim is to develop a theoretical understanding of digital maps/mapping from the perspective of the service system and its implications, the study was concerned with more than one form of enquiry, trying to address research gaps in the literature. The fundamental nature of this research was *exploratory* and *descriptive*, as the research set out to understand the nature of maps; furthermore, the study also has the implicit effect of creating knowledge and opportunities in the service system and service-design context of maps and mapping. Therefore, one aim of the research was to be *flexible* in nature.

Table 4 presents a list of research questions and the objectives of the research. Question 1 was identified through a review of the literature and map samples, which also provided a link between the nature of maps/mapping and the service system. An understanding of the nature of maps from a service-system perspective raises further questions that may expand service opportunities, service design practice, and knowledge in the field. As such three of research sub-questions and objectives were generated and answered under the overall research aim.

Research aims: To develop a theoretical understanding of digital maps/mapping from the perspective of the service system and its implication.		
Gap in knowledge or phenomenon	**Research questions**	**Research objectives**
Changing nature of maps through technology	1.What is the nature of maps and what are their changing dynamics in relation to technological development?	To identify key debates, trends, and changing parameters in relation to technological development (Literature review + contents analysis)
Changing nature of maps but lack of understanding of the implication from a service-system perspective	2. How can opportunities be developed in mapping services?	To identify areas of opportunities, challenges, and the relationship among players and potential beneficiaries in the service (eco)system (case study)
Lack of knowledge of ways to adopt and realise the implications of the service system	3. If service design can be implemented into mapping services, what value can we thereby expect to create?	To understand service design tools and methods in relation to value creation (participatory case study)

Table 4. Research question and objectives

3.2 Research strategy

These research aims and questions guide the research strategy. A research strategy or strategies, and the methods or techniques chosen in relation to these, should be appropriate to the research aims and questions that researcher want to answer. While multiple strategies can be used, the most suitable research strategy should be identified, such that some research strategy or strategies might have distinctive advantages when conducting research activity with a given aim, in relation to the questions and objectives proposed (Yin, 1994: p. 7). Robson (2002) demonstrates two possible research strategies—fixed or flexible research strategies. While a fixed strategy is commonly associated with quantitative data (i.e. statistical data), such that the researcher would be able to control the situation, a flexible strategy generally involves ways of supporting qualitative data collection that are typically non-numerical (usually in the form of words), such that much less pre-specification takes place.

It also often referred to as a qualitative strategy—case study, ethnography, grounded theory, are all common strategies, but we can also consider mixed-methods that allow the *use of two or more methods* (Robson, 2002). In a flexible research design, the research questions are often discovered, unfolded, and linked with research aims as the research evolves (Robson, 2002: p. 5). In this type of design, the detailed framework of the research design *emerges* during the study, and should be revisited as the research is conducted (ibid p. 82). As previously mentioned, the exploratory and descriptive nature of this research suggests that the chosen research strategy is flexible and aims to develop an understanding of the complexities of real life, while the qualitative data and evidence is provided in descriptive detail.

According to Yin (2003), the 'what' question can be either exploratory, using different strategies (i.e. survey, experiment, case study, or analysis/archival records, etc), while 'how' and 'why' questions likely use a case-study strategy, which consists of all-inclusive methods covering research into design logic, as well as specific data-collection techniques and approaches to analysing the collected data. In this sense, the case study strategy is merely a form of data-acquisition but can be considered a comprehensive research strategy that gives certain features of variation to answering research questions in general (Stoecker, 1991; Yin, 2003).

Taking into account the research questions presented in Table 4, as well as the criteria suggested by Robson (2011) and Yin (2003), an exploratory case-study strategy was adopted here as the most appropriate for the research. The case-study is an empirical inquiry that explores and/or 'investigates a contemporary phenomenon within its real-life context, especially when boundaries between phenomenon and context are not clearly evident' through a detailed contextual analysis of a limited number of events or conditions and their relationships (Yin, 2003: p. 13). This means that the case-study strategy can be used for investigation of dynamic, experiential, and complex processes and areas such as business networks which take place in a fast-changing and fluid environment (Vissak, 2010).

However, these criteria are only there to offer guidance to help the researcher to the most suitable strategy/strategies and method(s). Therefore, the research strategy adopted in this study is not the only way to pursue such an investigation, but allows for variation in the methods most suitable for answering the relevant research questions. In this sense, the exploratory essence of the research aims to build up an understanding in the field of study, but should also have a degree of flexibility such that it can adopt suitable methods to collect appropriate data during the research process. Further justification and description for my use of particular methods of enquiry and their variation in each study will be provided in the following section.

3.3 Research process and core setting

Myers and Avison (2002) have noted that '[a] research method is a strategy of enquiry which moves from the underlying philosophical assumption to the research design and data collection' (Myers and Avison, 2002: p. 7). A qualitative case-study methodology is a flexible method that provides tools for researchers to explore or describe complex phenomena within their contexts using a variety of data sources (Stake, 1995; Meyer, 2001; Merriam, 2009).

It then allows the researcher to explore topics of interest 'not explored through one lens, but rather a variety of lenses which allow multiple facets of the phenomenon to be revealed and understood' (Baxter and Jack, 2008: p.544). Several authors, including Yin (2003) and Robson (2002), have provided guidance for the case-study approach with the aim of ensuring that the research topic and the essence of the phenomenon is explored and revealed appropriately. Their approaches to the case study are based on the view that truth is relative and dependent on our understanding of the world of human experience, which suggests that reality is socially constructed (Cohen, Manion and Morrison, 2007). This approach therefore recognises the importance of the researcher's background and subjective experience. In this approach, the researcher is predisposed to rely on the participants' perspective on a given situation and inductively develop a theory or pattern of meaning throughout the research process, rather than beginning with theory (Baxter and Jack, 2008; Creswell, 2014).

With the exploratory nature of the strategy of flexible research design, research methods examined the data within a specific context closely and it is likely that the researcher will select a small geographical area and a limited number of individuals as the subject of the study. Three major research activities were adhered to here in order fulfill three research objectives over time: 1) to identify key debates, trends, and changing parameters in relation to technological development, thereby developing an initial framework for further contextualisation through a review of the literature and map samples; 2) to identify areas of opportunity, challenges, and the relationships among players; and also to identify the potential beneficiaries in the service (eco)system through the case study as a method; 3) to conduct a design project with Transport for London as a separate case study.

The following section describes the major research setting that determined the three research activities shown in Table 5. in more detail.

No.	Research questions	Research objective	Methods	Activities
Study 1	What is the nature of maps and what are the changing dynamics in relation to technological development?	To identify key debates, trends, and changing parameters in relation to technological development, thereby developing an initial framework for further contextualisation	Content analysis	Review of literature and map samples
Study 2	How can opportunities be developed in mapping services?	To understand areas of opportunity, challenges, and the relationship among players and potential beneficiaries in the service (eco)system	Case study	Four case studies
Study 3	If service design can be implemented into mapping services, what value can we thereby expect to create?	To understand service design tools and methods in relation to value creation.	Participatory case study	Conduct design project as a case study

Table 5. Relationship between objective, question, and research methods

3.3.1 Study 1: Map samples review—conceptual framework development

The research activity was an evolving process that was iterative but not linear in nature. In this process, a researcher may easily be tempted to collect everything, if a viable proposition is not in place. Several authors, including Yin (2003) and Stake (1995), have suggested that case boundaries need to be put in place in order to limit the scope of the study, thereby preventing superfluous information from flooding in when researchers attempt to achieve too many objectives in one study (Stake, 1995; Yin, 2003). Both refer to ‘propositions’ or ‘issues’, which are necessary elements in case study research and helpful in terms of identifying the relevant information about a topic or theme. This is because these elements can lead to the development of a conceptual framework that guides the research process in a logical manner and thus can be referenced while the research is being conducted (Yin, 2003; Baxter and Jack, 2008).

In this research, it was critical to have an initial conceptual framework in place prior to the case study activity, as it served an important purpose—namely identifying what would and would not be included in the research. The initial framework describes the relationship among logic, theory, and/or experience that was identified in the literature. Furthermore, it provided opportunities for the researcher to be able to shape intellectual constructs during the research development (Miles and Huberman, 1994).

As the research progressed, the framework was constantly developed and relationships between the intellectual constructs within the framework emerged when the collected data was analysed. Baxter (2008) and Yin (2003) suggest that the final framework should continue to be developed and be included in all the themes when it is completed. For this reason, the initial framework served three main purposes during the research activities:

- First, it enabled the researcher to draw out the scope of the research and achieve a sense of control in the research process;
- Second, it worked as an anchor for the research process, thereby providing a useful tool for selecting relevant cases rather than a tool for hypothesis testing;
- Third, it provided a comparative structure that is referred to at the stage of data interpretation across cases. Therefore, data collection and analysis potentially capture relevant aspects of the scope, topic, or theme in a systematic manner.

To serve these purposes, a series of propositions were synthesised based on the literature review and map-samples analysis, which aided further contextualisation during the case-study development. Building on the overall question and aims of the research, we can ask: what does it mean for maps to be a service, what would a theoretical understanding of maps/mapping from the perspective of the service system look like, and what are its implications? It was therefore important to understand the nature of maps and key debates from the service-science perspective relevant to maps/mapping-related services, underlining the importance of service-design practice from an implementation perspective.

To fulfil these considerations and to develop the initial framework, a large collection of map samples from the 13th century to late 2016 were collected based on the criteria identified in the cartographic literature—for instance, map forms, contents, and representations. These were then carefully divided into sixty map samples, which were then deconstructed based on parameters and factors identified in the service system literature, including technology use, service enablers, service usage, and purposes of use. These factors were used to describe the different aspects of maps/mapping service and their interaction with users and other stakeholders from a service-dominant logic perspective (see Vargo and Lusch, 2008), which was introduced as part of the literature review in Chapter 2.

In the process of map analysis, data visualisation was used not only as a way to collect data but as an effective means to analyse and extract certain insights. The adaptation of visualisation techniques in this process enabled the identification of interesting patterns related to map/mapping services in a much easier and quicker way. The analysis of the map samples was useful in describing the evidence and documentation of particular practices while also referencing interactions with a user-centred dimension. As a result, the map sample review findings revealed the following propositions:

- **Complexity of data generation** due to the ubiquity of data that transferred into information and thereby knowledge through maps.
- **Technology** drives users to be involved in the map-making process in a pervasive manner, whereby there are no clear boundaries between mapmakers and mappers; thereby the **role of the user** becomes more democratic and critical in the mapping process.
- **Expanded usage of maps**. Maps were used for service components and new service offerings.
- **Process of delivery of cartographic knowledge** to the user has become more comprehensive (within the wider service ecosystem).

Building on these propositions and the parameters already identified, the results of the individual analysis of the map samples were synthesised into a map taxonomy consisting of two axes: how maps are used (the level of map servitisation) and how users use maps (the level of users' interaction). In this taxonomy, nine type of maps were characterised as part of the initial framework development. A more detailed account of the procedure and the results will be presented in Chapter 4: Map Samples Review.

3.3.2 Study 2: Case study

The boundaries of each case were grouped according to the initial conceptual framework, which was created in the map sample review (see Chapter 4). The initial framework supports a demonstration of the progress of maps/mapping in relation to epistemological and ontological shifts in maps and mapping; therefore, it was particularly useful to draw case boundaries that offer guidance in selecting the most appropriate cases, as the framework indicates four different types of mapping service systems. However, there was no clear evidence to demonstrate the relationship between different types of maps/mapping service systems or the involvement of service design as a means of realising a service system. Therefore, the final framework was developed after the completion of two sets of case studies, namely study 2 and 3, at later stage.

3.3.2.1 Case study design and sampling

As the objectives and research questions were of an exploratory nature, the case study method was conducted alongside other methods of data collection such as observation and document review. Yin (2003) has suggested that the case study is useful when the researcher investigates 'how' or 'why' questions, when the researcher has little control over events, and when the focus is on a contemporary phenomenon with some real-life context. Dubois and Gadde (2002) have also noted that the 'interaction between a phenomenon and its context is best understood through in-depth case studies' (Dubois and Gadde, 2002: p. 554). The importance of exploring real-life context in the mapping service system and the investigation of contemporary phenomena through in-depth case descriptions and case themes involving multiple sources of data informed my decision that the most appropriate method would be that of a case study. Given Yin's suggestion, the five components of research design are particularly important and need to be clearly defined in a case study approach (Yin, 1994: p. 20). These five components are: -

- a study's questions,
- its propositions, if any,
- its unit(s) of analysis,
- the logic linking the data to the propositions, and
- the criteria for interpreting the findings.

As Yin (2003) highlights, research questions should favour of units of analysis over other possible options. In this context, the research question is defined as matching the selected analysis unit. Then the proposition can be expressed as the research purpose and the subject of exploration. The third component is related to the phenomenon or fundamental research inquiry that defines what the 'case' is. In choosing which case study was optimal, it was necessary to consider what type of case was most appropriate, accessible, and also had the potential to provide a comparative structure that would facilitate in-depth case comparisons, highlighting similarities or dissimilarities across cases. Therefore, the research design is thought to be open to relevant individuals, programmes, events, activities, or organisations, which allowed the researcher the opportunity to access projects or organisations involved in maps and mapping-related products and services.

In this study, a digital maps and mapping project, the service (eco)system (i.e. value-creation system) was selected as a unit of analysis. The result of study 1 becomes a guide for this unit of analysis; therefore, purposeful sampling was conducted and cases were chosen that potentially portrayed different perspectives on the problem, process, and/or activities concerned. This is also called 'purposeful maximal sampling' (Creswell, 2005). The last two, less well-defined components—linking data to propositions and the criteria for interpreting findings—can be done in many ways. The most promising approach is the 'pattern-matching' technique, whereby the series of data in the case may be related to the theoretical proposition (Yin, 2003). In this sense, Table 6 presents the five components of the case study developed during this research.

Research Questions	***How*** can opportunities be developed in mapping services?
Proposition (or purpose)	To identify areas of opportunities, challenges, and the relationship among players and potential beneficiaries in service (eco)system
Unit of Analysis (or Case)	Digital mapping project and stakeholders involved in the service (eco)system and value-creation between service systems
Logic linking the data to the proposition and **Criteria for interpreting the findings**	**Data as resource; complexity of data generation** due to the ubiquity of data that was transferred into information and thereby knowledge through maps. **Technology** drives users to be involved in the map-making process in a pervasive manner, whereby there are no clear boundaries between mapmakers and mappers; thereby the **role of the user** becomes more democratic and critical in the mapping process; **Expanded usage of maps**. Maps were used for service components and new service offerings; **Process of delivery of cartographic knowledge** to the user has become more comprehensive (within the wider service ecosystem). * These propositions were identified in study 1 and guided for data collection and interpretation.

Table 6. Research design components

3.3.2.2 Format of the case study

As there are different kinds of case studies, the design was decided by looking at the specific purpose of this study and its objectives. The most common types of case studies are for example, single case studies, sets of individual case studies, community studies, social group studies, studies of organisations, and studies of events, roles, and their relationships (Robson, 2002, 2011). Case studies can take either a single or multiple-case format. The choice of a case format is an important decision in case-study design, whereby the decision is related to the *phenomenon* that will be studied, along with its *purpose* and the *unit of analysis*. When the study contains more than one single case, then a multiple or collective case study is required, particularly when the researcher investigates cases to understand the differences and similarities across cases.

The distinction between a single case study and a multiple case study, as well as the conclusion of the case study, can be drawn from the exploration of similar results (similarities) or/and contrasting results (differences) within and/or between cases, which ultimately allows the researcher to analyse data within each case setting or/and across different situations in order to replicate findings across cases (Baxter and Jack, 2008; Yin, 2009; Stake, 2010; Gustafsson, 2017). Furthermore, these results can be either illustrative or confirmable depending on the context. In this way, the researcher is able to analyse data both within each situation and also across situations, while also assessing whether the findings are valuable. Therefore, the result of a case study facilitates an understanding of certain issues, thus providing input in relation to existing theory or providing new theoretical concepts. In the multiple case study design, Yin (2003) also emphasises that the cases have to be carefully chosen due to the nature of the comparable findings to be drawn, which also allow the researcher to be able to predict similarities or differences across case findings based on given theories. In this way, the researcher can clarify whether the findings from the results are valuable and/or strong and reliable.

Here, the case study approach was chosen as an appropriate research strategy and method, but a single case study wasn’t thought to be enough to satisfy the research objectives. Instead, a multiple case study approach was conducted for a given type of mapping business. This is because the main research aim was to study a complex phenomenon in its natural context, with each context located in specific industries where the context influenced the given digital maps’ service system. Each unit of analysis corresponds to different sectors, each with their own characteristics, different levels of operating and developing maps/mapping service systems, and unique business strategies. Through analysing multiple cases, it is more likely that we will be able to obtain a robust result, as the propositions are deeply grounded in various forms of empirical evidence.

3.3.3 Study 3: Design case study—Participatory case study with service designers

During the development of the four different types of mapping service-systems in study 2 (four cases), however, there was no clear information regarding service-design involvement in the four maps/mapping service systems. Some objectives remained unanswered, so further empirical investigation from a design researcher's perspective regarding the capacity of service design was required alongside the main case studies. The design project collaboration with Transport for London took the form of a separate case study, and was therefore set up as a participatory case study for data collection and analysis of the design project outcomes in study 3.

The participatory case study is understood as a 'mode of case study research that involves the participants, community or group in the research process', that is often designed to address specific enquires (Reilly, 2010: p. 658). The method emerged as a way to structure intervention and development within specific communities or groups (Lincoln and Guba, 2005). This method also blurred the distinctive boundaries of certain roles—for example, between researcher and participant, knowledge producer and knowledge consumers, while also being able to incorporate knowledge gained from the traditional case study method (ibid.). Adopting this method to answer research objective 3, the researcher was able to immerse herself in the live environment, thus acting in a more visible role, one that was highly participatory, reflexively interacting between what was observed and participating in the service design project. The overall approach to the study was participant observation, with the role of the researcher as a participant observer and reflective practitioner (Iacono, Brown and Holtham, 2009). This meant being an active member of project teams, doing activities which needed to be done in the project (such as interviewing users, analysing data, and preparing artefacts for research). Whilst the number of challenges can be raised, such as investment of time, building up relationships to get access, or engaging with participants, this method has substantial benefits for researcher, who is able to gain the view of both 'insider' and 'outsider' (Reilly, 2010).

In this respect, the participatory project with TfL and service designer was the most suitable for collecting the relevant data for objective 3, as the objective was to gain in-depth insights about service-design capacities in terms of tools and methods used at specific design-development stages during the execution of a service design project in relation to the subject areas. In addition, the service design project highlighted specific service design tools and process used by service designers, and feedback on the outcome of the project was received from professionals in various fields from the Service Design Network (Nov, 2017) as a means to evaluate whether some degree of usefulness of the service design implementation was achieved in relation to objective 3.

3.4 Data collection and analysis

The case study method relies on multiple sources of evidence and data-collection techniques. The data collection and analysis across all case studies was carried out systematically and sequentially, so that the data collection process could capture the most relevant aspects of the research enquiry. The data collection in each case was based on multiple sources of information such as observations (direct and participant), interviews (exploratory and semi-structured), analysis of documents, archival records, and digital artefacts (Yin, 2009). The choice of data collection method depended on each objective and aim of the research—when the research activities investigated complex phenomena, the research quality could be improved when multiple sources and methods of data collection were used. Different data-collection methods can provide increased levels of information that may lead to new questions, to be answered at a later research stage; hence, they ultimately support the researcher's conclusions by allowing triangulation, thereby reducing respondent bias (Tellis, 1997; Vissak, 2010).

In this sense, there were two set of data collection for studies 2 and 3; the substantial amount of data collection of study 2 was based on observation, document reviews, and interviews. Study 2 consisted of four different types of cases selected according to the established maps and mapping services identified in Chapter 4, while data collection for study 3 largely rely on participant observation. The detailed procedures and findings are presented in Chapters 5 and 6.

3.4.1 Data Collection

Whichever methods were selected for data collection, it was important to clarify the purpose and the relevance of the research enquires prior to data collection. As the case study had two different sets (study 2 and 3), each set collected both primary and secondary data, as shown Table 7. Interviewing as a data collection technique is widely and commonly used in qualitative case studies. An interview as a primary source is a way of gathering 'information from people through person-to-person interaction between two or more individuals with a specific purpose in mind' (Kumar, 2011: p. 109). The strengths of this form of data collection are that interviews can be used at different levels of the structure depending on the setting, thus can be also complemented by data collected using other methods to ensure higher quality.

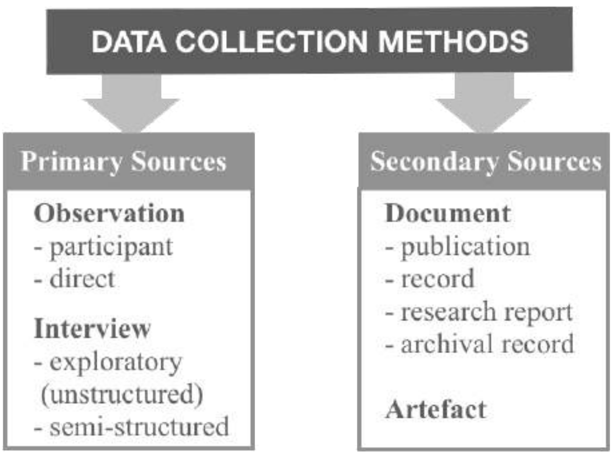


Table 7. Data collection methods

Two types of interview were conducted in the case studies: exploratory (unstructured) and semi-structured interviews. The exploratory interview provided complete freedom in terms of content and structure, while the structured interview consisted of a set of closed questions that were not flexible. In study 2, mostly exploratory and semi-structured interviews were used due to the broad nature of the field, meaning that the researcher had control in terms of the questions asked, which fitted the topics of interest. In study 3, most of question were deployed as semi-structured interviews, such that the questions were pre-determined based on similar questions and sequential orders used in the interviews. Interviews here were open-ended in order to facilitate informant responses while also allowing for data comparability after collection.

However, this method also has some weaknesses, for instance it is difficult to control interview situations and access confidential data, such that interviewees may not be totally honest and may leave information and observations unsaid (Vissak, 2010). One could use other methods and/or data, contact more respondents from different firms, and detail the context so that researcher would be able to develop different interpretations or viewpoints (Voss, Tsikriktsis and Frohlich, 2002). In this sense, both case studies in studies 2 and 3 adopted direct and participant observation as another primary data collection method, which was very useful in identifying the discrepancies between what people say and what they actually do. As such the data enables one to identify elements that participants may not even be aware of themselves (Kawulich, 2005; Bricki and Green, 2007; Guest, Namey and Mitchell, 2013).

As the choice of data collection method depended on each case's objectives and aims, study 2's aim was to collect data that could address different perspectives on the service system: how four types of maps/mapping service system run, their co-relationships, and how value is created and exchanged between them. It also attempted to observe the key actors, participants, and beneficiaries in both the wider service system and in the established maps/mapping industry without interfering in their environment by deploying obstructive methods.

The observation method provided the researcher (myself) with the opportunity to identify non-verbal emotions, determine who was interacting with whom, guide relationships with informants, and assess how people communicated and interrelated with others, thereby helping researcher to develop a holistic understanding of the context and phenomenon under study. The observation was an interactive experience to some degree and relatively unstructured in a way that is generally associated with exploratory and explanatory research objectives; hence it allowed the researcher to identify the terms that participants use and observe events that informants may not able to share during an interview due to sensitivity of information.

Furthermore, observation is a method of data collection in which the researcher watches and listens to a phenomenon in order to determine *what is going on* and gain a better understanding of the complexities of diverse situations, with direct participation in, and observation of, the phenomenon of interest within a specific context. It was important to select the sample in a systematic way to ensure that the source of the sample was credible and indictable. Two degrees of participatory observation took place in the development of both studies 2 and 3. I undertook purposive sampling, which means that participants and groups of participants were chosen purposefully as they were likely to generate useful data for the case studies.

As illustrated in Figure 9, highly observational and less visible observation was arranged in four case studies in study 2. As the author (myself) did not have much direct involvement in the activities, the aim was to *observe* the activities, implied passive observation. It was critical to observe relations between participants from different firms and in different contexts while maintaining a certain distance.

However, highly participatory observation took place in study 3, the design project activity. In the design project, participants observation arose from an ongoing working situation and fitted in with the purpose of the investigation and the researcher's circumstances. Participant observation in this case development enabled the researcher to capture a tactical knowledge of service design as well as understanding the viewpoint of the designers. In particular, this method allowed the researcher to *participate in* the activity of a design project that is at the same time being *observed*, and to collect data in the same manner as a team-member might collect data (Iacono, Brown and Holtham, 2009). In both ways, the collected data was descriptive and allowed a better opportunity to learn something that people and participants might not be willing to discuss during interviews.

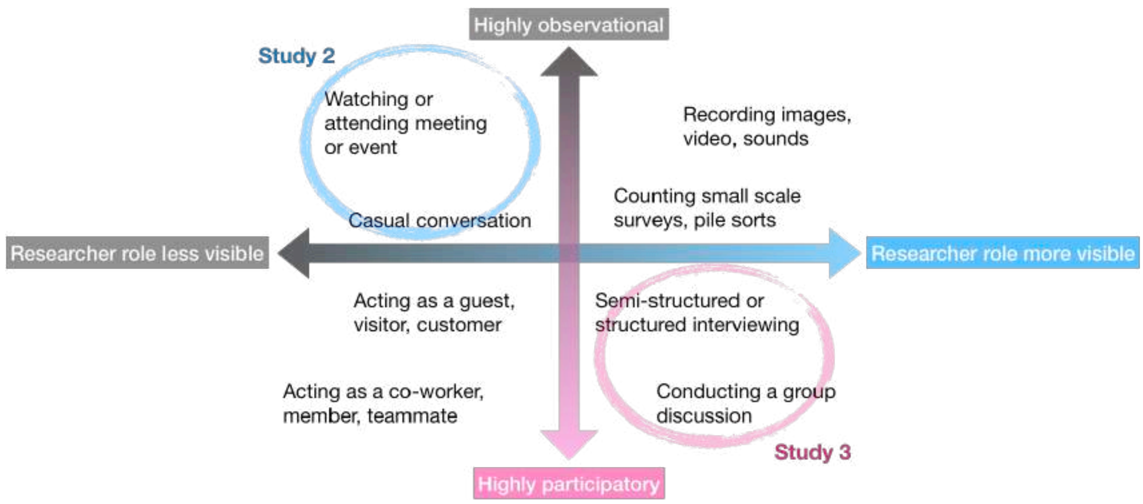


Figure 9. Participant observation continuum (adapted from Guest et al., 2003)

3.4.2 Data Analysis (cross-case analysis)

The analysis and interpretation of the information collected was conducted in relation to the research questions and purpose proposed in the case-study design section. The type of analysis used in this study is an example of an *embedded analysis* of a specific aspect of the case under examination (Yin, 2003). Through the data collection, a detailed description of the case (Stake, 1995) emerged. After collection of the data sources, a few key themes were focused upon, in order to understand the complexity of the cases rather than generalising beyond them (Yin, 2003). A thematic analysis looks across all the data to identify the common issues that recurred while identifying the main themes, namely those that summarise the data in accordance with the particular views that were collected.

Initially, the analysis consisted of multiple readings of the interview transcripts and field notes, which were derived from observations and used as primary data for analysis, and secondary archival data to support and refine the emerging themes. In this way, the case analysis identified key issues within each case, in the form of common themes, contrasts or similarities, thereby providing rich data in the context of the given case. In particular, the multiple cases chosen in this study each provided detailed descriptions of themes within the given case, after which thematic analysis was used across the cases, in a so called ‘cross-case analysis’ (Yin, 2003). The patterns, relationships, and meaning of the cases then emerged under case-based themes, as detailed in Chapter 5.

3.4.3 Validity/relevance

Despite the relatively unstructured form in which qualitative data is collected, it is important to ensure that the data analysis is reliable and valid. Validity helps reinforce how the data makes sense and in what context it can be applied. Triangulation is one way to maximise reliability and validity by carefully looking at evidence from a wide range of sources and using multiple methods of data collection, subsequently comparing the results from these sources.

The four case studies demonstrate the diverse viewpoints held by practitioners in different firms and contexts. These were not only conducted by interview but also using other evidence and data-collection methods, such as direct and participant observation, archival documents, visual images, websites, as well as newsletters and artefacts produced across the selected cases. Instead of focusing on data from interviews, observation was used as a way to increase the validity of the study, as observations may help researchers to develop a better understanding of the context and phenomenon under study. The validity is strengthened by the use of additional strategies alongside observation, such as interviewing, document analysis, surveys, questionnaires, or other more quantitative methods.

Relevance was a key criterion when prioritising both empirical sources and the literature used. The abundance of qualitative data sources collected and interpreted also meant that there was a variety of ways to interpret them. Qualitative research embraces complexity, but it is also a challenge for the researcher. Consequently, the overall research question and aim has been iteratively revisited, while the conceptual framework was used as reference to keep the study anchored.

3.4.4 Ethics

During the data collection, qualitative material was collected. There were three types of data: documents, both participatory and direct observation, and exploratory and semi-structured interviews used for certain categories of participants in order to develop a deep understanding of the phenomena in relation to the research aims. Before proceeding with interviews, the scope of project was explained, and a consent form was physically presented. The latter was carefully explained, and a stress-free environment was assured. The interview was then either video-recorded or notes were taken. The interviewee could withdraw at any stage if they wished to do so.

Chapter 4. Map sample review

4.1 Introduction

As detailed in the literature review, the shift in the nature of maps and the mechanism of mapmaking has been dramatically affected by the march of technology, democratic ways of using maps, and their expanded usage. The purpose of this chapter is to identify key criteria in map and mapping developments and to show how these are related to the service perspective, thereby developing an initial conceptual framework and facilitating further contextualisation.

The findings and key criteria from a review of 60 selected maps samples are outlined here; the results are synthesised into a maps/mapping taxonomy which results in a provisional conceptual framework before the main study is undertaken. The following section describes how map development trends and their changing parameters have been affected by both technology and expanded usage.

4.2 Map sample analysis

4.2.1 Initial sample collection (c.13c.–2016)

I used an adapted a form of qualitative contents analysis, defined as a method for subjective interpretation of content through a systemic classification that identifies themes or patterns (Hsieh and Shannon, 2005; Elo and Kyngäs, 2008). This method aims to "provide knowledge and understanding of the phenomenon under study" (Downe-Wamboldt, 1992: p. 314), rather than just statistics. The initial group of 250 maps, ranging from the 13th century through to early 2017, were collected based on the following four criteria. First, representations that include geographical references (i.e. geospatial data-based services); second, maps acknowledged by literature and organisations, for example literature on cartography, the British Library, Royal Geographical Society, and British Cartographic Society; third, digitalised maps including websites and mobile or kiosk platforms. However, the priority here was maps launched from 2008 onwards, especially at the point of widespread usage of Google Maps, OSM, and smartphones; fourth, maps that are available to the public with a high level of usage or awareness, for example maps featured in tech news or blogs with high viewer rates. These were then carefully whittled down into a final sample of sixty maps for individual analysis.

Applying a service logic perspective to maps and mapping, there are three distinct service spheres identified here, namely: the consumer (user) sphere; the provider sphere; and the joint sphere, where maps are located, and users and providers co-create value. Building on the assumption that maps/mapping are abstractions of value co-creation systems, the following factors were used for analysis based on parameters and factors identified in the service-system literature: the technology used; service enablers; service usage; and purpose of use, as shown in Figures 10 and 11. These factors are used to describe the different aspects of map/mapping services and their interaction with users and other stakeholders from the service system perspective (see Vargo and Lusch, 2008), as introduced in the literature review in Chapter 2.

Within the mapping service-structure, each map sample reveals how technological drivers have influenced maps over a selected period of time. This also reveals how each map has used technological relations in terms of collecting and representing data; how the purpose of map usage has developed over time; and the relationship between each map sample (see Figure 10).

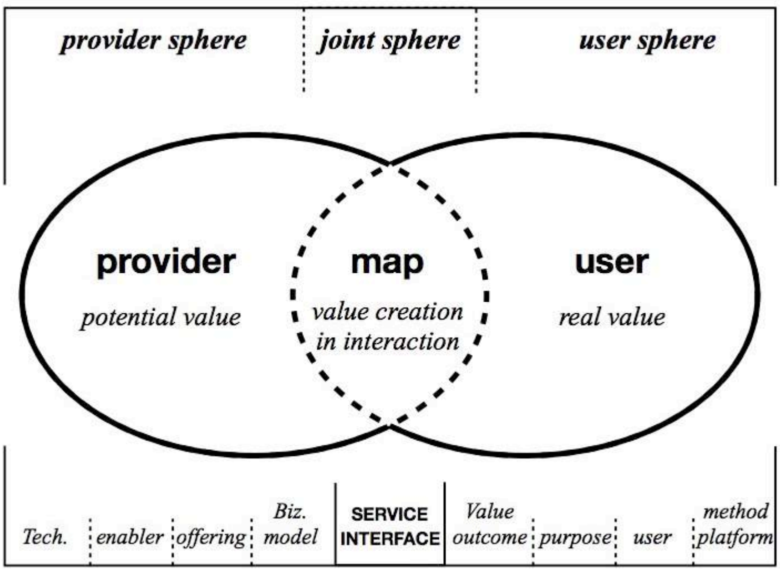


Figure 10. The service sphere in maps and mapping

Each map sample was deconstructed based on service-system elements in order to achieve a ground knowledge regarding how maps have developed in terms of technology and its usage (Figure 11). In the process of map analyses, data visualisation was used not only as a way to collect data but also to generate an effective means to analyse and extract certain insights. The adaptation of visualisation techniques in this process enabled the identification of interesting patterns related to map/mapping services in a much easier and quicker way. Hence, iterative approaches were deployed to draw out taxonomical groupings based on specific characteristics.

provider sphere				*joint sphere*	*user sphere*			
Tech.	*enabler*	*offering*	*Biz. model*	**SERVICE INTERFACE**	*Value outcome*	*purpose*	*user*	*method (platform)*

Figure 11. Entities in the provider, joint, and user spheres respectively (as unit of analysis)

The detailed result of analysis is attached in Appendix 1, 2 and 3 which has a few variations that stood until the results were drawn up and the categories and final abstraction made.

Figure 12. Analysis of map samples from a service logic perspective (see Appendix 1, 2 and 3)

4.2.2 Groupings of maps and mapping

The following section describes six types of map usage. The initial categorisation was performed primarily according to information type and technology driver. For example, topics, themes, or the content of maps themselves that have geo-referencing data were grouped under environment, safety, perception about place, emergency, politics, health, and economic headings. However, any map sample aiming to provide entertainment as well as cases of artistic representation were excluded.

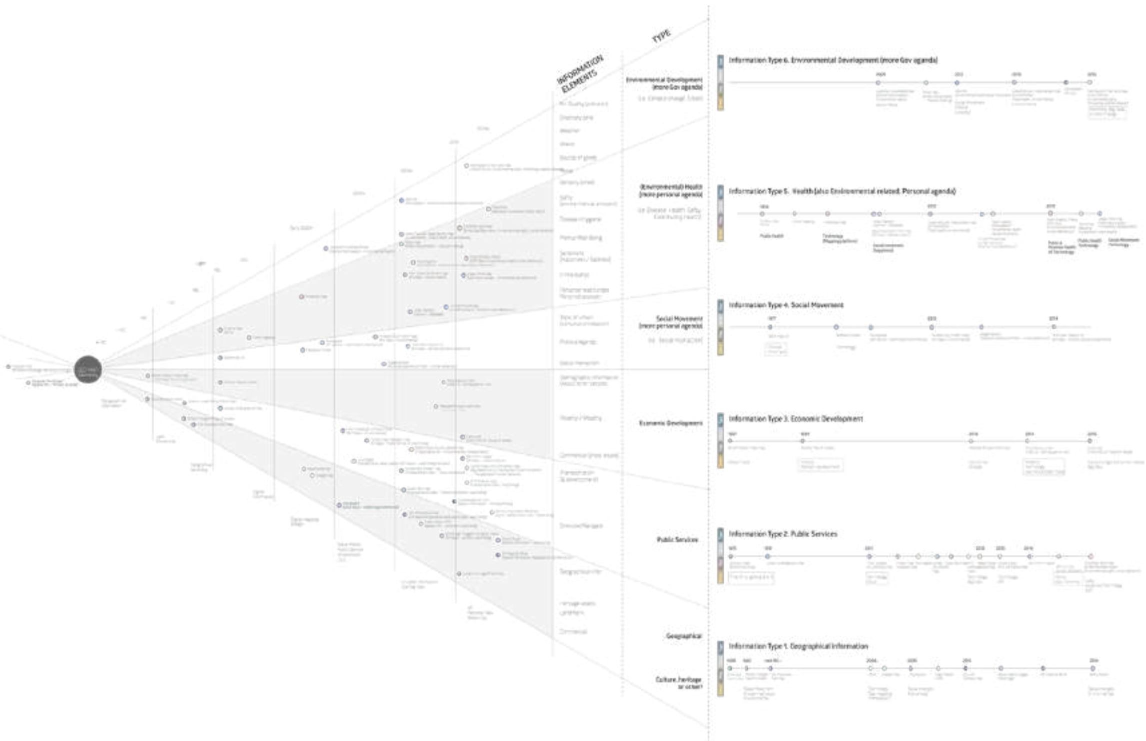
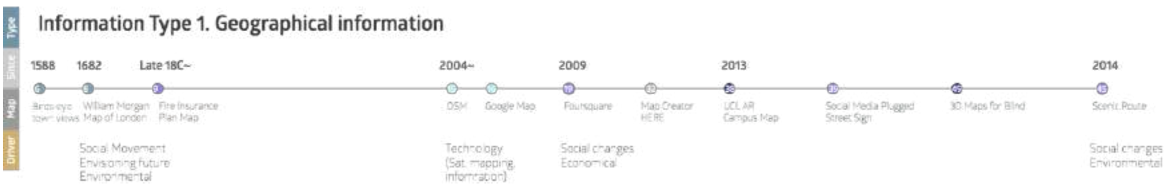


Figure 13. Six groups of map-usage from map analyse (see appendix)

Type 1. Geographical information



William Morgan's (1682) map of London (8) symbolised an idealised city after the huge losses from the Great Fire of London (1666). This was the first time the city had been accurately surveyed and measured, and it took over six years to complete. The government initiated this map development in a way to communicate with the public, as a strong statement of the future city and its prospects. It graphically envisioned the city so that a citizen would know what it might be like to live in London in future, by highlighting only the beautiful aspects of the city, while excluding its negative dimensions such as areas marked by poverty or prisons. It offered the public a sense of hope, promise, and pride. A few decades later, the map was re-measured more accurately and standardised. A Fire Insurance plan (9) was designed for the sake of public health and safety in the late-18th century which was to inform individual behaviour in an emergency. In the early-21st century, Google released satellite imagery (16) to the public, opening up new ways to navigate space while providing opportunities to businesses to make themselves visible on map platforms. Google, as a service provider, was widely adopted by commercial actors. In 2014, the Yahoo! Research lab investigated a new wayfinding service called Scenic Route Map (45). This service was derived from crowdsourced opinions. This wayfinding service offers a beautiful, calm, or quiet scenic route to a desired destination and can reflect users' emotional attributes. By adapting individual users' opinions and knowledge of an urban scene, the service provider and user co-create a new value.

Image 11. William Morgan's Map of the Whole of London in 1682 (Morgan, 1682).

Image has been redacted.

British History Online, 2014. Morgan's Map of the Whole of London in 1682. [Online]. British History Website, [Accesses 11 December 2014]. Available from: https://www.british-history.ac.uk/no-series/london-map-morgan/1682

Image 12. Fire insurance maps and plans (Charles E. Goad Ltd., 1885).

Image has been redacted.

Charles E. Goad Ltd., 1885. Fire insurance maps and plans in England. [Online]. British Library Website, [Accesses 12 December 2014]. Available from: http://www.bl.uk/onlinegallery/onlineex/firemaps/fireinsurancemaps.html

Image 13. Google Map (Google Map, 2005).

Image has been redacted.

Google, 2005. Google Maps. [Online]. Google Maps, [Accesses 10 November 2014]. Available from: http://maps.google.com

Image 14. Yahoo Scenic Route (Quercia, 2014).

Image has been redacted.

Quercia, 2014. Happy Maps. [Online]. Good City Life Website, [Accesses 10 November 2014]. Available from: https://goodcitylife.org/happymaps/index.php

Finding & issues

Apart from the map's fundamental nature, namely the representation of a geographical surface, built environment, and function of getting someone from point A to B, some maps are used by governments for the purpose of future urban planning. The integration of the user into the centre of map service development, supported by technology and citizen-derived knowledge, clearly shows the new value ascribed to the individual user (for example in the Scenic Route Map). The traditional nature of maps and theory concerned with the graphical representation of spatial understanding has changed: technology and common mapping platform likes Open Street Maps and Google Maps allow individual users to participate in a kind of knowledge generation in the form of explicit data contribution. VGI and neocartography have already been analysed as crowdsourced efforts towards geospatial knowledge output, and the map samples here similarly present a geospatial database that is freely available and produced in a collaborative manner.

Type 2. Public service (transport service)

Since the inception of location referencing, social media usage has increased dramatically, where social media feeds can be understood as providing useful insights. In some sample cases, the individual user's interaction no longer clearly appears on the mapping platform; instead a group of peoples' social media content is presented as a whole, thereby providing a picture of the actual dataset. The group's social media feeds act as enablers of map services, effectively revealing patterns and insights that often appear or help in the discovery of hidden information in terms of what is happening in a particular location and what is being imposed on particular subjects.

Data artist Eric Fishcher's Twitter map (21) aims to visualise retrospective sentiment tracking, illustrating where local people or tourists mostly go in cities, thus informing us how the city is determined by people while at the same time visualising traffic levels so that urban planners can use this data to fine-tune existing transport networks or establish where new routes are needed. Similarly, the Sentiment Mapper (23) has analysed public transport users' geo-located Twitter feeds, identifying where users' negative sentiments feed are created in order to establish problematic touch points during journeys. The Boston Bus Speed map service (37) has used real-time GPS data from the Massachusetts Bay Transport Authority to visualise straight lines from stop by stop, calculating corresponding speed times via an interactive map platform to demonstrate where traffic congestion is being generated. These cases can make cities cleaner, healthier, and more prosperous places to live while allowing the city planner or local authority a quick snapshot, thereby helping to draft blueprints for future development.

In late 2013, NYC Tunnel Vision (42) used a map as a platform to explore the city through factual data-visualisation rather than via social media content. The App pulls data from a variety of sources of Big Data—the US census, tube turnstiles, transport schedules etc.—and seamlessly integrates them into a new map service. The map service allows the user to discover where people are entering, where people are exiting, and how many people are in the subway at a given time by simply moving the phone around the map. The technology enables various types of information to be integrated through the maps, yet it appears that this type of map presents a new service offering. Here, technology helps the user to understand the information in terms of what users need in their situation at a specific time and space.

Advanced digital and IoT technology have become available: MindRider Bike Map (50) measures each user's mind (brainwave) regarding how stressed and relaxed they are and visualises this into a map by deploying cyclists wearing devices (on helmets). The brainwave sensor is built into a standard helmet that measures the user's stress levels by measuring attention level rises (when the user focuses on one thing, decreasing when they are less focused. In other words, it provides a clear overview of where the user is stressed and therefore unsafe. This data is visualised onto a map platform with a colour scale, from green to yellow to red. It appears to be a useful service for making cities bike-friendlier, for determining where street signs and other measures are helping cyclists while identifying where city planners might do more. There is substantial potential for this kind of information. Tourists who want to visit a given city could want more relaxing routes, with city officials identifying areas where bike lanes are not doing enough to make cycling easy, thereby helping to develop solutions.

Some scholars have argued that social media data is novel and a dynamic indicator, thus providing an aid to the city planner's decision making, making it such an intelligent and pervasive digital technology that that map-based services are no longer based solely on mobile screen-fed services or require users to actively participate in order to engage. Despite the user's 'mapmaking' role appearing to disappear or became passive in a way that builds up content or information on the map, they are still a substantial part of operating digital map-services by automatically embedding data regarding their interaction with the physical place, which is enhanced by various digital technologies such as mobile applications, big data, and/or the Internet of Things.

Image 15. (21) Flickr luminous cities (Baily, 2011).

Image has been redacted.

Baily, 2011. Flickr Maps. [Online]. Gavin Baily in Trace Media Website, [Accesses 15 September 2012]. Available from: http://www.tracemedia.co.uk/luminous/flickr_tags.php

Image 16. (23) Twitter map (OmniSci, 2011).

Image has been redacted.
OmniSci Ltd., 2011. Tweet Maps. [Online]. OmniSci Tweet Map website, [Accesses 25 September 2012]. Available from: https://www.omnisci.com/demos/tweetmap

Image 17. (37) Boston Bus map (Bostonography, 2013).

Image has been redacted.
Bostonography, 2013. Live MBTA bus speeds Maps. [Online]. Bostonography Website, [Accesses 13 June 2013]. Available from: https://bostonography.com/2013/live-mbta-bus-speeds/

Image 18. (42) Tunnel NYC AR transit map (Lindmeier, 2014).

Image has been redacted.
Lindmeier, 2014. Tunnel Vision App. [Online]. William Lindmeier Website, [Accesses 24 May 2014]. Available from: https://itp.nyu.edu/shows/thesis2014/william-lindmeier/

Image 19. (50) Mindrider Bike map (Ducao, 2015).

Image has been redacted.
Ducao, 2015. MindRider Maps Manhattan. [Online]. Arlene Ducao Website, [Accesses 10 Feburary 2015]. Available from: http://mindriderdata.com/

Finding & issues

While the concept of 'Volunteered Geographic Information' (VGI) and neogeography understood as an amateur geospatial knowledge practice that involves deliberately producing, manipulating, or visualising geospatial information for dissemination, there is continuous geospatial data production as a result of using maps and mapping-based applications. Although these geospatial data are being produced through the use of maps and mapping, the outcome is not representative of neocartography and VGI as an explicit data contribution. This means that the concept of explicit geospatial data generation is in line with VGI and neocartography, however the data generated as a consequence of using social media, smartphones, and other physical urban experiences constitute an implicit data contribution, which means that geospatial data is produced without the user's intention, who does not know what data she, as a user, actually generates. (i.e. location data at a specific moment of check-in at a location or the tab in an Oyster card). But these implicit data form part of the process of a digitalised personal experience, using location-aware devices and platforms that are highly individual due to the user's subjective data, but where the accumulation of these data can reveal the patterns regarding how urban system are designed and performed—thus it is highly valuable for both public and private organisations, for example. Maps here act as medium or platform that mediates between users and their location, transforming individual experience into revealing meaningful information and patterns of geospatial data that are useful for many stakeholders in arriving at a fundamental truth.

Type 3. Data visualisation for decision making

The central management of the government's Open Data agenda, which was initiated recently, means that large-scale data has been made available to the public, allowing them to explore it transparently, thereby freeing it up in terms of its access and manipulation. Charles Booth's Map of Poverty (12) of 1889 is representative of Victorian concerns regarding urban society and government intervention, with particular attention paid to acquiring information on the habits of the poorer sectors of society. His work was utilised to develop a pension scheme and helped the government's decision-making at the time. In 2013, the Quick Commute Postcode map (c) was developed by an estate agency based on transportation big data (2013), offering estimated commuting times in order to help individuals to decide where to live. Similarly, the 'Whereabouts London' map (43) in 2014, launched by the Greater London Authority, was a research-led enterprise offering a visualisation of a London map with an information layer reflecting resident' demographic information, including average house prices, crime rates, environmental health, age of living in relation to urban issues, and interests. This map service allows the user to explore the city in a new light and demonstrates how government Open Data can be used to improve our cities.

As Big Data is now streamed through map-interface aggregation services, both individual users and authorities benefit from these services. Map platforms have become more interactive and can be generated from datasets, e.g. from census data and traffic reports, as well as road safety, health, demographic, environmental, and education information. They can be scaled and targeted for particular regions (or more local sites) as the reader chooses.

Image 20. (12) Charles Booth's Map of Poverty (Booth, 1889).

Image has been redacted.

Booth, 1889. Descriptive Map of London Poverty. [Online]. British Library Website, [Accesses 10 November 2014]. Available from: https://www.bl.uk/collection-items/charles-booths-london-poverty-map

Image 21. (c) Quick commute postcode map (Findaproperly, 2013).

Image has been redacted.

Findaproperlyblog, 2013. The secret areas of london that could shorten your commute. [Online]. Find Properly Blog, [Accesses 10 July 2013]. Available from: https://blog.findproperly.co.uk/2013/07/26/the-secret-areas-of-london-that-could-shorten-your-commute/

Image 22. (43) Whereabouts London Map (Future Cities Catapult, 2014).

Image has been redacted.

Future Cities Catapult, 2014. Whereabouts London Maps. [Online]. Whereabouts London Website, [Accesses 12 November 2014]. Available from: http://whereaboutslondon.org/#/map

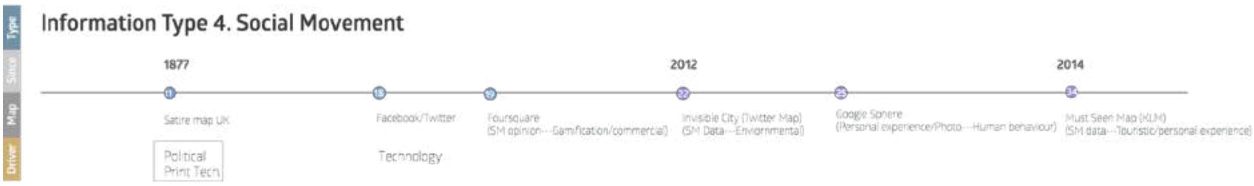
Finding & issues

Data visualization can be highly useful, especially in terms of showing patterns at a glance for different types of complex data and helping users understand them.

Data visualization has played an important role in the past and has often been used as a way to solve social issues (health, pensions, etc.). Maps were used as a media or platform for the integration of resources (i.e. data) and represent issues which are difficult to grasp.

Until the data is represented through maps, it is unclear what real value it might have for end users. In this space, the role of government in releasing data is critical; many stakeholders such as city planners or commercial firms reap the benefits of using geospatial data in the form of a public good, for the purposes of decision making and developing related services further, as pointed out by Kitchin (2007).

Type 4. Social Movement: Personal agenda



Since Google Maps launched, overlapping with the growing popularity of smartphones and increased social-media software usage (especially Facebook), Twitter has opened up a new dimension of map services, thereby empowering users/the public to actively participate (via smartphones) and articulate their own individual voices from the bottom up (18, 19). Authorities have started to adopt this method to communicate their message widely to citizens, indicating exact locations through map platforms. Moreover, the same platform is used to gather collective feedback and has become an interactive tool for many researchers to gain insightful knowledge about places. Some have tried to understand coherent urban issues at a temporal and spatial level. The ‘Invisible City’ (22) interactive map service has aggregated geo-tracked social media data to let the citizen and traveller easily discover the hottest spots and topics around the city as a demonstration of inhabitant behaviour and sentiment regarding a given city. Commercial enterprises (especially travel agencies) have actively used this platform to encourage users to consume their marketing activities while also using the channel as a media platform through which to spread word-of-mouth information (34).

Image 23. (18) Geotagging on maps (Geens, 2006).

Image has been redacted.

Geens, 2006. Flickr Maps. [Online]. Ogle Earth Website written by Stefan Geens, [Accesses 12 March 2010]. Available from: https://ogleearth.com/2006/08/flickr-maps/

Image 24. (19) Foursquare maps (Foursquare, 2009).

Image has been redacted.

Foursquare, 2009. Foursquare Maps. [Online]. Foursquare Website, [Accesses 11 April 2012]. Available from: https://foursquare.com

Image 25. (22) Invisible City (Christian Marc Schmidt, 2011).

Image has been redacted.

Schmidt, 2011. Invisible Cities: Tweets and Photos as terrain on a Map. [Online]. Urbanist Website, [Accesses 10 March 2012]. Available from: https://weburbanist.com/2014/02/19/invisible-cities-map-visualizes-social-networking-data/

Image 26. (34) Must See map (KLM Royal Dutch Airlines, 2013).

Image has been redacted.

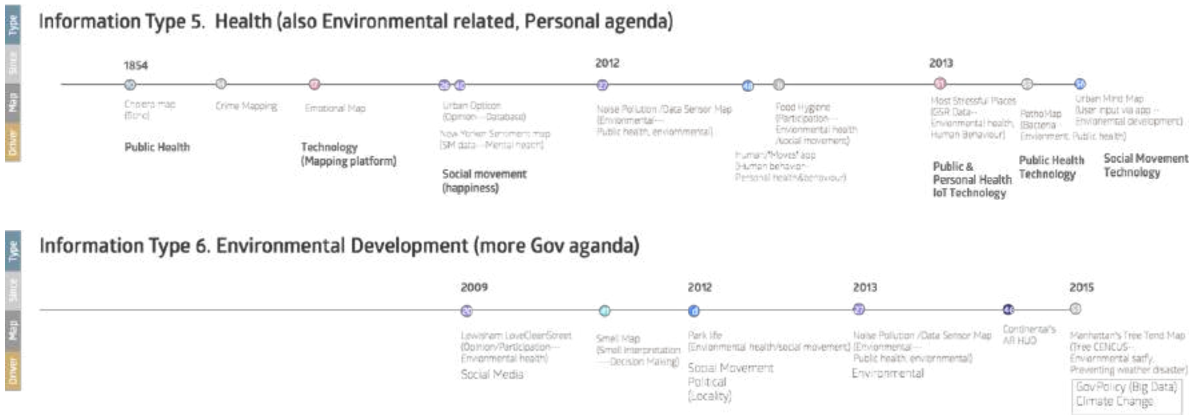
Code D'azur Ltd., 2011. KLM must See map. [Online]. Code D'azur Website, [Accesses 14 March 2013]. Available from: https://codedazur.com/work/klm-must-see-map

Finding & Issues

Personal digital devices and the user's privacy settings affect social media data-collection processes, for example in relation to how many urban users have applied geo-tagged social media and feed visibility settings, respectively. Social-media focused content is useful; however, it is critical to have a process of data verification in order to develop more objective usage.

Types 5 & 6. Public Health & Environment

This addresses issues and identifies problems, thereby assisting with decision-making that benefits the public. The physician John Snow's cholera map (10) of nineteenth-century London changed how we viewed the disease. In 1850 the sudden occurrence of cholera was a mystery and was also believed to be spread by airborne germs. Snow's mapping attempts made it apparent that the deaths were clustered around water pumps, shown in a detailed statistical analysis. His attempt clearly demonstrated the potential of the map's service role in terms of problem solving, a role that could support city planners' decisions regarding further improvements of the urban environment.



Initially crime maps (14) presented information supported by government crime reduction programmes, using statistical surveys to understand patterns of incarceration and to identify high-crime zones. With the growing popularity of smartphones and increasing social-media software usage, map services have started to bring individual knowledge into map services to resolve public health issues in urban spaces. This platform has been used to gather collective feedback and has also become a tool for city planners to achieve real insights. Crowdsourcing knowledge from users through their mobile devices has reduced the use of resources (time, budget), particularly compared to traditional urban surveying. The noise pollution map (27) and Urban Mind Map (56) have used users' smartphone applications to locate problematic zones that call for local-authority action. In a similar case, The Most Stressful Place Map (51) supported by wearable devices connected to a mobile application, have enabled the user to share factual data in an innovative way. Wearable devices automatically aggregate individual users' physical conditions and stress-levels in specific locations and this aggregated data reveals a pattern of problematic urban zones (where most people feel anxiety), an initial indication of the need for local authorities or city planners to initiate development.

Local authorities initiate map services to let the public report various social and environmental concerns (such as garbage, crime, and noise levels) while adapting bottom-up knowledge to respond to the given locality, thus improving well-being and making towns more attractive. The consequence of developing such a service is that to some degree the user becomes the active source of insights or a value-creator in themselves, helping the city planner to generate insights for further development.

Image 27. (10) John Snow's cholera map (Snow, 1855).

Image has been redacted.

Snow, 1855. On the Mode of Communication of Cholera. [Online]. British Library Website, [Accesses 10 November 2014]. Available from: https://www.bl.uk/learning/histcitizen/21cc/publichealth/sources/source13/snow2.html

Image 28. (14) Crime maps (Clarke & Cornish, 1986).

Image has been redacted.

Clarke & Cornish, 1986. The Reasoning Criminal. [Online]. Wikipedia Website, [Accesses 10 November 2014]. Available from: https://en.wikipedia.org/wiki/Crime_mapping

Image 29. (27) Noise pollution map (Envirosuite, 2012).

Image has been redacted.

Envirosuite, 2012. Noise Mapping, Modeling and Prediction. [Online]. Envirosuite Ltd., [Accesses 11 October 2013]. Available from: https://www.emsbk.com/mapping-modeling-prediction/

Image 30.(51) Most Stressful Place Map (Neumitra, 2015).

Image has been redacted.

BusinessInsider, 2012. A new smartwatch aims to spot stress early. [Online]. Business Insider Website, [Accesses 19 March 2015]. Available from: https://www.businessinsider.com/peter-thiel-funds-neumitra-device-that-measures-stress-2015-2?r=US&IR=T

Finding & issues

Most representations of maps are difficult to read, only showing the size of problematic area of certain locations in the form of diagrammatic representations. These maps are useful for providing a quick overview of problems, especially when users want to get a general idea about places; however, such maps do not allow users to navigate within the maps and look at the further detail on the maps rather than showing an outline. In this sense, the representation and function of maps is closer to the 'data visualisation' of specific datasets in diagrammatic views of geographical references, and the maps in this group are used as a medium or platform that transfers complex datasets into information with geographical references. Maps were also used as communication channels, in particular for local governments/agencies for effective communication and disseminate of information about issues concerning communities and local boroughs. In the past, similar map-usage has been utilised to understand and solve local issues and find possible solutions (i.e. Dr Snow's Cholera maps of 1854). This means that the purpose of utilising maps stay the same, but ways of processing, producing, and reaching users (i.e. citizens) has been largely digitalised and improved.

4.2.3 Result of analysis

The analysis of the map samples was useful for describing evidence and documentation of particular practices while also referencing interactions with a user dimension. As result of the map sample review outlined in the previous section, the findings therefore derived the following propositions:

(1) **Complexity of data generation**

Data have become ubiquitous, which now allows many stakeholders to measure patterns and map the world as it actually is and thereby arrive at fundamental truths. In this transformation, technology drives users to become involved in the mapmaking process in a pervasive manner, whereby there are no clear boundaries between mapmakers and mappers, such that the role of the user becomes more democratic and critical in the mapping process. The accumulation of data generated by personal experience (i.e. subjective data) can be turned to a form of collective knowledge that can be a strong asset in knowing *what is going on* at a specific time and location; as such it will be highly appreciated by many of the stakeholders such as a particular community, urban planners, private firms, and government agencies. The maps facilitate these collaborative activities, as well as engagement and interaction with other stakeholders which thereby enable the service.

(2) **Expanded usage of maps**

Maps today not only have a physical existence in the same way as goods or products, but offer services and service systems that have arisen from the transformational impact of technology on the content of maps, ways of developing maps, and their changed usage. The boundary between the consumer and the producer has blurred and is no longer distinct, and the role of users is becoming more important in generating new spatial understandings, constantly creating new space and new territories by remaking and rearranging the streaming of geospatial data. This means that the traditional role of the cartographer is no longer what it used to be, the result of the experience of users produces a new context of space through maps or location-related service, by usage of maps and mapping related services. This view aligns with the concept of value-in-use, or value-in-context, view that is found in service system studies, which means that maps and mapping become service systems and the outcome of a process of value co-creation activities between users and other key stakeholders, thereby opening up opportunities for new services and new mapping experiences as well as offering possibilities for service components and new services. On this view, the nature of maps has exceeded its artefactual value from both an ontological and an epistemological perspective. Therefore, viewing maps and mapping from the service-system perspective (i.e. as having a service-dominant logic) is crucial for understanding maps today.

(3) **Diversity of mapping production**

Maps integrate multiple resources and their usage has become both diversified and highly personalised: the user's experience has been significantly enhanced; maps have become more interactive and can be generated from various geospatial datasets; and they can be scaled and targeted at particular regions (or more local sites) as the user chooses. Both maps and geospatial knowledge-production used to be a liner process, although there were some attempts to include users, but the boundaries of mapmakers and map users (map readers) role was nevertheless clear. Since technology and the new role of users emerged in this mapping space, the mapping experience has become much more comprehensive and also has the potential space to explorer further.

4.3 Parameters of the changing nature of maps

Building on these propositions and the parameters already identified in our findings from the both the literature and map reviews, the results of the individual analysis of the map samples were synthesised into a map taxonomy consisting of two axes: how users use maps (the level of users' interaction) and how maps are used (the level of map servitisation). In this taxonomy, nine type of maps and an appreciation of the samples were characterised, and the following assumptions can be formulated, leading to an initial conceptual framework. The procedure and results are presented below.

4.3.1 Level of interaction

Maps are a medium that helps users to communicate using geographical information, with certain actions being associated with the geospatial information. In this process, technology has always been recognised as an essential part of mapmaking, and it has been an important driver of how maps effectively display and transmit various geospatial data to users. In maps, data takes the form of mere symbols that do not have any meaning, but they are associated with specific features in the outside world, while information takes the form of contextualised data that is processed in order to be useful and involves '*understanding relations'*. Here, knowledge takes the form of proceduralised information that allows know-how, that is, it involves '*understanding patterns'*, and facilitates users acting on or solving problems. Last, wisdom is evaluated through understanding and knowing which situations to react to in '*understanding principles'* (Ackoff, 1999; Rowley, 2007).

Applying this view to maps, certain stages are required. Original geospatial data can be identified, as well as which information should be included in maps, for example other sources of data such as censuses (location 1 in Figure 14), with maps acting as interfaces between data and users, thereby allowing interaction between the objectified data and the use of maps: in short, an interaction with objectified information (location 2 in Figure 14). In this process, the cartographer or designer plays an essential role in processing these steps by adopting different technology, whether the geospatial data goes on paper, screens, or mobile devices. In addition, there is the issue of data transferring into knowledge through the effective visualisation of geospatial data into information rather than just datafication.

4.3.2 Level of usage/servitisation

Technical changes have undoubtedly transformed maps and opened up new opportunities. For example, data algorithms can automatically generate information from various sources, even when users are unconsciously involved in this data generation (location 3, Figure 14): for example, the usage of transportation, food delivery, cycle hiring, and meeting friends can be distributed onto maps (location 4, Figure 14).

The data are harvested from social media feeds and apps on smartphones, social media, and sensors embedded in physical devices and the built environment—for example digitally controlled utility services and transport infrastructure, sensors and cameras, building management systems, and so on. These technical aids and maps' changing usage have undoubtedly transformed maps while also opening up new opportunities, especially given the dramatic increase in the complexity of the type and amount of data available for mapping.

The data layers on maps generated by the interaction between people, people and places, and people and infrastructure systems can be understood as a portrait of both human behavioural patterns at specific times and spaces in the situation as well as of how the infrastructure system has been designed, implemented, and used. These geospatial data on maps can thereby be utilised and re-assessed by many business providers and urban stakeholders using map and mapping as their service components. The outcome of this use of maps as a service can be viewed more holistically as an integration of resources (in this case geospatial data); while examining how traditional mapping capabilities and service activities can be combined to deliver an outcome or experience of service in terms of a servitisation indicates a more service-dominant logic that stands apart from the product view of maps (Vandermerwe and Rada, 1988).

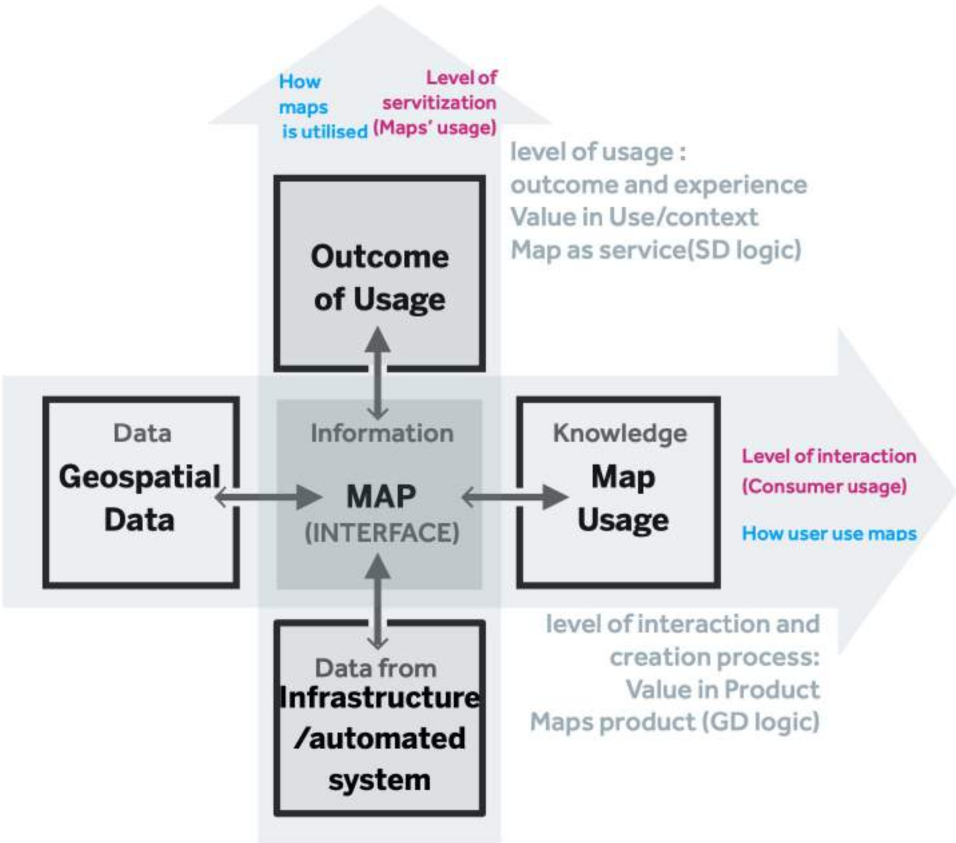


Figure 14. Mapping process as a form of service-system thinking

4.4 The taxonomy of maps and initial conceptual framework

Building on these propositions, the results of my individual analysis of map samples were synthesised into map taxonomies consisting of two axes: how maps are used (the level of map servitisation) and how users use maps (the level of user interaction). In this taxonomy, nine types of map and examples of these types were characterised as part of the initial framework development.

As Figure 15 demonstrates, the horizontal level represents the way in which maps are created. It is similar to the DKIW hierarchy (see Ackoff, 1999), which guides each step-in terms of the way in which the data is turned into knowledge and experience for users. This level is especially influenced by real interaction, namely when users use the maps, and also represents how the epistemological nature of maps has developed depending on their usage. On the other side, the vertical bias represents the level of value and level of servitisation in terms of how maps are utilised, representing an ontological shift in maps, which means that a higher level represents a higher value while a lower level is merely a service; the middle is the level of maps used as a service component or partly used as a product or platform to facilitate complex data and enable a service (see Figure 15). Each type of map is summarised in table 8 along with its characteristics, to enable further investigations.

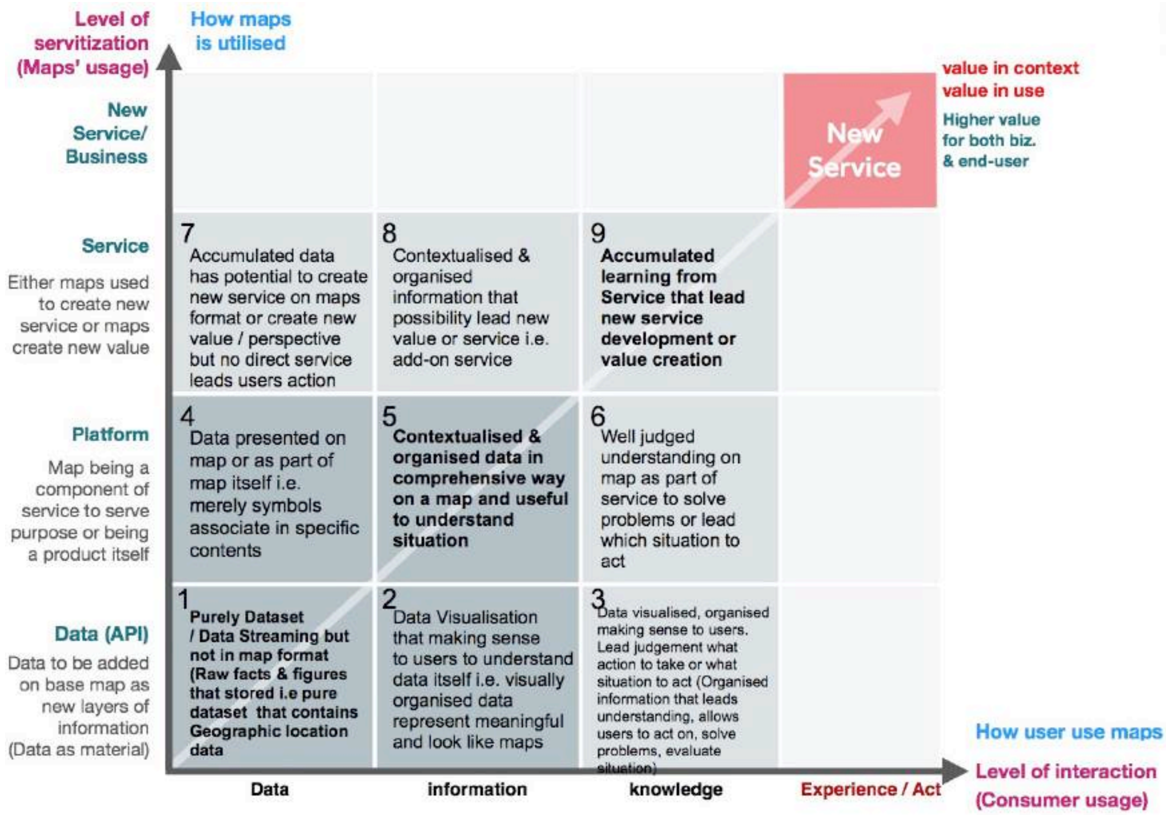


Figure 15. Taxonomy of map: levels of maps and mapping

	Taxonomy	Sample	Characteristics
1	Purely dataset. Data streaming but not in map format (raw facts & figures stored, i.e. a pure dataset that contains geographic location data)	TfL API	- **Data owner** - collected purely from the infrastructure system. They do not lead a service or platform unless it sits on a platform. However, it helps others to build a service, therefore creating value-in-use: *Lets others create new service & value*
2	Data visualisation. Makes sense to users in terms of understanding the data itself, i.e. visually organised data is represented meaningfully and looks like a map; however does not lead to particular usage.	Twitter maps (Eric Fisher)	- **Traditional designer**'s point of view. Tracking geotagged tweets from Twitter's public API, placed into OpenStreetMaps. It represents different city viewpoints; however this does not lead to service or user engagement, or interaction: *Data Visualisation / No interaction with user*
3	Data visualised and organised such that it makes sense to users and leads to judgements regarding what action to take or what situation to react to. Organised information that leads to understanding, allows users to act on or solve problems or evaluate situations.	London Infrastru cture Maps	Launched by **Greater London Authority**. An output of the London Infrastructure Delivery Board, which let users explore current and future infrastructure projects. It gives developers, investors, and utilities a better picture of what developments are taking place. *Integration of fragmented information / Systemic but not yet leading to value co-creation.*

4	Data presented on map or as part of a map itself. Merely symbols associated with specific content.	London Tree Maps	**Traditional designers**' points of view. Launched by the Greater London Authority. Census data applied to an OSM platform; however it does not pass information to users unless they have particular knowledge in relation to the type of tree and how this results in environmental issues.
5	Data contextualised & organised in a comprehensible way on a map, useful in order to understand situation. Map components are a core service and a product in themselves.	GoogleMaps, Waze, Smell Maps	**Platform provider/owner -** Google initiated changes in the nature of maps but also allowed various information to be laid onto their platform. However, services such as Google Glasses do not create new services or value; rather they change the way information is disseminated and interacted with by end-users. Arguably, they let other businesses and service providers offer their own business platform using Google API.
6	Well-judged understanding of a map as part of a service to solve problems or identify which situations to react to.	Crime maps (present predictable patterns)	- **Data scientists** and the Met Police collaborated to present predicted levels of crime. Based on the Census and cleansed data they built a prediction model. The information derived from the crime prediction model is represented on a map platform. Although it does not create a new service, this map lets a particular user group (the Met Police) prepare for particular situations and locations. - *Qualitative evaluation and display*
7	Accumulated data has the potential to create new service-map formats or to create new value, but no direct user interaction required.	Where about London	**Traditional designer**'s point of view. The integration of multiple datasets provided by a government body (OpenDataStore) is represented on the map platform. The map allows users to better understand an area's characteristics at a glance, has systemic integration of resources (few service design elements), and can be seen as having service design components; however this map has not fully brought users into its system. - *No interaction required by user / Data visualisation*
8	Contextualised & organised information that possibility leads to new value or services, i.e. add-on services.	ParkingRight App Uber	**Business side/Service provider**. ParkingRight App service offering add-on service to existing map service platforms. **Multiple stakeholders** are involved - local authorities, road planning, technology providers, marshals and drivers (end-users). The issue is lack of consideration of user experience. Service designers may enhance existing map services.
9	Cumulated learning from service that leads to new service development or value.	Citymapper BUS	**Service providers** develop their own new service by exchanging knowledge from users (learning through their own dataset generated by the way users use their service). The engagement and collaboration with other **multiple stakeholders** (platform providers, fixed infrastructure, governmental agency, end-users) is well considered in order to create new value.

Table 8. List of samples identifying specific characteristics

4.5 Summary

Digital technology and smart devices have altered maps into participatory platforms and changed the ways in which people and organisations are involved in their development processes, including the many complicated ways in which maps are created, while their usage involves wider stakeholders as well as relationships with them.

Since maps now work largely as services and as part of a service system, collaboration with multiple stakeholders—at least more than a couple of different entities—involves interactions that seem to be inevitable in order to develop or design maps as a service system. For example, business providers who utilise map platforms need to bring their users into the service system so that they can keep learning while understanding how their users use the service. The nature of maps is now that of a service system concerned with creating value. In this sense, how maps have emerged is now a secondary question, but what value is created and when it is used and in what contexts and sequences is a crucial issue. From this, the service provider can revise and enhance the service in order to meet users' real needs.

However, a service relying on map algorithms such as Uber cannot understand the challenges users face, for example drivers often experience issues regarding the way in which the map platform directs their ideal route while failing to adapt to road planning works or disruptions, thereby leading to incorrect destination arrival times and passenger delays and cancellations. Thus, they need to open up the usage patterns of their users and understand their needs, monitor these, and reflect on what is learned. Government agencies—especially those that own data that private businesses and individuals cannot access, such as TfL and local authorities—have the authority to collect, store, and disseminate data. These governmental agencies need to understand the data that third-party service providers need, and make sure they are collected using the right methods. In addition, they should return benefits to individual citizens in return for the sharing of data, for example from the use of Oyster cards at specific times and locations.

The map sample analysis was undertaken to answer research objective 1; the result of this section suggests activities for objective 2, namely looking a case study. The cases were selected as four categories of maps-service systems that require investigation in terms of service opportunities, the relationships between entities, actors, and the resources used, and the challenges they might face. Furthermore, the relevance of service design tools and methods in comparison with other disciplines in the development of map services should be emphasised as we move to the next chapter.

Chapter 5. Case Study and Findings

5.1. Introduction

This chapter aims to contextualise the initial framework and to understand service opportunities in the four areas of mapping service systems. The chapter begins by examining the rationale behind the examination of the selected cases by discussing each service type, thereby identifying the necessary resources and describing the service opportunities in each case.

The initial framework sketched in the previous chapter (4: Map sample review) is further developed in this chapter and is used to identify four types of service opportunities. The open-ended, exploratory and semi-structured interviews and observations in the field were carried out alongside looking at archival documents and artefact reviews. The case study is descriptive, thereby leading to findings that can describe the how maps/mapping have been used, how each case (i.e. service system) operates, describing key actors and the relationships between service system participants in the wider mapping service ecosystem in order to develop service opportunities.

5.2. Methods and case selection rationale

As the second objective and research question were of an exploratory nature, an exploratory multiple case study has been conducted with four maps/mapping services. The objective of this study was to develop an understanding of way in which service opportunities are developed, in particular identifying areas of opportunity, challenges, and the relationships among the mapping services (i.e. service systems), and thus the relationships among key stakeholders in the wider service (eco)system. In addition, the findings set out here are collated from views expounded in talks, interviews, and fieldnotes that may also include the researcher's own interpretations and observations, archival documents, and other artefacts or publicity materials. Public sources of citation are omitted for reasons of anonymity. Each case has its own service (eco)system, as illustrated in the relevant section of the case findings.

Each aspect of the cases investigated were guided by the common themes that were initially derived from the propositions in Chapter 4 (namely data as resource and the complexity of data generation; technology; the expanded usage of maps; and the process of delivery of cartographic knowledge), and consistently applied across the cases: 1) the resources, 2) technology, and techniques involved; 3) the usage of maps/mapping as a service offering; 4) the process of mapping in the service ecosystem; and 5) the value and benefits offered.

5.2.1. Context for case study

Since the aim of this study is to understand and identify service opportunities in digital mapping enterprises, a PESTLE tool was used to understand the wider context of the case studies. As a PESTLE analysis is commonly used to understand the given market situation, including its status and potential direction, this tool is widely used to understand the environment in which firms are embedded, including political, economic, social, technological, environmental, and legal factors, in order to scan the potential market available to a given environment. The PESTLE was originally designed as a tool to identify a business context and environment and was earlier termed ETPS (Francis Aguilar, 'Scanning the Business Environment', 1967) with the acronym being tweaked at a later stage.

PESTLE factors essentially come from the external environment, and are intended to review the context of a particular market context, the strategic proposition, the direction of business, or the product/service development concept. It can be useful for reviewing the fundamental perspectives and disciplines that help outline a given business's strategic context and to understand contributory causes. This can assist the business—or the researcher—in understanding the 'big picture' forces of change that they are exposed to, and, from this, to take advantage of opportunities while contemplating a certain idea or plan.

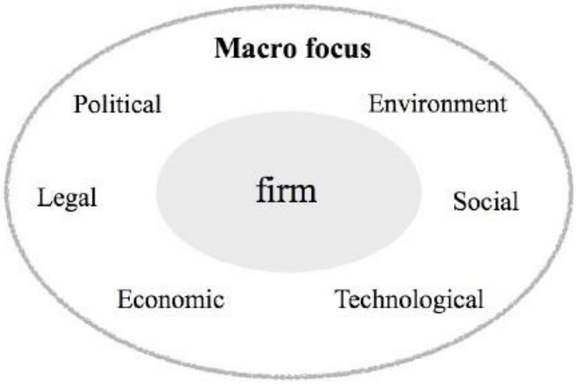


Figure 16. The macro level business environment

5.2.2. Relevant PESTLE factors for a digital mapping service

PESTLE analysis, in terms of its application, is based on six parameters that provide a fair idea of attributions and parameters affecting business, namely the political, economic, social, technological, environmental, and legal aspects outlined earlier. For the purpose of comparing which opportunity holds the most potential and/or poses obstacles for a digital mapping business, the following section briefly represents how PESTLE components relate to such services.

Political factors. There are many factors that determine the ways in which marketplace decisions are made. These dictate the internal and external political conditions, which are the most important parameters when outlining how businesses and organisations perform. These factors cover how and to what degree a government intervenes in the economy, including government policy, laws, taxes, trade regulations, data protection, and so on. In the case of the digital mapping business, government policy and legislation are concerned with emissions-contribution levels—i.e. the reduction of CO_2, PM1, open data policies, and industry incentives, funding and partnerships—which influences how business will be shaped by given conditions and regulations. In addition, many enterprises tend to utilise government Open Data as distributed by the Government Data Store, Transport API, and local authorities' data as free resources that businesses can use. For SMEs and start-ups, access to free resources can act as a form of financial and practical assistance when developing products and services as well as being a highly useful part of a business's offering to the customer.

Economic factors. Economics—or generating financial wealth—can a reason to conduct business. It is also a critical goal that businesses aim at. In other words, gaining or maintaining financial wealth significantly impacts how an organisation does business and underlines how profitability improves this stage of the business cycle in terms of financial conditions. Economic growth, the inflation rate, labour costs, and price fluctuations are all relatively influential factors that influence digital maps/mapping business. These factors can also impact on B2C organisations in mapping too. In particular, inflation and changes in customer demands, such as their buying power, can directly influence business.

Social factors. These are also known as socio-cultural factors and involve cultural aspects, such as attitudes towards investment, population growth, demographic trends, lifestyles, and social mobility. They are also concerned with consumer attitudes to products, services and social norms. Social factors are particularly attached to customer preferences, opinions, brands and buying habits, or patterns and demands for a given company's products or services. As this factor has a direct relation to customers, who in turn directly impact on a business, understanding customers and what drives their decision-making are key considerations for any business. In the case of digital map services, the outcome of product/service usage (i.e. consumer preferences, opinions, brand loyalty) is a critical issue for the business to consider.

Technological factors. These includes technological incentives and changes such as activity related to R&D, automation, or Big Data, which can substantially influence business operations and strategy in both negative and positive ways. These factors can determine the barriers to entry, as well as level of production and outsourcing decisions that can affect both internal business maintenance costs such as labour and capex (capital expenditure), as well as the product and service quality that lead to innovation. In particular, technical proficiency and skills, which involve a company spending on development, accessing new technology, and developing communication and infrastructure, is essential to developing an organisation's product or service. Indeed, technological factors can change a business in three distinctive ways: the modes of producing goods/services; the distribution of goods, information, and services; and communicating with target markets or customers. These include, for example, consideration of how technological advances might impact on data storage, collection, and access, disruptive services, automation, and the increasing move towards artificial intelligence.

Legal factors. Legal factors refer to government laws and legislation, which also shape the business environment. As such, there can be many meaningful legal implications for markets including consumer rights, legal conflicts, and health and safety issues. While there may be many stakeholders involved in terms of contributing funds from various sources, and likewise investment in such organisations, the legal aspects may involve not only internal stakeholders but also other third parties tied into partnerships or contracts as part of a supply chain. It is beneficial for companies to know what is or isn't the case in order to forge successful partnerships or trading arrangements.

Environmental factors. Environmental factors involve the actual physical surroundings that affect physical conditions directly connected to the environment, including pollution, waste management, climate change, and carbon footprint targets. In the context of map/mapping businesses, this could refer to fixed infrastructure such as transport networks, green areas, or road conditions that are associated with pollutant factors linked with government transport agencies and local boroughs. i.e. Transport for London and local councils.

5.2.3. Typology of a digital mapping service in an existing business landscape

In order to understand the most influential PESTLE factors in digital maps and mapping service systems (i.e. businesses) and how this relates to the established digital maps and mapping landscape, Figure 17 illustrates four distinct mapping systems using the map taxonomy developed in the previous chapter in relation to PESTLE factors. This illustrates how each type of mapping service system is related to external factors and identifies four clusters of business types.

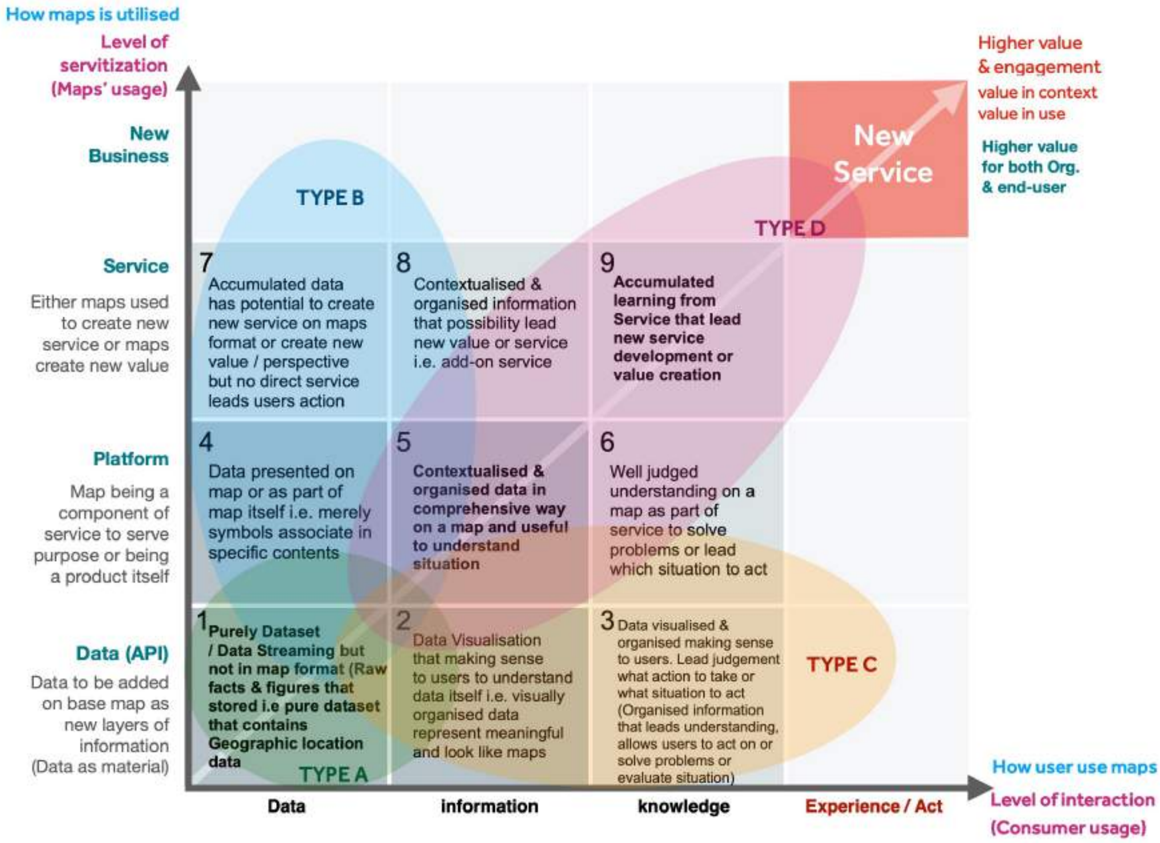


Figure 17. Typology of a digital mapping service in an established business landscape (UK)

By juxtaposing these in a map taxonomy—as reviewed in Chapter 4— four types of mapping service systems can be outlined in Table 9. Of the six described business, environmental factors, and their application in relation to the mapping industry, it appears that four aspects are critical. Political, economic, social, and technological factors are fundamental components for maps and mapping in the established market. Based on this, the following sections describe the relevant case in further detail.

5.2.3.1. Type A: Making geospatial data accessible to all

Type A, as seen in Figure 17. (block no. 1) mostly relates to organisations who stimulate third-party enterprises and developers to bring new products and services to the market. These are mostly government agencies; this group controls what data will be publicly available given technical, legal, and commercial constraints and the question of why such data should be open. Under the UK Government's Open Data initiatives and City Data Strategy, public bodies such as the London Data Store, TfL (Transport for London), or Ordinance Survey treat data as a public common good, releasing no legally sensitive geospatial data to third party organisations, developers, or individuals. Instead this allows businesses to utilise such data as a way of stimulating the wider supply chain, thereby creating gross value for customers, businesses, and the public. A number of companies use and re-use public organisations' data commercially, generating revenue directly and also indirectly, thus returning value back to public organisations. The provision of data is an important foundation for further development of new products and services that drive technological innovation and create economic benefits in the wider digital economy.

In the case of TfL, they started to develop new dataset ranges, from transport timetables, air quality information, to WiFi access points with specific time and location references collected from sensors in the infrastructure. On the London tech agenda, this openness allowed developers and partners to bring new products and services to the market more quickly and cost-effectively. As a result, organisations have access to over 675 apps that have been developed using TfL open data, with a number of them reporting over one million downloads/end users and providing an estimated growth in London's tech economy of £14 million, creating over 700 jobs related to the UK digital sector (TfL report, 2017). By opening static data and making it consumable in the right format (i.e. Application Programming Interface, API), new opportunities were generated. This supports organisations' operational costs and drives greater efficiency, which in turn leads to cost savings for in terms of not having to build apps in-house while offering ongoing support for such organisations' operations.

Image 31. TfL mobility service (Deloitte, 2017).

Image has been redacted.

Deloitte, 2017. TfL mobility service. [Online]. Deloitte Report 2017, [Accesses 10 August 2017]. Available from: http://content.tfl.gov.uk/deloitte-report-tfl-open-data.pdf

5.2.3.2. Type B: Making geospatial data more usable

Likewise, maps and mapping services in Type B take possession of data brokerage and servitisation by making geospatial data usable for others in a B2B (mining & selling data) model. The service involved in this area is based on technological resources, techniques, and R&D capacity, including data or information accuracy and a service offering to other third-party firms. For example, generating geospatial data by capturing specific data about ground surface from high-definition drones' cameras or improving the capacity of data received from sensors installed in the transport network infrastructure.

They also combine, connect, and remix various datasets, thereby providing new and useful insights from datasets and their mapping applications, platforms or software. It is this process of data collecting, storing, mining, and distribution on demand that constitutes a product or service package. Indeed, Type B's mapping service treats data as an artefact or raw material that can be sold to both private and public organisations who outsource technological assistance. Mapping portals such as GIS (i.e. Geographical Information Systems) integrate these data into map-layers on platforms that allow customers to interact with their service platform. Similarly, some of them are SaaS (software as a service) or on-demand software businesses (i.e. Esri). These services are hosted on a centrally-managed cloud platform, so that there is no physical access for distribution; rather they are deployed almost instantaneously. The GIS portal or platform sells useful data that is licensed on a subscription basis and is centrally hosted and managed. The geospatial data brokerage model is a significant marker of the ways in which these types of mapping services can become part of the wider supply chain in the service system. While major enterprises in this area have the capacity to develop geospatial data within the business, many SMEs and start-ups often rely on open data as a free resource.

Image 32. GIS portal: Interconnected and distributed to customers (Esri ArcGIS, 2016).

Image has been redacted.

Esri ArcGIS, 2016. Esri ArcGIS Desktop. [Online]. Esri ArcGIS Blog 2016, [Accesses 10 November 2016]. Available from: https://www.esri.com/arcgis-blog/products/arcgis-desktop/announcements/arcgis-10-5-prerelease-is-now-available/

5.2.3.3. Type C: Making geospatial data sensible by visualising it through maps

Maps and mapping services in Type C deal mostly with geospatial data and make it sensible, presenting useful insights or patterns of data and thereby supporting the user's understanding and decision-making based on various datasets. This type has roots in data interpretation and visualisation as a product or service proposition. According to Experian's *Global Data Management Benchmark Report* (2017), 95% of organisations say that they would like to use data to identify business opportunities and empower their decision-making, while 84% believe the understanding of data to be an integral part of deciding on their service strategy that would allow them to offer better services based on credible insights derived from the interpretation of geospatial data.

Data visualisation helps customers to make more evidential decisions by representing data in a visually understandable form using map-based platforms; thus, the customer can make more accountable judgements in terms of informed decisions. This is because people are able to process visual information much more quickly and on a far more intuitive level compared to textual content. From the raw dataset to the information and knowledge that leads to maps' final form, a complex process is involved in making data understandable and sensible for the user, including making clear what the data implies for them and what to do next in relation to their purpose.

While data visualisation in map-based products and services is essential in this type of map/mapping service, many geospatial datasets upon which business organisations depend are managed and released by government agencies. For example, data on real-time transport timetables (transport); demographic patterns, density of population/housing (social service); pollution density (health and safety); or number of bicycle hires in docks (alternative mobility), are all related to identical market sectors and are mostly owned, managed, and released by the government. If a government agency releases open data which is inconsistent in terms of both quantity and quality, or indeed if a government agency changes the terms of releasing open data, then the organisations who pre-dominantly rely on selling data visualisation solutions may struggle to maintain their service propositions in relation to offering meaningful and insightful representations of data patterns that their customers require. This means that C-types would be significantly affected by government open data policies and customer needs, or more specifically the availability of data under government control.

Image 33. a. Geospatial data visualisation (Murray, 2017).

Image has been redacted.

Murray, 2017. 80 Data Visualization Examples Using Location Data and Maps. [Online]. Carto Blog 2017, [Accesses 20 July 2017]. Available from: https://carto.com/blog/eighty-data-visualizations-examples-using-location-data-maps/

5.2.3.4. Type D: Making maps more valuable through users, government, and technology partners working together

The Type D correlation mainly constitutes consumer facing (B2C) services who are directly influenced by social and economic factors. In this type, firms use maps that allow monetisation by connecting information, things, and people which impact on users' social mobility. They deliver mapping-based products or services to end-users, such that users are easily influenced by economic, social, technological, and political aspects. Maps and mapping service in Type D do not generally build map platforms themselves, but rather partner with map-based platform or technology providers such as Google, TomTom, or MapHere in order to provide accurate information or connect with people and things. These products or services support users in saving money and time and are often affected by customers' preferences and attitudes, ultimately supporting customer needs in a more efficient way.

Furthermore, the ability to understand and extract insights or knowledge from the geospatial dataset is essential in these mapping services. As more customers use their products and services, better optimised mapping service opportunities can arise from an accumulated user-behavioural dataset within the service. Social factors fulfil a key role, as the result can be changeable, depending on how much and often end users engage with the product and/or services. Moreover, this type has the potential to grow, thus broadening its commercial range based on entirely new experiences by utilising accumulated learning based on the available data. Open data from public organisations such as TfL and London Data Store is a desirable asset in terms of utilising mapping product and service support in Type D businesses.

Image 34. a. Consumer facing mapping application (Buczkowski, 2018).

Image has been redacted.

Buczkowski, 2018. This mapping startup automatically generates more accurate maps than Google, TomTom and HERE. [Online]. Geoawesomeness Website 2018, [Accesses 20 June

2018]. Available from: https://geoawesomeness.com/this-mapping-startup-automatically-generates-more-accurate-maps-than-google-tomtom-and-here/

Image 34. b. Consumer facing mapping application (Lozinski, 2016).

Image has been redacted.

Lozinski, 2016. The Uber Engineering Tech Stack, Part I: The Foundation. [Online]. Uber Engineering Website, [Accesses 20 July 2016]. Available from: https://eng.uber.com/tech-stack-part-one-foundation/

Image 34. c. Consumer facing mapping application (Citymapper, 2016).

Image has been redacted.

Citymapper, 2016. The Citymapper—The Ultimate Transport App. [Online]. Citymapper Website, [Accesses 20 June 2016]. Available from: https://citymapper.com/london?lang=en

The following table summarises the wider context of the maps and mapping service case studies described in next section.

Factors	**Context for map and mapping service environment**	**Type A**	**Type B**	**Type C**	**Type D**
Political (policy)	- Government policy, legislation, i.e. data policy, road tax, pollution control - Open data i.e. Open Data initiatives, private data - Government funds to release to specific industries or organisations - Government incentives for a given industry or organisation - Regulation/deregulation - Mediate market conflicts/competition - Regulation-related data privacy laws	◎	o	o	◎
Economic (financial market value)	- Inflation, changes in consumer (B2C) demand - Rate, credit changes - Business cycle stage - Product price fluctuation (B2B)	o	o	x	△
Social	- Consumer (end-user) demographic trends - Changing lifestyle patterns	x	x	o	◎

(B2C, user, usage)	- Population growth (especially in London) - Consumer preferences/attitudes (time & cost) - Customer attitude towards competitors' products/services - Customer attitudes towards green activity, i.e. electric vehicles, energy				
Technological tech. innovation	- Data storage, access, dissemination - Data analysis, mining and interpretation - Emergence of competing technologies - Technical development and adaptation of new technology - Changing technological standards, formats or platform i.e. iOS/Android updates, payment system - Infrastructure level i.e. communication, mobile penetration	◎	◎	△	◎
Legal (privacy, conflicts)	- Regulatory and legislative changes i.e. limits to no. of PHV driving licences - Data protection laws, i.e. concerning personal data	△	△	o	△
Environmental (infrastructure)	- Changing transport network, i.e. deployment of Crossrail, Cycle Superhighway - Road conditions, i.e. accidents, road work - Green practices, i.e. emission controls	o	x	x	△

◎ strongly relevant **O** relevant △ less relevant **X** barely relevant or irrelevant

Table 9. PESTLE relationship with digital map/mapping service environment (UK only)

5.3. Case 1: Type A. Transport for London (data enabler, increases data accessibility)

This section considers a Type A business, a government organisation which enables the easy accessibility and increased availability of data, thereby helping organisations to develop products and services. Figure 18 illustrates the current TfL service ecosystem including the type of data available, the information produced, and the direct/indirect beneficiaries.

About Transport for London

TfL is the integrated transport authority in London responsible for developing London's transportation strategies and meeting its commitments. They run day-to-day operations and manage London's main roads. With more than 31 million trips having been made on the public transport network just using mobile phones in 2017, this is a sizeable task. As a member of the Greater London Authority family, led by the Mayor of London, TfL provides most of London's public transport services including London Underground, London Bus, Docklands Light Railway, London Overground, TfL Rail, London Tram, London River Service, London Dial Ride, Victoria Coach Station, and Santander Cycle (TfL, 2017c). They are also responsible for all traffic lights and 40,000 trees as well as regulating taxis and Private Hire Vehicles (PHVs) in London. They are a public organisation that does not make a profit and has no shareholders or parent companies; however, their income is dependent on travel fares, congestion charges, governmental grants, borrowing, and some other sources of income.

Since 2017, the draft transport strategy by the Mayor of London (currently Sadiq Khan) has stated that TfL is committed to creating fairer, more environmentally-friendly and accessible public transport services compared to private car use. The recent transport strategy has set an the ambitious target of 80% of all trips being on foot, bicycle, or public transport by 2041, thereby making the city a safe and accessible place for people to walk, bike, or travel on public transport, reducing private car dependency and consequently improving air quality, encouraging business, and revitalising communities (TfL, 2017a).

Moving towards an ambitious target in line with the policies outlined above, TfL is expected to ensure healthy streets and good public transport experiences through a seamless 'whole-journey' experience, especially when a travel distance is too long to walk or cycle. To this end, TfL has considered the preparation of new technology; this has driven innovation in terms of working with partners across London including the UK Government, London boroughs, transport operators, businesses and other stakeholders, all in order to make transport journeys easier using technology and data. TfL has also sought more efficient payment systems such contactless payment—a challenge, given that it is one of the largest ticketing merchants in Europe.

In recent years, there have been important changes in policies and the ways in which people travel that have impacted on TfL's role. The freezing of government grants for transport network operations has increased financial pressure on TfL, while they are expected to run longer operation hours (i.e. the night tube) while introducing a new line across London (i.e. the Elizabeth line) in order to carry a significant number of passengers into Central London. In parallel, population growth in London is estimated to grow from 8.7 million to 10.5 million by 2041, 28% more than in 2011, expanding TfL's role in moving people around (Greater London Authority, 2018)

The change in the way people travel and access information reflects the fact that over 75% of customers access travel information via mobile platforms rather than via the TfL website. In addition, about 5 million TfL twitter followers want the right travel information in order to plan their journeys in advance and interact with the transport service while they are on the move, whereas there was a 50/50 split several years ago. Travellers are mobile-phone dependent, as 83% use smartphones and 42% of Londoners use apps powered by TfL open data. This indicates that TfL has a critical role in managing its data rather than simply being a transport infrastructure organisation (fieldnote, Oct 2017).

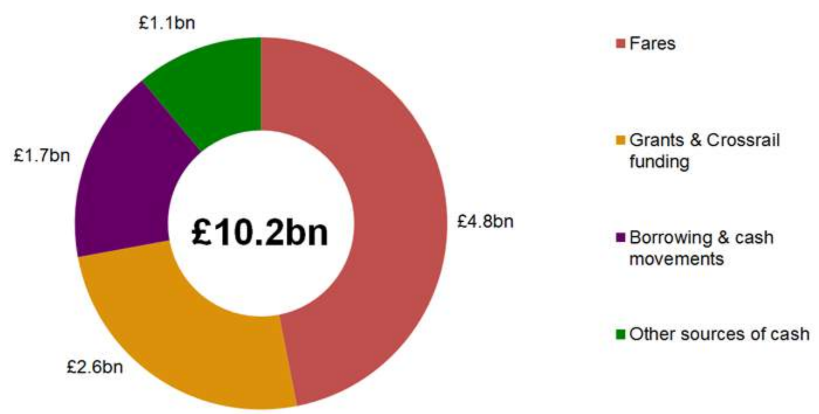


Figure 18. Breakdown of how TfL is funded (TfL, 2017)

5.3.1. Open data as a shared resource, thereby increasing data accessibility

As part of the UK Open Data strategy, TfL committed to making its data freely available, given that their data is publicly owned. A significant amount of data from many infrastructure-derived data points has been created and released over the last 10 years. Publishing public data is an integral part of TfL's customer information strategy, providing real-time information that enables people to use their services. It provides information about service locations, routes, and passenger delays that exceed their available online and offline channels.

The principle of open data is that it is free of charge and accessible in multiple formats, including transport timetables and service status and disruptions in an open format. TfL allows anyone to simply register on the TfL Open Data portal, thereby accessing and using the data free of charge while reducing entry barriers. In order to make this happen, TfL has been processing and following journeys, as detailed in Table 10.

In the early stages of opening up their data (i.e. in the late 2000s), TfL found that many people requested data from their website and developed products and services using TfL datasets. However, the information was mostly static (i.e. PDFs and timetables) and errors were frequent, causing unnecessary backlogs on the part of both developers and TfL, who were dealing with similar inquiries from external users (i.e. developers).

In 2007, TfL started to release their data as 'widgets', that is, as embeddable for live travel news for third parties, which was later re-designed in 2014 (TfL, 2014). At the early stage, the TfL website was functional and informative, but also rather flat and primitive and only able to supply historical travel data such as timetables and schedules over a certain time period in response to Freedom of Information Act requests (United Kingdom Government, 2011). During the later 2000s, TfL launched a website section dedicated to developers. They also additionally released dynamic data feeds (real-time travel data feeds) which could be used, re-used, and redistributed by anyone. The data provides information concerned the level of travel network and disruption information through both the TfL website and London Datastore, run by the Greater London Authority in 2010 (Greater London Authority, 2016).

With the significant increase in smartphone users, TfL had to develop the most commonly accessed method used for the site while meeting greatly enhanced user expectations for more real-time and customised data-centric services. In order to do this, TfL conducted a phased re-development of the new website alongside in-house data migration by adopting 'cloud' storage hosted by Amazon Web Services (AWS) from 2012 to 2014 (TfL, 2015). The website fully launched in March 2014 with a wide range of dataset migration using AWS. At this time TfL adopted Unified API (Application Programming Interface) that plugged in the dataset in a common format (XML and JSON) with a consistent structure. Historically their data was published in a various formats and structures that often made it difficult for developers to manage datasets together in order to develop applications and services.

Traditional approaches to making data available required developers to download datasets, which would require a large amount of time and generate costs that could act as barriers to innovation. With the support of the AWS cloud platform, TfL was able to meet developers' growing demands for data requests courtesy of a high volume of interactive traffic. As such, data users (developers) could analyse data without downloading or saving information. This means that anyone can access TfL data regardless of their storage space or computing capacity. Furthermore, TfL found it useful to manage the sharing of a vast volume of data in a way that allowed the organisation to be very flexible while making it easy for developers to scale up. For example, as it stood previously, '[w]ith a 50 Mpbs Internet connection, downloading 100TB of data would take around 203 days' (Wentworth, 2015).

By the end of 2017, TFL received over 13,000 developer registrations, ranging from technology platform organisations to individual developers worldwide. As a result, over 600 apps have been developed consisting of Unified API and they continue to grow in number (TfL Digital Blog, 2017). A recent Deloitte report (2017) detailed that TfL open data powers apps which 42% of London customers use, thereby enabling millions of journeys in London every day. It was critical for TfL to reach such people while providing the right information, ensuring that anyone who needs the correct travel information at the right time is able to access it (Note from observation at ODI talk, 2017).

5.3.2. Technology and data integration enabling open geospatial data

Prior to releasing transport open data, TfL had to define its open data through conversations with other transport authorities. Considerations included advanced cost-benefit analysis based on data investment, what value data can bring to both parties, who needs data, and the TfL's own requirements. Indeed, it is also critical to consider whether certain data should be available technically without leading to data implementation difficulties and legal conflicts. This is because the creation, collection, and release of new datasets results in high levels of investment in deploying sensors and is a prohibitively complicated and expensive process that requires robust technological processes.

Describing its end-to-end process, TfL has to have original datasets that are the source of customer-facing products and services. The data needs to be in the right format with the correct structure for developers and then integrated into the cloud at a central data hub which has unified all its transport data; whereas it was previously stored on different systems, in a different format, on different parts of TfL platforms. This required: technological investment in sensors; infrastructure; the cost of data hosting; and other—namely human—resources, all of which had to be in place at the outset in order to developing the original dataset in the right format:

> *If not, I think it will not help us to realize the benefits we have set up because we have a huge investment in developing a dataset.*
>
> *… we just won't make any data available if it doesn't serve the citywide goals… we started to see data as a product and bring in third party knowledge. We listen a lot so and, in some event or sessions we say here are our goals, what type of data should we be making available to you before we do it and invest some money in it. Again, let's just work with some sample sets and see what value you can create and when we do it we'll do it really iteratively. [fieldnote, Feb 2017]*

With the origins of their data provision based mainly on static information, as detailed earlier, TfL have harvested and released more dynamic data in sequence. Such data and information were mostly wayfinding-related data helping customers to plan journeys or were concerned with the transport network status, which may affect journey planning. Then, they gradually began to work with other public authorities and third-party organisations to acquire new datasets as outlined in Table 10. (TfL, 2017b).

In order to be consumable, these data are presented in three main ways: static data files which rarely change; data feeds whereby data files are refreshed at regular intervals; and in a unified API format that enables queries from an application to receive a bespoke response depending on the parameters supplied in their own software/tools. The way TfL makes data available in a unified API mode means that data is consistently organised in a format from which people can develop a product/service. It is also available in JSON and XML formats, which are generally universal for developers. Other data feeds and datasets can be provided in different formats based on a given developer's request. All of the data is hosted on the cloud platform, thereby simplifying it for the sake of ease of and making it flexible in terms of scaling up and down depending on the demand for the data. Rather than just making data available, this makes data accessible in much more useable formats for developers.

Air quality	London Air API (from King's College London) and Atmospheric Emissions Inventory.
General	Journey Planner API, Timetables, Station Locations and Station Facilities.
Tube	Tube Timetable, departures, boards, line status and station status, Wi-Fi access points
Bus, coach and river	Live arrivals, bus stop locations and routes, iBus (contracted buses tracking in London), coach parking sites/locations and pier location.
Roads	Busiest times at Blackwell Tunnel, geographic boundaries of London road network and Congestion Charge zone, live traffic disruptions, live traffic camera images (CCTV), and licensed private hire operators
Cycling	Monthly statistics on number of cyclists on Superhighways, Cycle Superhighways and Quietway route data, Cycle Hire data

Walking	Walking times between adjacent stations within Zones 1–3, Central London routes that are quicker to walk.
Oyster	Oyster ticket shop locations
Accessibility and toilets	Step-free guide and toilet mapping data
Network statistics	Busiest times on trains and stations, Public Transport Access Level, Origin and Destinations Survey, London Underground passenger counts data, Dial-a-Ride statistics and Oyster card journey information.

Table 10. List of available TfL data feed sources (TfL, 2017b)

In addition to this, data protection (i.e. personal data in the information) is another concern due to a certain type of data which contains personal identifications. In their open data service guidelines, TfL clearly states that it does not hand over every single piece of data as they wish to remain in rigorous compliance with data protection provisions. These relate to personal data in information and automated systems, software, or processes that extract content in relation to the Oyster, Congestion Charging, and Santander Cycles unless licence agreements with TfL are in place due to commercially and technically sensitive legal conflicts.

Apart from the available open data, TfL holds a lot of data internally, including depersonalised ticketing data (Oyster and contactless payment data) and WiFi connection data that can potentially detail complete customer journey behaviour. Despite having the largest contactless merchandise system in the EU—e.g. Oyster and contactless payments through bank cards, Apple Pay and Android Pay—many journeys are missing and disconnected. The data only details customers' entry and exit information at Underground and rail stations as customers have to touch in and out; it also does not trace those entitled to travel free of charge. Bus journeys used to be more difficult in terms of monitoring information about complete customer journeys. TfL only obtains 'touch in' data when a passenger gets off a bus or transits to another travel mode. Indeed, the TfL Big Data tool looks at bus interchange information (termed ODX), so that TfL can figure out multi-modal travel datasets by adding up the origin and destination pairs. On the TfL blog in 2016, TfL state that:

TfL is unlocking the power of data to gain insights into how passengers are using the network and drive its transformation into a smart transport system. The availability of big data analytics tools and technologies means that organisations, of all sizes and sectors, are increasingly able to make data driven decisions that can make a real difference to customers' lives. In this case, it will mean more accurate passenger insights and easier journeys for customers. [TfL blog, 23 Nov 2016]

Other attempts have included a WiFi data trial to better understand Underground customer journeys. TfL conducted a short trial connecting WiFi data from 54 London Underground stations for four weeks (21 November–19 December 2016). This experiment collected WiFi connection requests from customer mobile devices while customers passed through Underground stations. The data was automatically de-personalised so that TfL collected neither browsing data nor individual identifications. This helped TfL to generate a more accurate understanding of how customers move through stations, interchange between TfL services, and how crowding arose, thereby offering them the chance to plan better services and station upgrades (TfL, 2016). TfL believed that understanding the customer journey flow would increase revenue from companies who were willing to advertise on station poster sites while also helping retailers to better target customers. This revenue would support reinvestment and allow for improving public transport services (Irvine, 2016).

While TfL unified transport open data, allowing simplified access to real-time streaming data in a consistent format for developers in the TfL service ecosystem, these data are not available to third parties, but only supplied by TfL's in-house team to those responsible for managing, collecting, and generating the data. This means that this data is only available inside of the TfL organisation, such that the in-house teams become internal data consumers of TfL's own project, which is not available to developers who operate outside of the TfL service ecosystem.

5.3.3. Shared technology and shared purpose—for others to build a service offering

Open data as a movement has been a technology-driven innovation. Often, the biggest challenges for organisations is to consider how to become open and how to engage with external stakeholders in the wider service ecosystem. The starting point is to consider the outcome of open data rather than the resulting significant investment in technology. Dealing with open data is not just about making data available and seeing what happens in response but includes opening up potential benefits through sharing technology with those that have shared service purposes. TfL has been actively working with a number of different organisations to experiment with open data feeds and to improve data itself.

Figure 19 illustrates how TfL opens up data and identifies their data partnership with certain categories of actors, as well as the subsequent data flow in support of the current mapping service ecosystem. As shown, TfL's open data is used by various types of business organisations and is spread across various scales, underlining that not all these activities can be performed by TfL alone.

First, data aggregator companies such as TomTom, Transport API, and Elgin combine and harvest open data from other data sources. Before 2016, TfL worked with the satellite navigation manufacturer TomTom to try to create a bespoke data feed covering planned roadworks in an industry-standard format by detailing traffic disruption and effective route planning, while evaluating how this data could be used to bring better information to road users. These organisations sell bespoke data feeds to other mapping companies like Google and Uber, supporting their service by assisting them in being more accurate and timely. These data-aggregation companies play their role in data brokerage, mainly by delivering data to digital mapping and mobility companies, thereby facilitating easier and more interactive data utilisation as well as leading to better service development.

On the other hand, TfL has been working with start-ups, SMEs, and sometimes major players to utilise their platforms to achieve significant market reach by ensuring they use TfL data. TfL provides a real-time open data feed to mapping platform-based companies such as Google Maps and Apple Map, whose have the highest market share in the digital mapping sector. In this way, the tremendous number of users of these mapping platform companies conveniently access and use public transport information. This means that TfL is able to indirectly reach a larger number of transport customers by enabling them to access up-to-date and accurate transport information without needing to interact with the customer directly. Hence, these major market players (i.e. Google, Apple) also enable third-party organisations by letting them adopt mapping platforms as base maps, such that other third parties can develop transport and mapping-related services through using these platforms:

> *We work with Google to highlight where the route might be and where the levels of disruption might be. So, again, people are using Google to plan their journeys and hopefully not be disrupted by events taking place in the London whether it's the London Marathon and other major events because in London there are major events very regularly. [Note from AWS talk, Nov 2017]*

The data partnership with Waze/Google Maps, Apple Map, Citymapper, and so on, has helped TfL to run road networks more efficiently. In the case of Waze, the cooperation was based on a data partnership that used a crowdsourced tool focused mainly on the road network. In this partnership, TfL provides data indicating where road disruption is expected so that Waze can effectively reach out to drivers and inform them of delays. In return, Waze sends new data to TfL that are beneficial for both parties, thus creating shared value for both parties as respective publishers which also emerges from their relationships with users.

> *Waze gets incident information so there are instances where we might get information back quicker than other from ways [and] quicker than other channels, so we then validate the information that we receive from ways and immediately make some operational changes.… Apple Maps are listing some of our taxi rank information. They're also listing our docking station information, which hopefully will stimulate people to use a bike. [Note from AWS talk, Nov 2017]*

It is important that TfL create the right engagement programme and understand how users and developers are consuming the data, in what format, and in terms of how this works together in order to develop product roadmaps. TfL develops features that are relevant to customers who are generally expected to be TfL customers, thereby driving win-to-win processes and programmes by supporting the right consumer-facing products and services.

5.3.4. Sustaining the service ecosystem through data partnership and engagement

TfL's open data initiative sustains the mapping service ecosystem of third-party developers who rely on live streamed transport data. However, it is not just about making TfL data available and seeing what happens to it. TfL works with numerous partners in support of the growing developer community, ranging from the professional to the amateur. Responses to TfL's challenges and issues help deliver the new products and services that customers need. Thousands of developers use TfL data/APIs to design and build applications, services, and tools that can drive crowdsourcing innovation through the creation of new opportunities and complementary aids.

TfL's partnerships and collaborations with other organisations in the technology industry are key to driving innovation and solving challenges caused by changes in the ways in which people travel and access information. TfL also tries to tackle the capital's challenges by hosting 'Hack Days'. These events bring developers together to see how they can utilise our data and thus make improvements. For example, this includes helping developers to experiment with how they can interrogate TfL traffic data as provided by tiny sensors that are buried in the road, thereby leading to further data feeds. This also provides feedback if a data feed is broken, gone down, or something is not in place where it should be. TfL has found that it is vital to maintain a closed loop with the app developer community through channels such as Tech Forum, events, and blog posts highlighting their challenges while facilitating access to the right people and skills and receiving feedback from open data users, a process which has been ongoing since 2016.

The Head of Commercial Innovation at TfL has emphasised that data being invested in the right structures is very important, hence consumable data formats makes it easier for developers to *participate* in the ecosystem, rather than simply providing them with data access. He has also highlighted that it is crucial that organisations such as TfL share their challenges and issues as a public organisation; moreover, sharing know-how regarding being an effective part of the ecosystem helps all parties to become involved. He argues that one of the key considerations around open data and engagement programmes is the early creation of a two-way dialogue between the organisation and developers. This indicates a genuine partnership, whether with start-ups, SMEs, or large enterprises, in terms of thinking about how these work together to build good products and services. In this way, investment in technology and people in relation to product development improves TfL's operational service by allowing third parties to gain access, be connected, and configure data on its platforms:

> *There are nearly 700 apps developed by TFL data that are used by over 42% of Londoners so the story is a good one and we want to do more in this space…give access to the right people. Quite often we found that some of the start-ups and SMEs just want access to people—maybe the policy experts, maybe specific individuals around the technology—as opposed to wanting other things. [note from AWS talk, Nov 2017]*

TfL has recently appointed a person who engages with developers on a regular basis, so that the organisation can collaborate with the 'hackathon' in terms of the transport network, maximising its capacity. Offering TfL data in a usable format free-of-charge and providing a dedicated space for developers stimulates information provision innovation. It also enables developers to think creatively and test their analytical skills while providing Londoners with up-to-date information about public transport and road networks. By openly sharing our transport data, new apps can be created that make travelling easier for customers, which in turn is helping to solve some of London's transport challenges. In this way, TfL believes that the transparency of public institutions can be improved while challenges in relation to existing modes of operation can be solved. This also helps TfL to develop niche products that offer information channels to the public quickly while supporting partners who can produce new products and services for both third parties and TfL customers, thereby extending TfL's services and creating a virtuous circle of open data that grows organically.

5.3.5. Value and beneficiaries of opening data

Certain benefits have resulted from the above-mentioned efforts. In terms of TfL as a public organisation, it has received several benefits from opening up its data. First, TfL has generated trust and offered data transparency, which is important for a public organisation. They have also achieved benefits through third-party organisations by allowing them to develop new products and services for TfL customers. It also helps TfL to distribute correct information relating to over 31 million trips in London through various third-party channels while communicating with users in an active and efficient way through the customer's choice of channel. Moreover, opening up data drives innovation, thereby enabling the development of niche products and services for TfL customers.

It would not have been possible for a single organisation such as TfL to develop nearly 700 apps within such a short period time; these apps also lessen the pressure on their service operations and the latter's cost (i.e. TfL call centres) as they do not need to produce apps and respond to inquiries in-house, but can focus on other priorities, saving resources and increasing efficiency:

> *Some of them have developed a business, now a commercial business, through the use of TfL data… TfL making its data available is right thing to do from a transparency perspective and by not making that data available I think they'll drive some more inefficiencies in the organization because we'll be getting more queries through about our operations. [Note from TfL talk, Oct 2017]*

In opening their data to over 13,000 registered developers, TfL can create potential cost savings by eliminating the need to develop apps themselves. Indeed, TfL also jointly develops innovative products and services with third-party developers by leveraging the value and cost savings of partnerships as a means of crowdsourced data. This allows TfL to perform new analyses and improve operational quality, such that new commercial opportunities can be generated.

TfL appears to believe that opening data as a resource results in new businesses emerging and the resultant job creation further supports London's tech agenda through the creation of new business, public agencies, and public benefits to a wide range of stakeholders or users. What is less well-known is the economic value and social benefits of their approach. Although TfL and Deloitte have outlined survey findings about the positive results of open data (Deloitte, 2017), it is more difficult to estimate the magnitude of such benefits; while open data can certainly facilitate the development of technology enterprises, SMEs, and start-ups that generate employment and wealth, these are not yet measurable.

TfL seems to focus on time and customer experience. Passengers will be advised on how to plan a trip through apps developed based on TfL's real-time information, allowing them to adjust their route and plan their trips knowing when the next bus and tube will arrive. The time saving derived by receiving the right information generates productivity. This also includes data for roadworks and traffic accidents as supplied to SatNav, which runs software and apps that allow individual and commercial drivers to adjust their routes to avoid traffic congestion. This reduces latency, may shorten journey time, and reduces emissions. Customers are thus more likely use TfL services regularly while customer satisfaction is also improved by ensuring that accurate and reliable information is readily available.

In terms of London-based value, a new business can use TfL's open data to market a variety of new apps and services. Many of these are related to high productivity and efficiency, and thus have a significant impact on job creation in the supply chain. This also enables TfL to develop new partnerships. As the data provider and transport operator, TfL has developed MaaS (mobility as a service), and acts as a key stakeholder in encouraging and promoting innovation in the transport sector by just opening their data and engaging with developers. As a result of releasing more data and developing partnerships, TfL appears to create more value for those travelling in London, thus encouraging developers to support the wider service ecosystem.

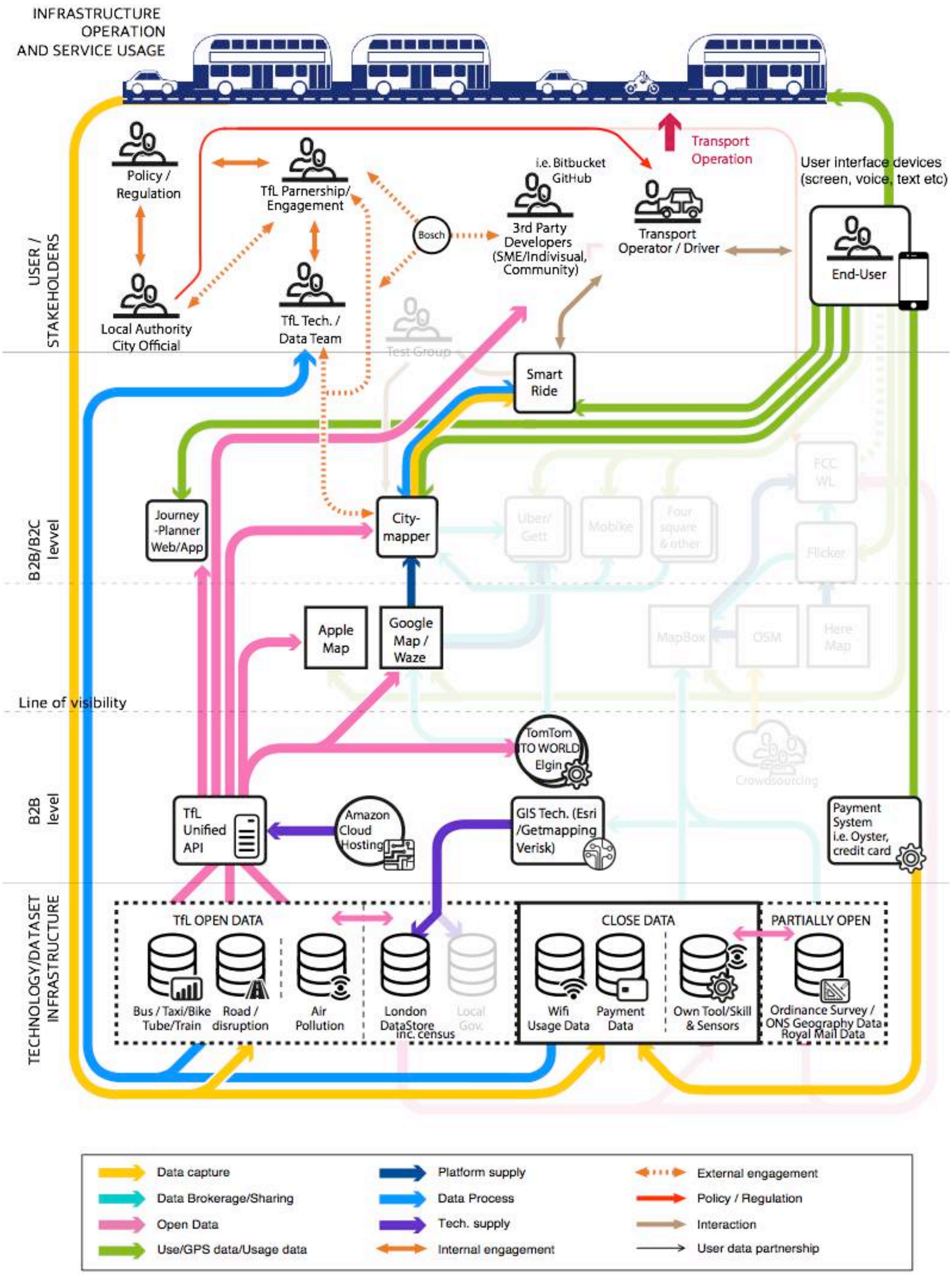


Figure 19.TfL service (eco)system (drawn from Case 1 finding as of March 2018)

Summary

TfL as a government agency does not directly generate revenue to run organizations. Their operational and service costs are met by their customers' transportation fees and government subsidies. This means improving customers' public transport experiences would provide value to the organisation as well as generating additional resources that TfL can use to run public transport services. Rather than developing mobility-related mapping services directly, they release their data. First, many organisations—including start-ups, SMEs and individual developers—then created digital services using TfL's open data; second, they promote active participation and regular engagement with programmes such as hackathons, competitions, blog posts, and events with developers, thereby reaching out to developers who drive the rapid development of innovative services at a low cost that TfL would not be able to develop internally. This means that, the more data it releases, the more innovation catalysts are possibly created that cater to the greater good. However, it is questionable when and how to disclose the data at certain level, especially related to data generated by customers' use of TfL services that are currently closed and would be subject of debate within TfL.

Research findings in Case 1 (presented in Figure 19) demonstrate how the current TfL service ecosystem operates and what relationship among key stakeholders exists and creates value. Accumulated transport usage data is stored in a database, some are offered in an Open API format so that other public and third parties can utilise them as Open Data without the manipulation of other datasets. However, the data include personal identification modes such as smartphones, which access open WiFi while payment-related information is removed and closed. As shown in diagram, TfL do not develop customer facing application themselves, but instead facilitate partnerships with third parties' to improve their service, offering guidance on how to use their data assets better while letting third parties utilise their Open API and improve the customer's experience of public transport use. In other words, TfL controls the governance of data management, stores the data, manages access to the data which is stored (i.e. on the

Amazon Cloud service), which helps multiple people who can access it without restrictions in terms of time and place.

Some geographical information that is provided by other third parties such as GD (Case 2), who have relevant technology and techniques, and offer technical support to TfL (i.e. supplying sensors, accurately calculating geographical specifications).

Open API data isn't visible to end users until it is utilised by other platform enterprises such as Google, Apple, and Citymapper, who make this data readable and useable, while TfL also collaborates with companies such as Waze and Citymapper to improve public transport and road incident-related information, thereby aiding service quality—as TfL is unable to develop such content or reach customers given the limitations to their internal resources.

As shown in this diagram, it is essential to open up the data from government agencies in order to activate the service ecosystem in maps/mapping; thus, there are also greater opportunities to be expected in 'closed data' that are not currently open to the public. It is also essential that they continuously communicate with other third parties' in order to understand the latter's requirements—such as data format, structure, release frequency, and so on. Therefore, they can open up a dialogue with others and allow access to many other resources, while actors can participate in service ecosystems, thereby facilitating collaborative activities between players both inside and outside of the service ecosystem.

5.4. Case 2: Type B. GeoInformation data group (data brokerage, increases accuracy and usability of geospatial data)

As in Case 2, this section is a description of a Type B business run mainly for the servitisation of geospatial data to government and corporate organisations (known as B2B). The main service provided in this type of service system is data brokerage and the intermediation of geospatial data, which are the central service opportunities of Type B organisations.

About GeoInformation Data Group

The GeoInformation Data Group (GD) is a privately-owned company dedicated to providing accurate geospatial technologies, notably cartography, web-mapping services, 3D visualisations, and airborne and ground-based survey solutions for both the public and private sectors. Since its inception in 1998, GD has focused on the development of new products and services for the geospatial industry. They are partners and data consultants to the national mapping agency, namely the Ordnance Survey and its products and services. They launched the world’s first commercial 3D display technology, which provided digital aerial photographic image databases for software and applications, and they have won several major awards in the GIS field.

GD’s products—in particular, UKMap and UK Building—contain public-sector information licensed under the Open Government Licence (OGL) v3.0 and Ordinance Survey (OS) data (Crown copyright since 2015). These products also contain Royal Mail data with the most up-to-date postcodes and address systems (2017 onwards) and National Statistics data for demographic-related information (2015 onwards). Putting together public data and their own data, they have created a powerful geospatial dataset for many organisations which focus mainly on selling specialised techniques and masses of accumulated data. They are recognised in particular for many of their development initiatives, that cover: transportation, planning and building control, parking, policing, mapping, infrastructure and forest mapping, emergency response, water utilities, environmental planning, and land and property. Using detailed high-resolution imagery techniques and technology, GD's many client organisations range from local and regional governments and government agencies through to commercial partners such as urban modelling, utilities, and insurance companies.

5.4.1. Increases usability and accuracy of geospatial data (geospatial data servitisation)

Creating more usable and extended coverage and accuracy in geospatial data is a core value for the organisation as a geospatial data supplier. The company applied UK national standards for the first time in the creation of land-use maps and developed a unique classification of objects on the ground, mainly compiled from photo interpretation. The imagery is based on the geospatial database and is also provided as one of its constituent map layers. Furthermore, the recent development of geospatial data applications (GIS tools) delivers a value-added large-scale mapping database that has information about current land use, building heights, and retail activities, all in order to help customers to understand and assess areas, thereby identifying cost effective solutions.

Some are based on largely automated data, while GD also has surveying skills and cartographic knowledge in place due to the many rules, restrictions, and guidelines in cartographic production that lead to some information not being easily accessible within common open data and entry level two-dimensional free maps and geospatial data. For example, such data details green zone areas, land registry, underground waterways, or the number of carriage and vehicle permission weights on the road, which are very important to city planners, local authorities, energy, retail or logistics companies. These geospatial data are managed in their online assets management system (i.e. GIS data portal), and are mostly procured by B2B-faced enterprises. This GIS portal delivers complex data in the form of information packs that are important to client businesses, often involving large-scale projects that require the involvement of many stakeholders in complex procedures.

Based on the geospatial database they have created, GD also offer training, events, and consultancy to support clients in understanding how to deploy the data and the best representational modelling format for ease-of-use. These are required in the collection of data/information about the locational situation, evaluating modelling simulations in order to predict the results of a specific course of action, if it is followed. By merging various mapping databases, GD's GIS solution has a large range of attributions as well as accurate geographic representations (terrain) of above and below the ground features, as described in the following table. These features in the available datasets are particularly beneficial for users who need access to building divisions and detailed height specifications as well as being useful to those interested in land use. For example, architects, surveyors, developers, and environmental consultants are offered the most up-to-date and comprehensive range of geospatial data, allowing them to instantly download and use Computer Aided Design (CAD) or similar mapping application.

Categories	Feature details
Topographic features	• All topographic features mapped from high resolution aerial imagery
Rich mapping	• Including buildings, vegetation, hard standing items combined with land use (e.g. residential, transportation retail etc)
Addresses	• Property-level address data, house names, numbers, ranges, postcodes etc.
Trees	• Individual trees and tree stand
Colour and Grey Scale	• Colour or black and while scheme for survey work
Land Use	• 280 class multilevel land-use classifications with high-level land use (e.g. residential, retail, transportation, communal homes, retail centres, taxi ranks)
Height	• Height of all building features, above sea and local ground levels
Retail	• 101 classification of retail use with shop names, addresses, and multi-floor shopping centres
Transportation	• Detailed mapping of multiple transportation features and markings including speed bumps, crossings, pavements, pedestrian areas, advanced stop lines, cycle lanes, disabled parking bays, bus lanes, etc.

Table 11. GD's UK Map Database available for the Greater London area

5.4.2. Technology and techniques enhance specification and feature of geospatial data

One of GD's GIS products, UKMap is a tool that creates large-scale topographic mapping. It redefined professional base-mapping using rich mapping data to improve how we understand spaces in analytical geometry. The product is an integrated geographic information source that is designed to be viewed at a scale of 1:1,000 topographic mapping. This product accurately locates buildings, property boundaries, roads, trees, and a multitude of other features, which are digitalised on a 1:500 scale, and contains an unprecedented level of detail including building height information derived from LiDAR surveys and the latest aerial surveys, to maintain a consistent building polygon while each height value is given to a precision of 0.1 meters (Verisk, 2017).

This specification emphasises the relationship between objects in the three dimensions, which means a technical capacity to capture both above and below ground, for example the relationship between underpasses and elevated road compared to the ground details (i.e. elevated walkways to buildings, parking bays, speed bumps and so on), so that it can provide a more comprehensive representation of complex urban landscapes and large built environment. The same approach applies to below-ground features, making it especially suitable for measuring the connectivity of utilities—for example for the London Underground. These technical skills and capacities, created in a highly accurate 3D database, offer clients the most accurate possible representation of a 3D urban environment's dimension within a topographic database. These technologies also cover land-usage code at greater coverage, that is, inclusive of more than two hundred classifications that enable a systematic analysis of land usage and helps users to be able to access sites and thereby develop strategic planning for specific purposes.

These GIS databases are delivered to users through a Basemap platform, which is composed of two sets of mapping layers. One is the Base Map Layer, which is composed of polygon layers that act as containers for other data to be laid on top of. The other is the

Overlay Layer, which typically overlaps with terrain features like electrical power lines, trees, street names, built environment occupancy status, and point of interests that are not typically mapped to the ground features of common consumer maps like OSM and Google Map. These classifications and codes consist of nine categories with more than 1,400 unique references and classification codes in a hierarchical structure on the maps. These details have great strength in terms of acting as both references and tools of analysis, especially when linked to land-use data. It also supports the organisation of who deals with various geographical information inquires, by offering greater flexibility and details in the geospatial mapping database.

As these geospatial data have to be maintained with up-to-date information on above ground level as well as below, GD state that they update their database every six months to include all the changes that have been collected by their surveyors and digitalising team. In this work, both Base-Map and Overlay data is maintained using aerial imaging platforms and ground-based survey skills, by a team that constantly collects and revises the Point of Interest (PoI) data partnership with Flickr to get crowdsourced PoI information—an essential part of this work concerns retail and postal information, as a bespoke service that is one of the most frequent requests from their clients.

Image 35. Classification layers (Verisk Geomni UKMap, 2017).

Image has been redacted.

Verisk business, 2017. UKMap—Accurate, detailed, feature-rich mapping. [Online]. Geomni Verisk Website, [Accesses 12 September 2017]. Available from: https://www.geomni.co.uk/ukmap

5.4.3. Expanded usages of geospatial solutions (GIS tools)

While GD emphasise that their data have been collected to the highest standards by partnering with the Ordnance Survey (OS)[17], Britain's national mapping agency who makes the country's national and official maps, GD appears to let-on that the integration of other geospatial resources (i.e. data) is a critical part of their mapping service when they state that '[o]ur product covers all of the major areas in London and major cities [….], and links the postal address based on data from Ordinance Survey products' (Interview, Dec. 2017).

There are many organisation producing geospatial data that include data from the OS national mapping agency. Organisations such as the ESRI, Getmapping, and the GeoInformation Data Group create GIS software packages for desktop and mobile devices—along with data-management systems and solutions through Web Services that stream a range of datasets in all scales of OS mapping as well as aerial photography in rasterised data.

Currently OS has more than 320 partners producing a wide range of GIS products and software as a service (SaaS) in the large-scale mapping industry (*Verisk*, 2017), which means GD is one of them, and that over 320 companies have access to the same geospatial datasets and GIS platform supported by OS. Although OS creates the most accurate and official geospatial datasets and topographic maps, they do not provide *add-on* services like GD does.

In GD's case, they offer geospatial *solutions*, for example providing 'a unique and accurate profile of residential and non-residential building stock classified by age and type and use across the UK for many industrial sectors in a single system' (Verisk, 2017); they support insurance companies in adopting GIS to visualise aggregated geospatial data patterns to

[17] They are a government-owned digital business company helping governments (1 April 2015), companies and individuals to use their digital mapping and geospatial data more effectively

predict flood patterns and estimate correct premiums; retailers in building at the most appropriate new locations based on population numbers; and emergency services in using GIS in order to locate their vehicles at any given time by drawing on data-driven historical patterns of where they are most likely to be needed. Regardless of the type of organisation, GD builds customised GIS packages that suit the specific requirements for geospatial data and information, which are also accessible through annual subscription-based pricing.

As GD's key clients range from public and commercial organisations such as TfL, the Metropolitan Police, Thames Water, the London Fire Brigade, HM Land Registry and so on, this means that this mapping product and service supports a wide range of geospatial-related organisations to implement a large number of applications for those bodies who regard geospatial accuracy as a critical element.

5.4.3.1. Transport for London

When it comes to TfL, who are responsible for all aspects of public transport in London, GD's product has been used in the 'Legible London' project to create a wayfinding system including landmarks and local information that encourages walking and cycling that builds upon the land-use characteristics data from UKMap. It was used to develop the cycle infrastructure by allowing transport planners and designers to understand the categorisation of street types and characteristics of local areas based on the volume people and their locations.

Image 36. Cycle superhighway (TfL, 2017).

Image has been redacted.

TfL, 2017. Cycle Superhighway 11. [Online]. TfL Website, [Accesses 12 July 2017]. Available from: https://tfl.gov.uk/travel-information/improvements-and-projects/cycle-superhighway-11

5.4.3.2. Local authorities and the complex built environment

GD work with local authorities in support of various public issues, and development in London means that there are many reasons why highly accurate mapping databases are required for tasks related to the complex built environment. From site and facility management to emergency planning and redevelopment—these all require a high level of detail, whereas existing free mapping data/solutions often only provide entry level and rather limited geospatial information. GD highlights that the local and regional authorities (e.g. Harrow council) have benefited from the use of aerial photography and a comprehensive overview of land coverage across the region from GD products for planning and development. GD ran surveys so that authorities could monitor green areas (trees and plants) across London, for example. Furthermore, GD's geospatial database in UKMap presents the most populated areas as well as landmark features displaying rivers and major parks, while also highlighting industrial or significant built environment areas (e.g. Park Royal, London Heathrow Airport, and the O2 Arena) (company report, 2007).

By having a large-scale and accurate land database, GD stresses, 'a local authority gets the best results and keeps costs to a minimum in terms of ground management that requires complex and extremely intensive resources' (fieldnote, Sep 2017). Therefore, local authorities are able to locate and calculate the expected time and cost of maintenance work, as well as the travel time required throughout the borough to ensure that the correct level of resources and manpower is invested under planned maintenance programmes (e.g. the London Borough of Harrow). In terms of building management, GD products have also been used by several Housing Associations and property developers embarking on large urban regeneration projects, while local authorities have tried to manage common space on behalf of the wider community in order to secure the park as an open space, a green corridor, introducing community leisure and sports facilities during the transformation process (e.g. Olympic Park). Similarly, during the London Airport expansion project, a tremendously accurate geospatial database was produced from bespoke aerial imagery through UAV survey (unmanned aerial vehicle, i.e. drone), which effectively customised base-maps in support of the airport's expansion.

5.4.3.3. Health and safety

In terms of public health and safety, the Metropolitan Police uses a wide range of geospatial data (i.e. street and building restrictions, entrance or construction structures, etc.) and applications to ensure civic safety and maintain their responsibility. The GD product (UKMap) is one of these applications, available to staff to help them when their enforcement is required quickly. Previously, they used geographical information systems (GIS), however many of them only had access to GIS applications that lacked seamless data linkages within the same system. GD's product and its GIS solution provides a complete range of mapping data including aerial imagery and bespoke datasets that can illustrate detailed information for Met operations and investigations. During the Olympic Games, the Met used geospatial data, including an audit of all street furniture around the Olympic sites and the route network; while police officers used UKMap to identify high-risk building and avoiding the risk of fire during the London Riots (August 2011)

5.4.3.4. Utility infrastructure

Since mapping has been digitalised by technology, many map-based products and services have begun to adopt Application Programming Interfaces (API) and become a standard web mapping service. This allows customers to access and integrate data into their systems without any data management overheads or support.

GD also released their geospatial datasets in an API format, thereby providing a mapping function that is easily integrated with an organisation's salesforce applications and workflow to manage their operational scheduling.

As organisations that perform street works should submit accurate planning work details and a schedule to the relevant local authorities by law, having this mapping application and GIS (i.e. UKMap) helps their clients/users (eg. utility companies) to specify the accurate location of street work and the best possible work completion schedule so that the authority is able to inform the residents. The significant point here is the accuracy of planning work reporting, which reduces the level of uncertainly and inconvenience while improving operational efficiency compared to previous manual mapping applications.

GD helps utility companies to refurbish and maintain their infrastructure and networks, and their UKMap product and service is used by one of the UK largest utility service providers.

In terms of commercial application support, GD's services have been used by many organisations in water and energy, supporting them to develop better knowledge on which to base infrastructure development, energy usage, and energy consumption forecasts. With the support of aerial imagery analysis, construction organisations have a better understanding of the spatial constraints of working on dynamic construction sites, particularly working in sewage. Moreover, information about building structures, materials, and occupation type are important for the assessment of the heating capacity of buildings, which is a major issue in the UK. This information, along with that relating to building and surroundings, is used to evaluate insurance related to buildings and roads.

Many insurers, brokers, and reinsurers can assess potential loss, the cost of risk, and price policies according to geospatial data. Thereby GIS and risk modellers allow insurers to better understand the location of properties and whether an individual property is located in a flood-risk zone. This geospatial database has been used by organisations for urban planning, to detect illegal developments, to predict gas and water leakages, and for insurance valuation and property development. Insurers can now easily collect data in order to better understand the risks and thereby assess potential losses.

Image 37. Land use and rural infrastructure mapping (Verisk, 2017).

Image has been redacted.

Verisk business, 2017. UKMap—Accurate, detailed, feature-rich mapping. [Online]. Geomni Verisk Website, [Accesses 12 September 2017]. Available from: https://www.geomni.co.uk/ukmap

5.4.4. The service ecosystem's development of geospatial data usable by organisations

In GD's services, technology plays a key role in making data usable and saleable to another organisation. Even technology helps them to retain a leading and competitive market edge, where the introduction of new technology and the adaptation of cutting-edge technology on the part of other competitive organisations may impact on the uniqueness of services/solutions, thereby meaning that they can be less readily monetised as their solutions are highly dependent on their technological aspects. It is crucial for GD to keep developing unique geospatial datasets by integrating other data that are useful for clients and partners as well as maintaining the organisation's cartographical knowledge. A lot of organisations rely on automated data generation and collection, arguing that mapmaking now operates under a changing paradigm due to technology and automated data collection. However, there is still some geospatial data that requires certain level of human verification to ensure that the data is accurate and error-free. In GD, the ability to collect geospatial data from large imagery scanning on the ground and reproduction of these geospatial data through a combination of additional data (whether Open Data or data partnership with elsewhere) appears key.

My conversation with a former GD GIS specialist (a freelance GIS analyst) saw her strongly emphasising that creating new products and business opportunities nowadays really depends on the capacity to deal with data sources (mixing and matching datasets), along with a knowledge and understanding of certain tools (i.e. AutoCAD, GIS and topographical language, cartographical knowledge in this case) as well as the ability to analyse and interpret graphical data. My source highlighted the essential ability that is required of a GIS specialist, namely understanding geospatial data using surveying skills, and a knowledge of national standard rules and guidance such as the width, number of lines, weight restrictions, and limitations of express motorways, as well as cartographical language specifically applied to certain locations or built environments in order to verify automated datasets (freelance GIS analyst). With highly advanced technical equipment and techniques such as robotic and 3D scanners, the ability to read data has become increasingly useful, such that the specialist can develop useful insights based on the dataset and suggest ideal solutions. However, she also argued that ‘someone [a GIS specialist] who has these skills is very, very, rare and niche’.

Facilitating these products and services using skilful techniques requires a tremendous amount of Capex (capital expenditure) to maintain the operation of such services. In the opinion of one of GD’s consultant’s, they (GD) prefer to build a long-term relationship with a large organisation, so that service monetisation becomes stable and the monetary model (selling data and consulting) can keep running.

This consultant also emphasised to me that there are many companies doing the same thing and competing with each other. Interestingly, GD regularly facilitates annual conferences, events, and showcase so that buyers can, for example, exhibit the best in mapping from modern cartography or even aerial photography at the UK mapping festival.

While the conference invites companies from various geo-technologies in the geospatial sector to present the latest technologies and products, leading experts from public and commercial organisations and sometimes direct competitors attend so that the conference becomes a place to meet sellers and buyers rather them than becoming involved in the development of end-user products and services.

Image 38. Geospatial Data group showcase (2017), British Cartography Society conference (2017)

5.4.5. Value and beneficiaries of geospatial data

While government agencies aim to improve the accessibility of open data, there are concerns around open data on the part of data suppliers from the brokerage perspective. The opening up of data is a government-funded initiative; however, since the government started to open up data and make it more affordable, this has slowly started to threaten existing business models, in GD's view (GeoCom 2016 report, 2016). To some extent, the government's making some partial geospatial data accessible and free is crushing GD's specialised business operations. One example is the Environment Agency's data: they have released all LiDAR (Light Detection and Ranging) data, making it free in 2018, which will result in some organisations losing revenue from these data sales—which in turn has caused a dilemma regarding which data to sell.

There has also been debate concerning the cost and benefit of open data at the GeoData 2017 conference: while there are clear benefits of open data given the dramatic increase in the download of free assets, general interest in the use of geospatial has risen exponentially. Many people and organisations in the conference appeared to be reluctant to pay up-front for something when they might not be clear about what value it could bring (especially from their consumers' perspectives), and questioned what people do with such data and what value can be added.

One of GD's Sales Director's claimed that 'around 20% of open data comes from the Ordinance Survey and these data and platform is used to produce paid-for-products and services in the GD business', which also leads to innovation in their service. Within GD there is concern regarding the degree to which government agencies will finance and release geospatial data, while they also believe that open data should not necessary mean 'completely *free of charge*'. Hence, due to the general public perception of open data, it spreads the wrong idea when we say that the valuable geospatial datasets they are currently selling are provided for free. He also highlighted that there is a real prospect that small GIS-related organisations could be wiped out because the data they were previously collecting and adding some value to and then selling to clients could disappear due to a lack of price competition. Furthermore, the data and services they are offering as a package is not the same quality or level of details that the government (Ordinance Survey and Environment Agency in this case) is releasing for free, and changes will mean a slow but discernible impact on their service. On the other hand, he argued that there is a strong perception that open data is too varied in terms of its formatting and structuring, while clients are too busy to dig for data and extract insights themselves. Therefore, he and his colleagues appeared to believe that open data had just not had a huge direct impact on GD as yet compared to what they imagined previously. GD seemed aware that they should continue to develop new services in the longer term. Much of their revenue comes from commercial services provided to the insurance and real estate industry, which are not part of open geospatial data. In addition, their current big clients much prefer to receive full service packages inclusive of new geospatial datasets along with GIS tools and consultancy under annual licence subscription packages, or to retain a fee-based service which fully supports clients day-to-day working requirements while also removing headaches that concern every aspect of dealing with geospatial knowledge. He therefore thinks such the events and showcase they run also help to manage account and client relationships, which have become important to maintain.

Based on the findings, the diagram below illustrates GD's service system in a wider mapping service ecosystem and indicates the key stakeholders and their relationships with other actors who participate in this service ecosystem.

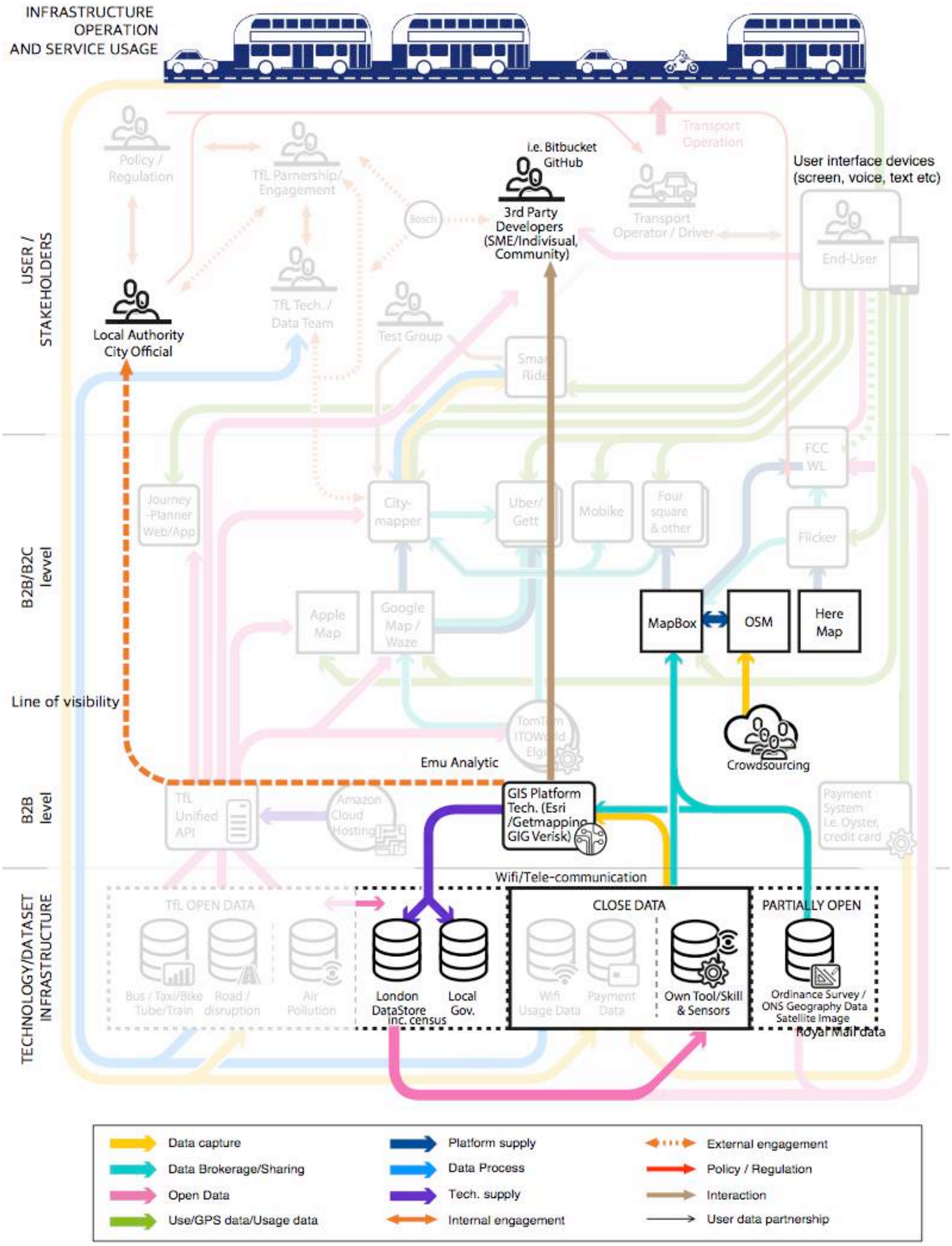


Figure 20. GeoInformation group service (eco)system (drawn from Case 2 findings, as of 2017)

Summary

Selling data and data brokerage role is a major service provided by a GD type of service system and primarily involves developing GIS services using highly accurate available geospatial data with a wide geographical coverage. For such these types of mapping service systems, technology and human verification deliver improved technical specifications, which are crucial to GIS products and services. Rather than providing end-user-focused services, they typically offer B2B services and sell new data to other B2C companies and public agencies, or they generate new data through data aggregation that collects, mixes, and integrates data from other sources. However, there is substantial competition between similar companies, while GD is also highly technology dependent and affected by improvements in newly available technologies alongside high operational costs.

Figure 21 illustrates the service system for GD. GD is mainly a B2B company that supplies geospatial-related technology to others and plays an important role in every single part of the GIS market. Although these types of mapping service systems are not exposed to the general public and end users, GD produce the most accurate information in terms of detail, scope, depth, and breadth of terrain data using their own technological capabilities, for example sensor development, terrain measurement technology, and high specification equipment. As shown in the diagram, they mainly work in fields such as public transportation, hospitals, insurance, retailers, local public offices, and other public and private sectors. While providing their data to digital platform enterprises in particular, their activities are not directly visible to end-users. However, their role is crucial, and the diagram presents a small section within the service ecosystem. The impact and role of GD are fundamental in developing maps/mapping-related products and services via authoritative geospatial data.

5.5. Case 3: Type C. Whereabouts London map (data visualisation, make data sensible)

About Future Cities Catapult, Whereabouts London project

Future Cities Catapult has a large portfolio of city data-centred projects, many of which include partnerships with local authorities promoting the success of the smart city by addressing the lack of standardisation in data technology.

One of the notable projects is an interactive map, Whereabouts London (WL), which is a web application that allows people to explore clustered regional data about the Greater London Area. As an ongoing mapping project, Whereabouts London has been developed between Future Cities Catapult and the Greater London Authority (GLA) as a collaborative research and development project using publicly available datasets from the GLA's Datastore and open source code. It was been launched on the 23rd October 2014 with great interest and publicity. Whereabouts London and London Datastore2 have explored how public open data can be used to help cities and citizens to see their environment in a new way. They have also demonstrated how London could look like if a new boundary was drawn by blending different types of datasets that are openly available. The map represents a way to map areas of London based on how citizens and neighbourhoods behave rather than in relation to place.

5.5.1. Increase connection of geospatial data resources

Since the Mayor of London announced London Datastore 2, the second iteration of the Datastore project launched on 23rd October, 2014, the upgraded data sharing portal has designated over 500 datasets to be downloaded and accessed through APIs in order to help citizens, local authorities, businesses and professional organisations, researchers and developers to understand the city and develop solutions to London's problems. The original London Datastore did not host available data relating to aspects of London life such as health, crime, employment, and carbon emissions statistics, which are now available. Users can also now request new data sets and suggest analyses. There is also a City Dashboard representing how the city is performing against key performance indicators, which allows users to interact with data and drill down further. The Datastore supports and showcases several hundred applications backed by data such as Whereabouts London, Bike Share Maps, Citymapper, and so on (GLA, 2017).

The London Datastore was previously supported by non-profit organisations, and the Open Data Institute (ODI) and Future City Catapult (FCC) played an important role in the Datastore scheme. The GLA had committed to release open data to give developers confidence in the provenance of the data available for the FCC's Whereabouts London map project, which launched in conjunction with Datastore 2. The earlier Chief Executive of Future Cities Catapult and a Smart London board member commented that 'Data will increasingly drive how we run our cities and our businesses'. As part of their initiative, the FCC created the Whereabouts London project to assist users in considering the built environment in a new light, thereby underlining the importance of data and the role that government can play in harnessing innovation as data.

The collaboration between the FCC and GLA, in terms of collating data to produce a digital platform in the form of interactive mapping, focuses on the city's demographics. This map emphasises the need for increased collaboration between cross-sectors and promotes public data and digital solutions for the purposes of experimentation and data sharing, thereby making better use of public goods (i.e. public data) while improving the understanding of how people behave in the city. WL used 235 types of datasets drawn from a huge number of sources about both local places and the people who live there. The data includes: age, occupation, educational qualifications, car ownership, local parks and open spaces, even the number of photographs uploaded to Flickr, which taken together create a profile of a neighbourhood and its inhabitants. Based on the similarities that characterise people and places, WL's map looked at other snapshots around London based on sorting places into one of eight categories. These are not defined by physical location but are based on the type of people in the city. In this way, people can see their surrounding neighbourhood and help the wider citizenry who live there to see the area in a different way. Indeed, the WL map connects all these disconnected data into a mapping platform in order to see what insights emerge. Typical maps represent a place but not the people who live there and their lifestyles, whereas WL clusteres different sources of data (mostly numerical values) into eight contexts, which are, interestingly, not necessarily under the oversight of the same local authority.

The result represents London and its citizens in a visually prominent way, despite many Londoners already being aware of the differentiation of the city's areas. In other words, although it is divided into 33 boroughs, some parts are reflected in other locations. Many boroughs have different types of societies, for example young people are gathered in rental houses in east and south London. The elderly is spread farther away. The wealthiest boroughs of Kensington and Chelsea almost exclusively wear uniforms, whereas northwest London, for example Willesden, has the highest proportion of foreign residents working in sales occupations, while poorer people are in social housing. In this way it has potential implications for the way in which local council services are provided, and whether housing, hospitals, and schools can be built across borough boundaries ('Data-driven cities: City slicker', 2014). This means that developers and researchers can collect further data and work towards generating novel insights in a new way. Indeed, the data indicates insights and patterns when it is linked under certain contexts and represented in a given map compared to when it is dealt with by different organisations.

Image 39. Platform for city data visualisation (Image credit. Future City Catapult)

5.5.2. Data aggregation and visualisation techniques

In order to build the WL map, a great deal of effort was exerted in terms of integrating a range of data from various sources. WL used new spatial search functions to extract data about neighbourhoods across the city. The team merged these with other data sources from the Food Standards Agency, the Office for National Statistics, the Land Registry, OpenStreetMap, Flickr, and Transport for London (*Whereabouts London*, 2014). It analysed over 235 open datasets with machine learning techniques to redraw the map of London. As illustrated in Table 13, WL were able to build interactive maps representing 33 London boroughs, illustrating the similarities and distinctions across traditional boundaries by bridging information from these different sources. To build this distinction from numerical value data, WL used an algorithm called K-Means Clustering[18] to identify neighbourhoods with similar characteristics.

As listed in the table below, various data sources are handed by different departments or organisations in statistical raw data formats (.csv) rather API, such that the developers involved had to connect them together in order to allow their visualisation. WL has been developed in collaboration with technologies, data scientists, and front- and back-end developers to build an API-supported AngularJS19 app that allows users to explore map boundaries. WL used mashup tools which help to identify where boroughs could share services, provide better services to their citizens, or even to help people searching for housing in a new part of town. The k-Means clustering provides code to map clusters and polygons using R-script.20 This code uses Weka21 to integrate the input characteristics with the cluster and execute k-Means clustering on the command line. This code is written for the automation of k-Means clustering. In addition, R-script is a process that generates the resulting cluster map quickly and is typically performed manually in Quantum GIS

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[18] K-means clustering is one of the simplest and popular unsupervised machine learning algorithms.

[19] AngularJS is what HTML would have been, had it been designed for building web-apps.

[20] R is a programming language and free software environment for statistical computing and graphics supported by the R Foundation for Statistical Computing.

[21] Weka is a collection of machine learning algorithms for data mining tasks. It contains tools for data preparation, classification, regression, clustering, association rules mining, and visualization.

(QGIS)[22]. R scripts require shape-file geometry and cluster output and can be found in the R subdirectory. Initially Weka was used to categorise the data, but R can perform its own clustering.

Image 40. Cluster maps, whereabouts London (The Economist, 2014).

Image has been redacted.

The Economist, 2014. Data are slowly changing the way cities operate. [Online]. The Economist Website, [Accesses 12 December 2014]. Available from: https://www.economist.com/britain/2014/10/30/city-slicker

Dataset name	Data Source accessible by LDS (aggregation of government data)	Open/ Close	Free resource	Format
Adult Qualification Level	Census (Office for National Statistics)	Open	Free exc. Registry	MS Excel (.csv) or PDF
Age Profile	Census (Office for National Statistics)	Open		
Car Ownership	Census (Office for National Statistics)	Open		
Central Heating	Census (Office for National Statistics)	Open		
Crime	London Metropolitan-Police	Open		
Distance Travelled to Work	Census (Office for National Statistics)	Open		
Dwelling Type	Census (Office for National Statistics)	Open		
Establishment Type	Census (Office for National Statistics)	Open		
General Health	Census (Office for National Statistics)	Open		
Greenspace (Local Parks)	Local Authority	Open		
Hours Worked	Census (Office for National Statistics)	Open		
House Sale Prices	HM Land Registry (Price Paid Data)	Paid		
Household Composition	Census (Office for National Statistics)	Open		
Location (Boundaries)	ONS Geography Portal (Office for National Statistics)	Open		
Location (Centroids)	ONS Geography Portal (Office for National Statistics)	Open		
Main Language	Census (Office for National Statistics)	Open		
Method of Travel to Work	Census (Office for National Statistics)	Open		
Occupation	Census (Office for National Statistics)	Open		
Passports Held	Census (Office for National Statistics)	Open		
Places to Eat	Food Standards Agency	Open		
		Open		

[22] QGIS is a free and open-source cross-platform desktop geographic information system application that supports viewing, editing, and analysis of geospatial data.

Pubs	OpenStreetMap	Open		
Social Classification	Census (Office for National Statistics)	Open		
Tenure of Dwelling	Census (Office for National Statistics)	Open		
Flickr Photo Count	Yahoo Flickr Creative Commons (Hosted on AWS)			

Table 12. Whereabouts London data sources and format

5.5.3. Representation of geospatial data into knowledge

London's boundaries have been divided and merged over hundreds of years, but always based on geography rather than people's activity. As data continues to grow, people can think of places where citizens live in completely different ways. Using data from London Datastore and other publicly available datasets blend various sources to understand London's demographics and how its people live. Whereabouts London (WL) is a data visualisation experiment using open source data and was designed to commemorate the launch of the second phase of the London Datastore. WL highlights how much residents value the independent boroughs and also the enormous spending power of households living nearby that could potentially continue to improve. People understand space as a hybrid, a space between the physical and the digital in which urban life takes shape through the space in which people reside and which is also shaped in accordance with dynamic places (e.g. trips to and from work) or static places (home, work, leisure, restaurants etc.) which are understood and placed under a given theme.

Integrating data from the Food Standards Agency, the National Office for Statistics, the Land Registry, OpenStreetMap (OSM), Flickr, and Transport for London, the WL map clusters London into eight matches based on similarities between people and places. For instance, looking at areas and people with similar socio-cultural backgrounds, they are not based around the same borough., i.e. they live in different parts of Greater London. Even so, modern urban spaces are no longer simple. Indeed, Whereabouts London map is just one way to interpret data to understand what makes our local areas similar to, and distinct from, each other and the same information can be used by anyone to create their own map to suit their needs and interests.

The WL map has been used as a container for all these various data sources and turned into an interactive map. The FCC Project team used Mapbox as a map platform, which mainly uses OpenStreetMap-derived geospatial data, and which also contains Ordinance Survey Geographic Information data. To fulfil people's dynamic urban desires, a number of photos from the photo-sharing social media platform Flickr API have been used. While Ordinance Survey and other GIS organisations have published Points of Interest (POI) reflecting their uniqueness of service, WL used a Flickr photo count as a POI. All the photos are taken by either residents or tourists and include geographical locations as collected by users' mobile phone GIS. The WL project team were able to look at the number of photos and where they were taken, thereby identifying which areas are of greater interested and tagged more often. In this way they were able to extract information about public interest in certain areas while also spotting areas which are not normally informed by Open Data. By merging social media and open data into one map platform, the WL map illustrates areas in different ways.

Connecting open and other geospatial data can be potentially important and useful to a wide range of people and organisations, however the way in which people use it to create something based on a user-friendly interface is even more important**.** Making sense of statistical information by placing data on the WL map can provide useful insights. In addition, WL interactive maps are used to correlate people and locations using city Big Data (mainly based on the National Census) as the basis for interactive maps (Catapult 2015). In the WL map, when users hover the cursor over a map, the colour code is displayed in the linked location and illustrates demographic information. For example, the east side on the map represents 'Whereabouts 1' whose residents are 'professional and well educated'. This text describes the group as 13% of the city's population, with the highest degree level, who are also are more likely to commute to work via train; they have above average rate of home ownership and are more likely to work in professional and technical occupations.

Image 41. Whereabouts London Zone 1, 2 (Future Cities Catapult, 2014).

Image has been redacted.

Future Cities Catapult, 2014. Whereabouts London Maps. [Online]. Whereabouts London Website, [Accesses 12 November 2014]. Available from: http://whereaboutslondon.org/#/map

A slightly different group is identified as 'Whereabouts 2' which reflects residents who are representative of the London average, but score higher for racial diversity than any other neighbourhood. As a group they make up 12% of London's population, they have the highest proportion of foreign residents; are more likely to work in sales occupations and have a high proportion of family households with children. Like any of these mapping exercises there is much to consider and discuss in the detail, but it makes for informed way to look at London's areas and their surrounding neighbourhoods in a new light.

An open citizen database on which the map is based is one of the most fundamental aspects of the project, one that facilitates easily accessible information in the public domain. Indeed, and citing its historical lineage, WL refer to their data maps as being like John Snow's Cholera map or Charles Booth's Poverty map in terms of bringing the value of visualisation to the attention of—and thereby befitting—London's citizens. In addition, the design value of data visualisation in WL certainly helps make city data easier to understand.

5.5.4. The sharing of code with the developer community in the service ecosystem

There are potential benefits to the use of a WL-like platform. For example, local authorities can explore how to share their services with other authorities, while transport providers can offer travellers much better services. Local or regional complaints targeting citizens and behavioural changes (i.e. waste management, energy saving, etc.) can be generated in new ways; real estate can also use it to promote or plan new developments in target areas based on customer preferences (i.e. nearby schools, green areas, ease of access to public transport, etc.). WL potentially provides a short guide for individuals and organisations. However, the WL project has not developed into further services due to conflicts between some local authorities based on a sense that people may develop misconceptions about areas especially where there are higher rates of crime and social housing, for example.

Therefore, all the code sources and tools generated for creating map clusters have been released to the GitHub developer community, where 28 million developers work on reviewing code, managing projects, and building software. Indeed, the WL team released and also published a technical guide and step-by-step tutorial so that developers undertaking similar initiatives and seeking similar solutions can utilise mapping open sources for further development of its usage.

5.5.5. Value and beneficiaries

Before making sense of the data, first it needs to be available and connected in such a way that it can be handled by local councils. As more data is released, the city is also able to analyse them itself. The Assistant director of intelligence at the Greater London Authority (GLA) claimed that using data to gain insights and make decisions across the city is tricky. One of the most substantial problems is that the GLA does not control every service in London boroughs; instead each local authority has their own processes and services in relation to local issues such as social care, waste collection, street parking management, and so on (fieldnote, 6 July 2016). Also, different levels of data and information are available to private third-party contractors, who may run the service in each borough differently.

This raised the question of whether releasing as much as data as possible while letting developers find solutions is the best way, and also of who should create solutions based on the city's data—both subjects for debate. As part of its support for data aggregation, FCC has installed sensors to monitor air pollution in order to advise councils and related companies that report statistics regarding how to deal with pollution more effectively, so leaders of the local authority will also need to learn how to use data effectively. In addition, WL maps project have experimented in the sense that they represent how citizens live, thereby indicating London's major issues (i.e. housing), which will potentially influence city planners.

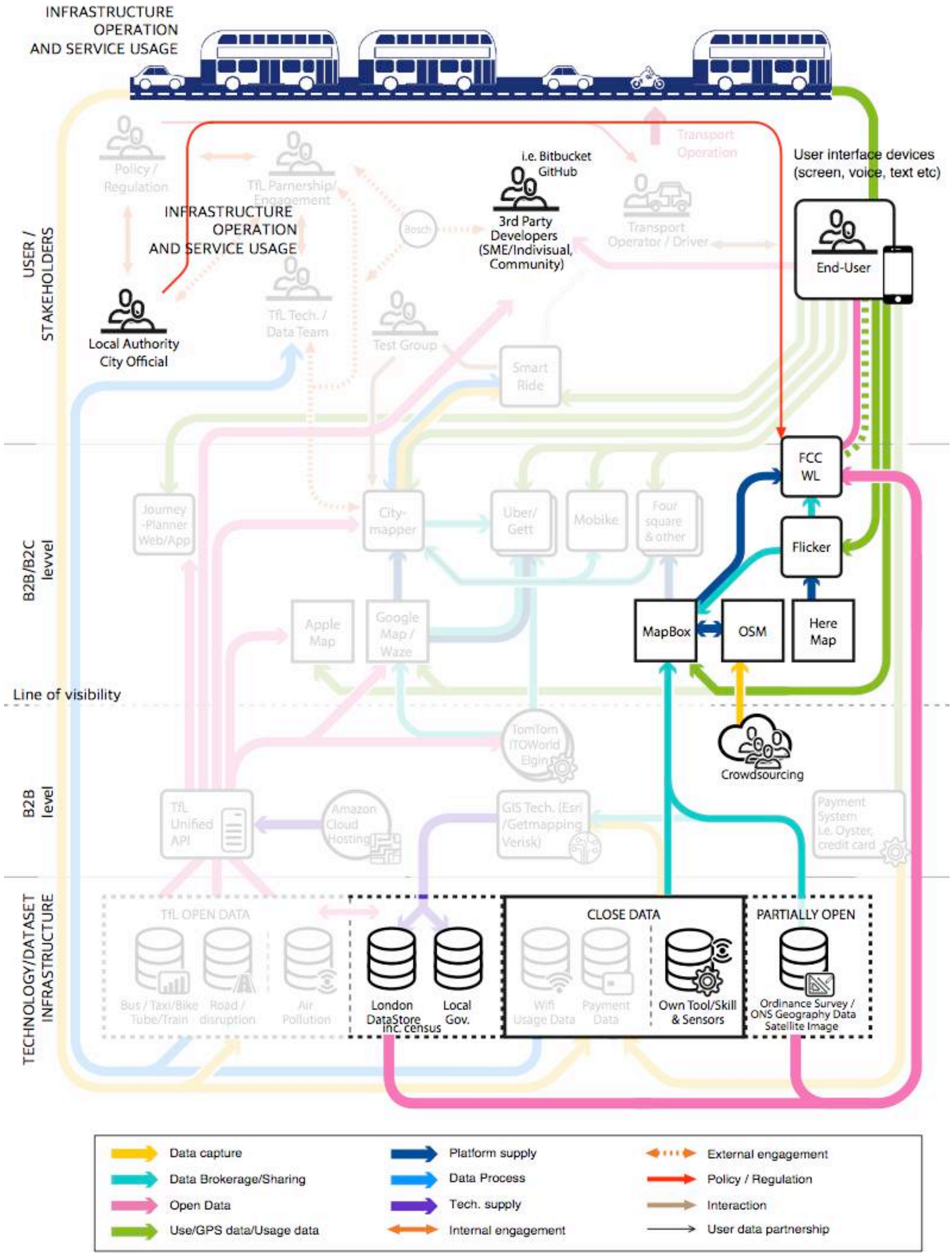


Figure 21. Whereabouts London (eco)Service system (drawn from Case 3 findings as of 2017)

Summary

As a result of the case study 3, the diagram provided in Figure 22 demonstrates the service (eco)system for WL. WL maps developed mapping services using various open data as free resources and a third-party basemap platform (eg. MapHere) that displays these data. Unlike other cases, the development of WL maps does not require any investment of resources (i.e. data, use of other maps platform). Instead they integrate Open Data APIs with other types of crowdsourced free data like Flickr API. The main task in developing WL maps was to design the logic of how these datasets are interactively connected to API, thus display compelling forms of visualisation of data through specific programming language. The geospatial open data derived from the London Datastore, Ordinance Survey, and Office for National Statistics are in Excel (csv) format and users cannot be read it unless laid out on the basemap platform.

Although a wide range of data visualisation on WL maps reveals data patterns in terms of insights upon specific locations, there was lack of direct user engagement that could turn it into a real service implementation or service opportunities due to limited advanced communication amongst relevant stakeholders. The opportunities lay in the useful and valuable reference for residents, government agencies, and private companies such as estate agents, helping them to make more informed decisions and to develop other related services using insight derived from various data visualisation through maps.

The WL mapping service is experimental and seems to be a good attempt to simply express information that is difficult to verify with information provided by the existing councils. The main challenge appeared to be a lack of early engagement with possible stakeholders becoming involved in the service ecosystem. For example, advanced communication and engagement with local councils rather than regional authorities would give the WL team a better understanding about specific restrictions or inexpediency of the local council.

Instead, the WL map was released in the developer's community so that the data source and development guide, tips and techniques would be open to developers who might benefit from using WL maps. WL's experimental work would not be feasible if there were no freely released tools to visualise various datasets such as the government's Open Data, social media data, and the use of free map platforms. This means that the greater the number of collaborations with other actors, as shown in the service ecosystem diagram, the more likely that the real value of the service will be appreciated.

5.6. Case 4: Type D. Citymapper and SmartRide (making geospatial data valuable)

About Citymapper (CM)

CM has around 50 staff and provides transport transit services in 40 cities, with its headquarters is in London. It is a venture capital-backed, and raised £32 million investment for its urban navigation apps; while its valuation is likely to be in excess of £250 million (2017). The CM app offers routing services like Google Maps, but based less on mapping and more on getting from A to B, integrating multi-urban modal transport, from walking, cycling, to driving, all with an emphasis on public transport. CM aims to enhance users' everyday journeys whereby people use it to find a bike to hire, plot a route to a meeting, or work out how long it will take to get home. In addition, their service is underwritten by user-generated data (crowdsourcing), derived from open data (provided by transport authorities), and collected by the locally-employed community.

While TfL provides the transit data, CM collect and analyse their user's usage data based on their service usage along data provided by TfL open data. Learning from the accumulated data, CM continue to develop upgraded services based on an iterative project and have made this into new services (e.g. Black Bus, SmartBus) through their knowledge of user behaviour in collaboration with other service partners such as Uber, Gett, Mobike, and Zipcar. This service provides real-time demand information, helping customers allocate vehicles efficiently across the network, thereby minimising waiting times and reducing the cost of the mobility infrastructure. Recently, they developed a new service (SmartBus), entering the on-demand taxi market, but the result was not positive in this new service—which differed from their usual routing services.

5.6.1. Utilisation of data as free resource

5.6.1.1. Free resources and openness

Several years ago, there were many debates around open data and whether it should be freely open, particularly when people were pushing governments to open data up. Since then the UK's Digital Strategy has allowed people to reach their goals by making data more accessible, while the increasing availability of open data has coincided with an increased demand in transport, retail, and restaurant sectors across London. It has created demand for improved information services, thus raising the value of the digital economy market by approximately £30 billion (Deloitte, 2017). In particular, companies like CM were granted substantial benefits in terms of access to and utilisation of transport-related open data. Data can certainly be one component when creating a product/service and offers new insights that possibly lead to better services in the long run.

While many companies prepare to realise innovative ideas, small companies like SMEs and start-ups often experience limited initial capital and sometimes insufficient resources to realise their idea when they plan to start a new business. This also applied to CM when they planned to develop a new bus application service. CM launched a bus transit service in 2011, incorporating open data such as live feeds of bus timetables, real-time transport data, disruptions and planned road works in the app. The number of CM map-app users has grown fast as an alternative to mapping services offered by Google Map and Apple Map as a form of public transport open data that advises users on hoe to get to their destination easily and quickly. This changed the way bus routing, choice of public transport, and fares information was made available, moving towards a multi-modal format so that the customer experience could be designed using this freely available resource in a substantially more useful way.

In an interview in TechCrunch (2016), the founder of CM said that he believed that opportunities were created through access to the free dataset that government agencies hold. This data was thought to have helped many other businesses (including them), although the agency was building something for their own purposes—even if it seemed like their role was as an infrastructure company rather than a public endeavour:

> *First because back then we wanted a focused app and to solve a smaller problem because we're starting with no resources and I think when I felt like there was no opportunity to fundraise…*
>
> *When real time data happens, it is incredible.… I mean the open data thing…and I think we've benefited from that.*

By opening data and allowing other businesses to work with it, government agencies also receive benefits, including the fact that they improve public transport experiences in return and activate a wider service ecosystem which can help many stakeholders such as themselves, businesses, and users/customers. This means that government open initiatives stimulate other market players to build realisable business ideas, enabling government agency services to be improved while enriching economic value, thereby empowering public service and opening up new opportunities.

5.6.1.2. Data sharing and resource utilisation

The use of open data is certainly one way to realise a business idea and create a service. When CM developed their initial mapping apps service using open data, it was a challenge to receive all the information they needed to make apps much more compelling and valuable to users. Another challenge was the high dependence on open data, which possibility threatened business in the longer term. As is the nature of open data, everyone, including competitors, have access to it and can create something from it—and they sometimes pitch the same idea. For service innovation in mapping, it can be a challenge to specialise when companies use the same set of open data.

In similar way, ODI advise that the first thing to do with data is to find a problem or thematic type of data that exists, rather than seeking the data and then trying to create a problem that does not exist. Thus, the problem should be related to many people, then identifying what resources are available and how these resources are going to be applied and integrated into the business idea:

> *Consider what an ideal solution might look like for the user and then insert open data into along that user journey. So, I'd say understanding how the data is going to be applied in the problem is probably the first thing. [ODI Friday lunchtime lecture, Feb 2018]*

The way CM differentiates itself from other players is that it gathers data from multiple sources, including taxi companies, weather forecasts, places of interest, and so on, and subsequently disseminates its data to other players as well as through partnerships.

While CM used open data to expand the coverage of transport apps, its availability and data quality varied, leading to limitations in terms of utilising open data. In the process of adopting various geospatial data, they developed a number of internal tools that allowed them to create and manage new datasets derived from app-usage data, such as users' transport search inquiries, indicating where they wanted to go, and the busiest areas at specific times and locations. Interestingly, CM also opened up their products/services in a form of API, making their information more accessible. Third-party developers can integrate CM's API into their application, which might benefit the people using it.

As it collects and creates invaluable geospatial data, CM is able to understand the exact routes of millions of people, including where they are travelling, when, and what modes they are taking at specific times and locations of the day.

By collecting open data and disseminating their own, CM is therefore able to obtain knowledge regarding where problems exist in the public transport service and the physical movements of app users while continuously improving the service/app, based on data patterns captured by their own and others' services.

When more people use and navigate more trips with the CM app, more data is generated and accumulated in CM's database, which is of the highest value and is closed to outside users, only accessible inside of CM. It means that more data is generated for them to be able to understand users' behavioural data and to develop a greater understanding from their service usage data. This give them an immense advantage in terms of creating efficient, potentially dynamic routes with profitable factors. This way, CM helps users and other developers ultimately help themselves by receiving back much larger crowdsourced data, which enhances their knowledge and becomes another essential resource CM can utilise. In this way, CM makes their routing service more precise.

While they obtain a large number of users by offering useful information about multi-modal transit information for free (1.74k users rated CM 4.4 in the app store as of March 2018), CM had no meaningful way to generate revenue before they launched a new service (e.g. Q10 Bus, SmartRide). Until then, the majority of their financial resource was investor venture capital. While the app is free for end users, they can sell or share their data too, which would be valuable to city businesses who can act on a large dataset to find other ways to attract customers and businesses.

5.6.2. Technology and technique: Configuring data into a map platform for a better user experience

The development of digital services for consumer transport applications is CM's main activity. Their primary value activities are data engineering and product design (namely, application design), thereby delivering an ideal solution for a better transport experience. CM spends nothing on marketing to acquire new users, but they do invest in making good products—in the process attracting users and supporting their needs as the focal point of service development. In order to do this, CM maintains an exceptionally lean and iterative practice regarding the improvement of products, while exploring new service opportunities for customers.

CM is a relatively small company, consisting of approximately 50 people working in mainly three divisions, namely business operations, data engineering, and a product (or design) team that are related to their product and service. CM needs a data scientist and engineer to configure the various data provided by TfL and others, as the data is not always correct or transferable when it combines with other datasets and it is quite demanding work.

The engineering and design activities in CM service consist of extensive data mining when they combine various types of data. CM embraced open data from its inception, and it was a core component of how CM apps worked. They initially started interacting with sources of open data regarding whether they could make this data generate more rich insights just by glancing at it. The skill here is in differentiating the service from others in terms of the capacity to process data and extract unique insights, thereby mitigating the risk of dependency on public open data.

> *There's a lot of work that goes on before. we even decide to bring a dataset on board to validate the impact that data will have for a customer and solving a specific customer problem, so we want to understand who the customer is, where the friction in the points of data is. [Interview 21.H]*

CM data sources are not only related to open data. CM works with third-party data providers and generates data itself by combining different datasets. It is often able to extract additional insights by going beyond the input of either of the original two datasets. By gathering together and linking authoritative sources from not just open data but all types of information, this means that when CM reviews open data it considers how it will link up with other data sources it has access to and evaluate how much of a challenge it will be. For example, the proprietary source of information and authoritative open dataset that they weave into the App product is combined with other sources of data to become a complement of the foundation, and this helps them to improve the level of care over data and endeavour to make it reliable and trustworthy.

The importance of collaboration across teams and the advantage of being a small team with a flat organisational hierarchy has also been recognised—CM's ability to consult, communicate fast, and to use efficient processed based on problem-solving is apparently cross-functional in this case.

To enhance the effectiveness of their task-based practice, CM has designated a couple of days each month to facilitating a collaborative working environment, called 'Product Day'; all employees have to participate and vote on tasks including who should be taking care of what, while also selecting new ideas in relation to short- and long-term goals. Depending on the kinds of problem and expected solutions, a specific team—whether data, engineering, or design, depending on the nature of the problem and its solution—is selected to lead a given initiative in a democratic way.

In this process, problematisation and higher prioritisation initiatives are defined by the senior management team, namely those that would impact on wider business goals, while low prioritisation tasks are selected by employees in a voting system. Once the tasks have been chosen, each team prepares an idea for solving the problems, whether they are department units or a collocation of individual members who are pitching a solution and new idea in given time.

> *... not one department is leading but involves all team [which is made up of] engineers, designers, business people, and the senior, CEO... then the rest of the team meets two days later. We are pitching projects and improvements that we want to see happening and people are voting and there is a discussion [and] all that ... [interview 6.1.0]*

Since the task is cross-functional and, in a sense, multi-division is involved in these projects and tasks, the tasks are achieved depending on the nature of the skills available. When the problem is more rooted in the back-end system, then the engineering team leads the tasks. On the contrary, if the problem is more complicated and related to the customer experience (UX) side, the design team discuss the right thing to do at the development stage. The design team is not usually involved in projects or tasks at the initial stage, including defining needs and new insights that could possibly lead to new service opportunities.

The main role of the design team in CM is to coordinate across other departments, essentially focusing on the product's (app) frontend feature enhancements, UX (user experience), and User Interface enhancement, while testing prototypes and creating graphical communication (e.g. marketing materials for internal and external pitches); while the data and engineering team focuses more on identifying problems and gaps in datasets in relation to the data and the backend system.

This is because the 'trustable' and ease-of-use are at the core of CM mapping service principles, as something derived from their data, which is essential to the disciplines of data science and engineering. Design seems less involved in this space, especially in identifying service opportunities, however, as D1 states, design does support the user's convenience and ease of use, which are prime points of service—thus the design discipline might be more useful here than other disciplines.

> *'trustable' all comes from data. Design doesn't have too much back of trust.. [interview d1]*
>
> *…we are a very small team of three designers, one user experience researcher, one lead design and UX design [meaning product design], one for branding and marketing communications [meaning graphical work]… [interview 6.2.2]*
>
> *We cannot always design or fix things before it goes live; [we] launch it and every week try to improve….[it is a] very iterative processes and there are a lot of phases at the end of the process … because we are such a small team and the cycle of development can be four weeks or sometimes even one week… [interview 6.3.2.]*

Despite the recognition of the importance of the design process, day-to-day work is highly concentrated on the techniques required to enhance specific features in relation to specific UX design problems. It appeared that in these processes, often the decision-maker asks to be 'shown the thing' as a first step, i.e. to grasp the phenomenon.

CM is also identified that the adaptation of the design process or design methodology based on specific design steps—such as user research, personal development, service blueprints, touch points and so on, all of which are related to service design tools and methods—can be highly beneficial from a design point of view, as well as the ability to prioritise a list of problems and to measure their impact and suggest a new solution. This approach involves, rather than a highly specialised single skill, a multi-skilled workforce that influences other teams (T-shaped skills). This knowledge and these practical skills can convince the senior management, particularly when the firm has limited resources in a short period of time, due to the pressure to release products in order to meet users' needs in a highly competitive environment, according to Designer.

> *... there is no proper design process. So, you know, the proper service design, do user research then personas, then service blueprint, then look at the service touch point, you touch them out, etc. ... it's very, very, important to have this knowledge as practice processes… but here they run like: what is then solution? 'show me the thing' ... and there is lot of phase of end of process needed... because we are such a small design team and the cycle of development is so short we have to find the way to convince them of the proper design processes...[interview d1]*

This suggests that the design team makes a less substantial contribution in terms of leading service innovation, but they still play a critical role in advocating new approaches that are relevant to their service end users.

For these reasons, there is a space for opportunities between the ideal design process and the implementation process, a balance between a fast-iterative process and ideal design process in terms of realising an effective design output based on making the users' experience more convenient and easier:

> *Everyone is aware of this but [time is] very short... a balance is required. I believe we fit together... our design processes need to be proven and not everyone is aware of the design process... communicating and prioritising them as a senior impact pitch problem... which is prioritisation; there are real tasks to do, so this is what we are doing, a little bit in rush... [the] point we should improve is the internal methodology: to think about the way we design a service. But the reality is so short; we have to find ways to convince the design processes…*
>
> *there are different types of design we deliver and, ideally, we are looking [to be] good at one thing and [to] teach others... good service should deliver win to win, win for many stakeholders, whether internal or external… [interview 6.5.2]*

5.6.3. Maps as service component and a new service offering

It is recognised that CM has a unique service offering and that this can make them distinctive compared to others. CM's founder has emphasised the significance of developing its service idea to find a useful problem, and has talked about his previous experience struggling to make sense of the bus system in getting from one place to another in London. The open data only came later, resolving the problem by adding data to mapping apps, thereby ensuring that people reached their destination more quickly:

> *I wanted to be a product person and build something, I mean a useful problem we can solve… a lot of people wanted to understand how to use the transport better so the whole importance of this kind of bus is to create a comprehensiveness that is everything about the app. [TechCrunch 2016]*

CM initially developed transport apps that represented information about how to get from A to B through the Bus-map app. This included information about real-time ETAs, timetables, waiting times, and public transport transits through their unique route-planning algorithm. The mapping service started to improve journey planning based on a mix of public transit options (buses, tubes, trains) and commuter transit experiences, and they soon expanded to wider transport choices by combining transit and cars for city-based multimodal mobility.

CM is increasingly being compared to Uber rather Google Maps. Indeed, CM's aim is to create highly sophisticated systems that link data from buses, trains, and even taxis on (mainly) commuters' smartphones. The tool they have developed improves and fixes transport open data that many other mapping service companies use (likes Google, Uber, and Waze). Accurate and reliable transport information for commuters and ultimately redraws how the city transport system works. Although they are a transport mapping app company, CM does not invent map platforms but essentially uses Google Maps as a base map with add-on data. It is generated by dynamic algorithmic software and live open data feeds which identify traffic hotspots as well as where people are trying to get to.

CMs mapping service is backed by 'fixed' open data; while providing instant routes and real-time ETA predictions, CM has also integrated other mapping services like Uber and Gett so that they are able to provide multiple mobility-based information, thereby reacting to users' demand, choice of travel mode, and budget, making CM as a single point of access. The CM transport algorithm and data on its mapping application not only helps users to have a smooth transit experience, saving them time and expense, it also returns empirically improved data to the government transport authority.

While CM has provided travel information to app users, it has also collected invaluable caches of user's search inquires, destination points, and app-usage data from its application platform. With data generated in their app, CM has been able to learn how people use public transport and is able to identify where transport infrastructure gaps exist. In recent years, CM has recognised a large gap in the tube network in particular areas and times around London based on the accumulated user data. The latter data has been collected in collaboration with a taxi-hailing service called Q10 Bus, which aims to make better use of space capacity in taxis (sharing black cabs) while sealing public transport gaps.

The solution offers clear environmental benefits: shared transportation and support transport running on underserved routes during rush hour. Thus, this helps the map-based application to attain leverage in a way the public sector cannot. There are benefits for both sectors. The transport authority has a better view regarding where transport and infrastructure gaps exist and how people tend to move and travel within the city network, while CM shares the outcome of service usage. In this way, CM helps both the government agency and the end-user, who is also a customers of public transport services.

Image 42. Citymapper app (ArchDaily, 2017).

Image has been redacted.

AD Editorial Team, 2017. Citymapper, World-Renowned Urban Mobility App, Launches London's First Pop-Up Bus Route. [Online]. ArchDaily Website, [Accesses 14 July 2017]. Available from: https://www.archdaily.com/870884/citymapper-world-renowned-mobility-app-launches-londons-first-pop-up-bus-route?ad_medium=gallery

5.6.4. Data partnerships and collaborative activity in the service ecosystem

Certainly, data partnerships with other players who have similar target customers is a possibility. Simply having the option of browsing other transport modes in one app, for example, Uber and a Gett taxi, would mean that all parties would achieve mutual business goals. For example, if one party acquires some slice of the taxi charge and another receives a potential customer who might need a taxi hailing service.

To increase the service opportunities, it was recognised that CM needs to continuously identify collaborators and partners who have shared goals based on mutual benefits (i.e. the partnerships between TfL and CM, Uber/Gett and CM). An understanding of the market's value chain is key to starting to build up relationships with partners and collaborators. With a deep understanding of the partner's business goals, CM can identify interested parties whose support might be needed before and during the project's progress. Moreover, value should be something exchangeable between each party in order to reach certain business goals.

For CM, all its valuable assets are in their data and the tool that generates the data. Clearly, data is a big component of its service while also being an enabler for people to develop these products/services. It is also about how emerging technology and data can help both parties' businesses to run more efficiently, thereby reaching their goals. They have understood the importance of data partnership, which is common practice in CM's business model. The relationship between CM and TfL already recognises that CM is an advocate of the transport agency's open data and they back TfL by helping them meet their customers' needs, which is ultimately what TfL wants to achieve as a public agency. Through this activity, CM has been able to achieve four things.

First, CM has been able to understand how transport networks work, particularly the needs of transport operators, drivers, and passengers. Second, it has learned how to improve existing routes in the fixed transport infrastructure while identifying new and better routes. Third, CM has learned a lot about the public transport operations and the city. Lastly, they have gained the know-how required to be granted a licence by TfL.

Having all this knowledge and conducting a number of bus–taxi hybrid service trials, CM has invested in their own new hybrid bus service that is fully integrated into apps and has been tested (SmartRide tested, May 2017, launched Feb. 2018).

This service offers real-time integration with existing CM routing apps that track buses, book seats, and show the number of passengers already on board. It also involves sharing a ride model similar to Uber Pool. Unlike the Uber app, all rides will be shared, and the minibus only travels on predefined roads with passengers getting dropped off and picked up at fixed points. Users (i.e. passengers) will pay with a credit card connected to certain apps, offering an affordable price between that of a bus and a cab, and a fixed charge based on the travel distance and time of day. The service is also fully partnered and licenced by TfL; while Uber, on the contrary, has experienced many controversies in terms of licensing.

Additionally, there is another dedicated app for drivers, and CM has transformed the traditional bus system (i.e. the old paper scheduling and operational management system) into a digitally wired system that is far more efficient. It is also integrated with the existing transport infrastructure, so that passengers can swap to other transport modes whenever they need. CM has moved from being a digital mapping apps company to an on-demand minibus operation service for a fraction of the price of Uber. It represents how CM has attempted to improve the fixed physical transport system by developing new solutions, showing how things can work better for wider urban stakeholders by expanding their service and aligning public transit services. Although CM's busses received public interest when they ran a few trial days of 'on demand' SmartRide (Tested on March, 2017, launched on Feb 2018), their solution had to be amended due to requests to meet TfL regulations. Furthermore, while CM introduced its first commercial bus service, they have faced a critical problem operating in London, namely the regulations just mentioned.

During the trial, CM gathered enough data to tweak the route in a more efficient way over the first week of the trial, However, TfL obstructed their responsive route-changing, requiring them to apply to the local transport authority for permission, which involves a lengthy approval process. Their initial idea on-demand fleet initiatives (meaning real-time driving route changes) failed to receive permission due to TfL's strict regulatory frameworks (Announced Wired, Financial Times, Feb 2018). CM had to change its initial plan from a fully responsive bus to fixed route-running minibus/van service, which hinders its innovation. Additionally, this affects not only CM but applies to all other high-tech transport companies. It is imperative to be aware of and meet the regulatory provisions enforced by TfL, as failing to do so may result in a revocation of permissions and licences.

This was a big challenge from CM's perspective, as they had to change their initial purpose by operating a 'fixed-route' rather on-demand responsive operation, and also changed from responsive bus to PHVs (Private Hire Vehicles, such as taxis), as PHVs are less regulation-bound. As they detailed in a blogpost, this fell short of their expectations because the company '[b]uilds technology for the old bus world, with all its constraints', meaning regulation (Wired, Feb. 2018).

Image 43. SmartRide, Citymapper (Citymapper, 2017).

Image has been redacted.

Citymapper, 2017. Introducing the Citymapper Smartbus. [Online]. Citymapper Blog, [Accesses 08 May 2017]. Available from: https://medium.com/citymapper/smartbus-7b6848241526

It is the norm for city agencies to fulfil wider stakeholders needs with respect to regulation and balance, rather than focusing on public needs. It is essential that organisations have a thorough understanding of these regulations and conditions in advance, thus prioritising ongoing early engagement or open dialogue with key stakeholders and actors in the wider service ecosystem. As such, service providers can understand where the obstacles may lie.

5.6.5. Value and potential beneficiaries

Since CM has run several series of mapping services based on open data, it has gained a lot of empirical knowledge that is useful for further service development opportunities and potentially other urban stakeholders too. One example is their latest service, SmartRide, which has taken three big steps in terms of service transformation towards the launch of a new hydride bus-taxi mapping service that will emerge from the basic bus–transit mapping app.

Until several years ago, we had only very basic public-transport mapping services backed by open data, where the basic service provided the information to CM about how people move and how transport is operated at specific times and locations through their mapping platform. Knowing how people are moving, where they go, and where the busy areas are is an outcome of mapping service usage; as a result, CM was able to identify gaps in the fixed infrastructure and offer a responsive, on-demand service as their new brand.

Each of phrase of iteration was back up by data mining in collaboration with an external community of developers and users, meaning that developers could gain practical knowledge for their future service ideas, while users have the opportunity to voice their expectations during the testing period. Ultimately all these collaborative inputs allowed CM to gain empirical information about their future services and benefit from the small size of the company.

Image 44. SmartRide service proposition (Citymapper, 2018).

Image has been redacted.

Citymapper, 2018. The Responsive Network (Part 3/3). [Online]. Citymapper Blog, [Accesses 22 Feburary 2018]. Available from: https://medium.com/citymapper/the-responsive-network-part-3-3-f9d8394d84f3

Although the outcome of SmartRide is not yet visible, it is not clear that it should be seen as failure, even given the alteration of CM's initial service offering due to regulation; but it is clear that they have speedily expanded their service coverage and the number of registered users has sharply increased during the short operation time. Based on this, it is evident that CM have gained a great deal of practical knowledge and that invaluable data was generated—including user behavioural patterns derived from use of their service—which has a lot of potential. This means multiple urban stakeholders, whether public transport agencies, taxi companies, insurance companies, or retailers could benefit from the new empirical datasets.

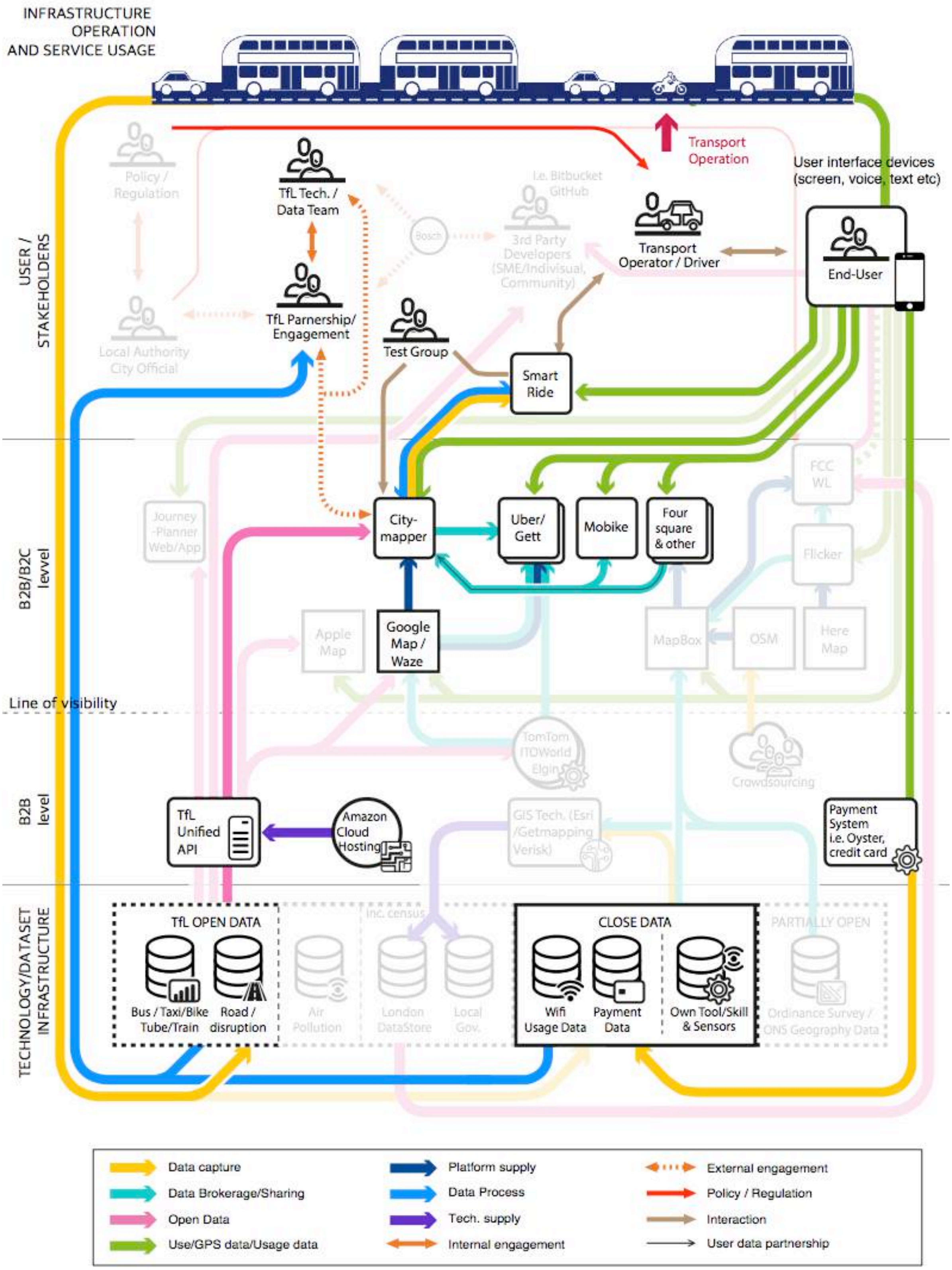


Figure 22. Citymapper service (eco)system (draw from case 4 finding as of March 2018)

Summary

While SMEs and start-ups often experience a lack of business resources, the open data initiative acts as a free resource for them, one that often creates opportunities and stimulates new service opportunities. The challenge is to collect the valuable data and information needed. A high dependence on open data may result in a lack of unique business ideas. There is also a need to develop their own tools and ways to create and accumulate various datasets within CM. As a small company, they actively engage with internal and external customers to understand feedback regarding what is working well—which helps them to improve. They follow an iterative process on the release of each new product. Interestingly, CM involves the entire staff in the process of developing an idea, and goal is customer convenience. The management prioritises tasks based on the most important business goals, and lower priority items are all run by employees through a democratic process of making and delivering better products and services.

Unlike the other service systems illustrated in the previous three cases, CM maintains a considerably larger number of collaborations with other firms/organisations and thus uses more resources within the service ecosystem. It thereby acts as a service provider that is able to achieve new service opportunities, such that more value is created for end-users. They tend not to focus on one boundary within the ecosystem, but connected with others, integrating external resources, whether they are government agencies, public or private firms, as long as the data assets, technologies, and platforms can be transferred between them. One interesting point is that CM exchanges a lot of data resources with other firms, even though they are direct or indirect competitors in the same market, such that end users benefit and derive the most value when they use CM's own service.

While their end users derive more value by using CM's own service, CM also benefits by being able to extract insights about users through service usage data. Instead of heavy dependency on government Open data and others, CM is able to utilise its customers' actual service usage data, from which it can extract more in-depth insights, learning from users, improving services, and further developing new services based on learning from customers' usage data. This in line with the view that the more resources (technologies, skills, and knowledge) that can be shared within a wide service ecosystem, the more value can be generated, which is ultimately the goal of new service opportunities for platform-based enterprises, thus fulfilling end-users' needs.

5.7. Summary

As the result of these four case studies, we see four distinctive areas of each service system (i.e. business) within the wider mapping-service ecosystem. There are four areas of opportunities and each area has different limitations in terms of maximising value. The creation of the service system relies on an interaction across the service ecosystem, which allows all players to co-create value through the sharing of resources; thereby the value of data, technology, and knowledge can be maximised. Each geospatial service system operates independently, sustained by a specific arrangement of resources between the service system and each of their relationships to one to another.

The first case enables common resources to be more accessible to others in order to create value for end-users; the second increases the level of accuracy and the availability of resources; whereas the third case focuses on making sense of geospatial data with insights emerging from the understanding and representation of resources. The final case is based on an optimisation of resource-integration by engaging with wider stakeholders, such that greater value is co-created for final users as well as for other stakeholders in the service ecosystem.

The following diagram, a completed view of the four service systems, presents the ways in which the four service systems interact, access, and share their resources. It represents the key stakeholders who are most influential in the service ecosystem and visualises an absence of each them, meaning the failure of our current existing service system. The findings are significantly dissimilar to one another, while also clarifying roles and responsibilities in each service system, thus outlining practice in each service system in the wider ecosystem. Each of actor's detailed co-relationships are attached in Appendix 4.

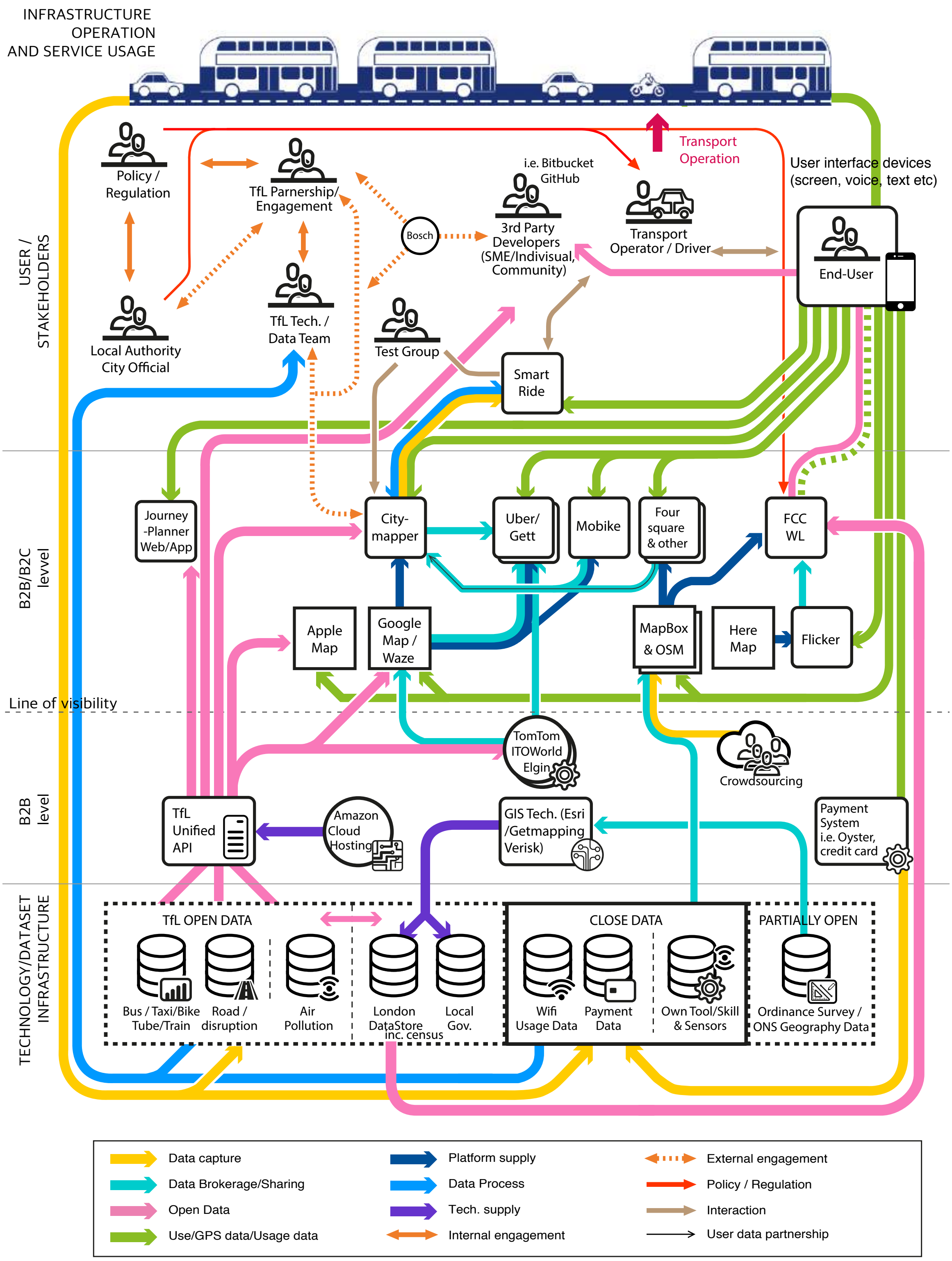


Figure 23. Geospatial service ecosystem drawn from the results of case studies (as of Mar 2018, UK only)

Chapter 6. Design Project

6.1. Introduction

To explore the practical nature of the research question and objective 3 (as outlined at the beginning of this thesis), some further empirical investigation from a design researcher's perspective, regarding the capacity of service design, was required, alongside the main case studies. The design project was conducted between Royal College of Art Service Design Master students and myself in response to the brief from Transport for London, as a collaborative project: a service to reduce air pollution in London that would also be a way to collect data and analyse the design outcome regarding research objectives.

This chapter details the process and results of the service design project. The purpose of this project was to explore service design capabilities in the implementation of a mapping service system, thereby determining whether service design methods and tools can bring value in the development of a service system in maps/mapping, especially when maps become a service.

Although a service-dominant logic provides a clear theoretical understanding of value-creation dynamics and highlights that service should be experienced by service users (Vargo and Lusch 2008), as yet, service providers have taken the dominant position in value creation, rather than users, and it is clear that this theoretical position is yet to be understood in practice. In this sense, this chapter demonstrates how service design methods and tools could be implemented in support of value co-creation in the mapping service system.

Given the knowledge synthesised in Chapters 2 and 4, this chapter argues that the involvement of design in the development of maps/mapping service entails working towards a service system; thereby service design has the potential to support value co-creation practice in maps/mapping when it becomes a service. It also illustrates the procedures of service design projects while detailing the tools and methods used.

Involvement in the project has enabled the researcher (i.e. myself) to be able to apply an initial framework to the project, while also developing an in-depth practical understanding of service design capabilities. As a result, this chapter outlines the outcome of the design project as recognised by a range of key stakeholders, including global leading professionals and academics in related fields. This acted as a means to evaluate the value proposition and the design project as a separate case studies (research objective 3).

6.2. Context and aim of the design project

While earlier chapters provided insights into service system logic in relation to the nature of maps/mapping, actual service design tools and methods as used in live projects have not yet been outlined. Given the literature and map-sample reviews, it seems more appropriate to view maps/mapping from a service-dominant perspective rather than a cartographic perspective that treat maps as artefacts. For decades, service research has been considered a perspective on value-creation, while service logic has emphasised value and value co-creation by re-conceptualising the role of customers as at the centre of value creation, which are the key concepts of service logic (Vargo and Lusch, 2008). Although the theory of service-dominant logic offers a clear understanding of service value-creation, an empirical understanding and reflection regarding the implications of value creation in practice is not yet available.

Wetter-Edman (2011) has proposed that 'design practices using *designerly* tools and methods might be a way to realise a service logic' (p. 100), with design activities being described as part of value-creation when actors participate and integrate their resources while developing a service as part of user activities. Service design practices emphasise users' understanding, thereby facilitating collaboration and participation at the specific times and spaces at which value is co-created. Service design also has solution-driven capabilities, methods, and tools that anticipate customer experiences and activities by facilitating and integrating service providers' processes (Wetter-Edman *et al.*, 2014).

In light of this, the study of how service design tools and methods can support value creation—hence realising service logic in mapping services—offers a way to observe and participate in the service design project. In this project, the maps sit between service providers and users in a joint sphere, while facilitating collaborative activities in specific contexts of *time* and *place*. This means that the design of the maps aligns with the design of a service system, which may bridge the gap between service-dominant logic and service design by re-contextualising and/or reinterpreting the service offering.

The design project was therefore set up as a design research model for the purpose of data collection and an analysis of the project's outcomes. In addition, the design case study can provide methods of data collection from which the researcher is able to understand and capture a specific context at different stages of the research—for example, exploratory or descriptive elements at later stages. Given this, the researcher can be immersed in the live environment, and thereby plays role of designer, being more visible, actively and reflexively interacting with both the research framework and the design outputs as part of the research effort.

As the objective of this design project as a separate case study was to gain in-depth insights into the execution of service design in relation to research objective 3**,** the project was conducted with service designers at RCA and TfL and was intended to identify opportunities to realise a service logic through the use of design practices and tools.

6.2.1. Data collection

During the data-collection phase, qualitative data was collected. There were three types of data involved: documents, observation (participant and non-participant), and interviews (exploratory and semi-structured interviews) conducted based on the categories of participants that were identified during the project development. In total, the participants were drawn from seventy drivers, taxi marshals, passengers, head of finance at TaxiApp Ltd, air quality experts, and a travel manager in a local borough. Before proceeding with each interview, the scope of the project was explained, and a consent form was physically presented. The latter was carefully explained, and a non-stressful environment was assured. The interview was either video recorded or notes were taken, while the given interviewee was informed that they could withdraw if they wished to do so. The insights arising from the data collection stage were also defined, which resulted in the opportunities afforded by the service design project.

6.2.2. Project context and setting

The project was conducted with service designers from Service Design at the RCA between October 2016 and January 2017, while additional project development was conducted during May–June and November 2017 in order to evaluate the outcome of the design project with the Service Design Network. This design project was initially developed to respond to a challenge set by TfL to reduce air pollution in London, which due to congestion increased significantly between 2012 and 2015, while travel times in Central London have increased by 12% each year (TfL report, 2016). The goal was to improve London's air quality using a service design approach, while offering sustainable transport choices and bringing together better transport experiences.

The following factors were taken into consideration when the researcher became immersed in the service design project in relation to research objective 3: First, identify key *actors* who might be contributing to pollutant behaviour in the wider transport service system; second, identify data, information, knowledge or products accessed as *resources* by users during their transport *experiences* and their relationships to maps/mapping systems; third, identify new service experiences offering unique *value propositions*, thereby exerting a positive impact on reducing air pollution in London.

Based on project requirements and research inquiries in relation to maps/mapping, the first task was to identify *actors/players* involved in the service ecosystem, so that the researcher would be able to understand the 'as-is' situation that prevails in the mapping service system, and then to contextualise the findings further. Service design then follows a process so that the relevant stakeholders are able to work together. The approach puts the service provider and the service user at the centre of the development of the service concept, so that the relevant stakeholders are able to work together as a means to value co-creation. This is elaborated in the four phases of the double diamond framework: Discover, Define, Develop and Deliver—as initially formulated by the Design Council (2015), shown following Figure 24.

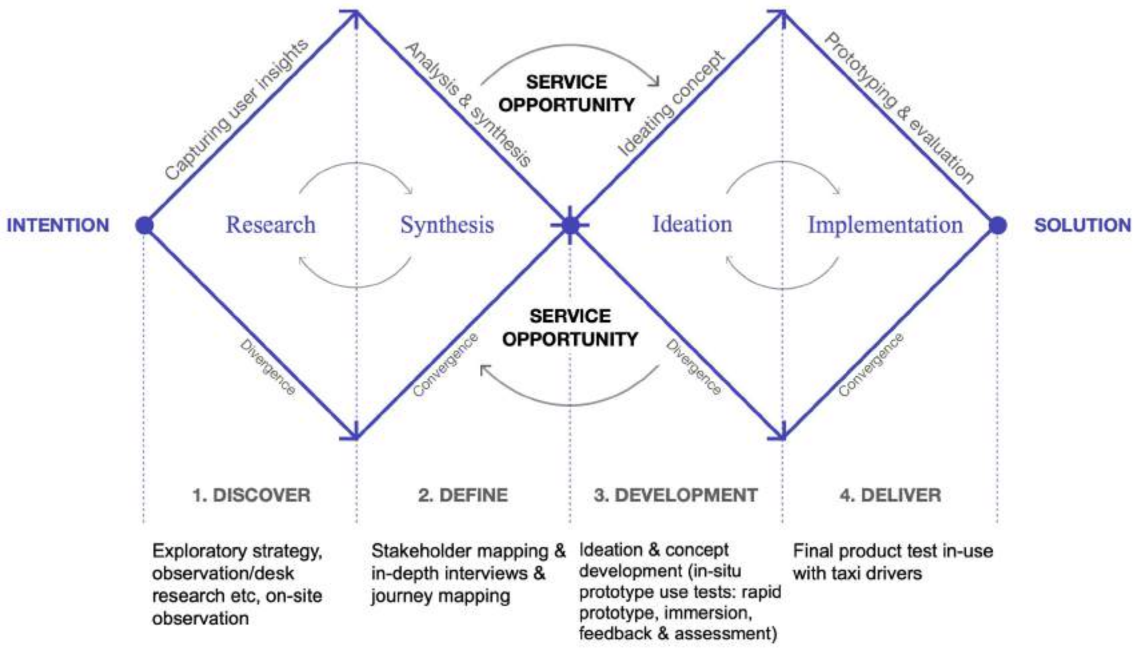


Figure 24. Design process developed in the design case study

Phase 1 – Discovery: Exploratory strategy, observation/desk research etc, on-site observation.

Phase 2 – Definitions: stakeholder mapping & in-depth interviews & journey mapping.

Phrase 3 – Develop: Ideation & concept development (in-situ prototype use tests: rapid prototype, immersion, feedback & assessment).

Phrase 4 – Delivery: final product test in-use with taxi drivers.

Phrase 5 – Feedback from Service Design Network professions both in the field and in academia was used as a means to evaluate the project’s outcome and its relevance in the context of service innovation in maps/mapping (feedback attached in Appendix 12).

6.3. The design processes

6.3.1. Phrase 1– Discovery: Observation & interviews

The following insights were identified during observation and interviews (data collection). Understanding that the highest levels of pollution are in the centre of the city, the design team decided to visit three different pollutant hot spots. After visiting Hyde Park Corner, Piccadilly Circus, and Camden Town, immediately evident was the large number of empty public transport vehicles, mainly black cabs. According to TfL reports (2015), black cabs are diesel emission vehicles that contribute to the rise in pollutants, namely NO2 (nitrogen dioxide) and PM10 (particulate matter). Looking at the impact of taxis on the city, black cabs are largely a diesel-fuelled form of transport. According to IBIS world research **(**IBIS, 2016), industry revenue was forecast to increase at an annual rate of 1.3% through 2016–17, reaching £9.4 billion. The current market trend for taxi apps focuses on customers, making the driver highly vulnerable**.**

Image 45. Air pollution hot spot map (King's College Londonair, 2016)

Image has been redacted.

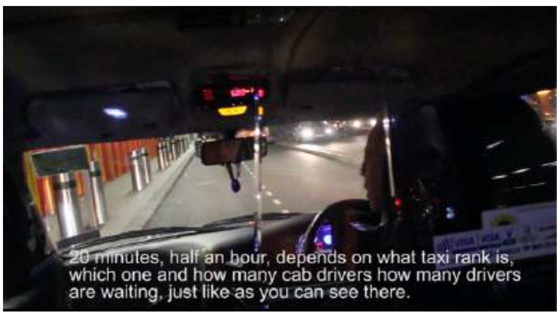
Londonair, 2016. Annual Pollution Maps. [Online]. London Air Website, [Accesses 11 November 2016]. Available from: https://www.londonair.org.uk/london/asp/annualmaps.asp

Insight from key stakeholders

In order to get more information from the key stakeholders, the design team conducted over seventy interviews with drivers and passengers during the design process. Black-cab drivers are self-employed and mostly own, lease, or rent their vehicles. They learn 'The Knowledge' of London roads and streets in an intensive four years of training, which requires memorising the London streetscape in order to earn a licence; they also have a strong code of conduct. They faced challenges when their income fell as Uber was introduced (by approx. 30%), which was often stated during interviews. In addition, the government now requires that any new black taxi purchased after late 2018 must be an environmentally friendly non-diesel vehicle.

As opposed to Uber drivers, black taxi drivers tend to not rely on digital apps/tools to find potential passengers, and do not rely on navigation via maps but occasionally use traffic or accident notifications such as Waze. Accordingly, they only respond to simple notifications or information about passengers within a half-mile radius while looking out for roadside-hailing passengers. Some hailing applications dedicated to black cabs are similar to the Uber model, such as Gett and Hailo, however for the most part they find passengers on the road or at particular spots such as hotels, major rail stations, and so on, meaning that they largely rely on luck while 'drifting' along roads to find passengers. Furthermore, drivers return to the most popular areas like major stations as soon as they drop off their passengers, without guarantee of their next fare. The absence of an integrated digital platform that gathers together the driver's knowledge or data also influences these challenges.

Based on drivers' experiences, verbalised during the interviews and observations, the most regular types of passengers are business commuters and tourists who want privacy and comfort. Business people value privacy and space in terms of working while moving. They prefer black cabs while traveling in central London at peak times as black cabs can make use of bus lanes, making journeys quicker than other PHVs; furthermore, other PHVs are shared with other passengers who they do not know. However, some passengers also use black cabs when they experience extreme weather conditions or are carrying heaving luggage.



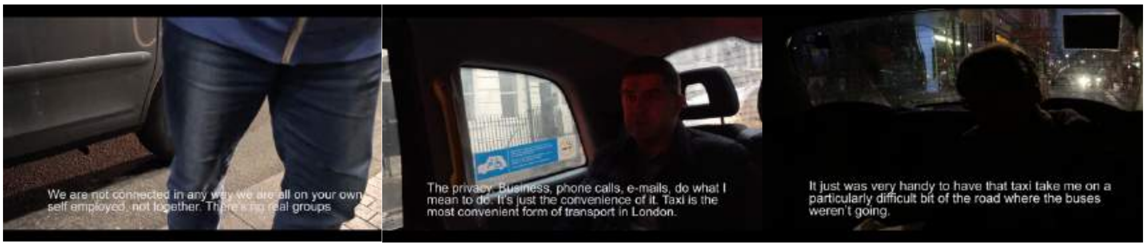


Image 46. Observations and interviews

6.3.2. Phase 2– Definitions: Stakeholder mapping & journey mapping

During this stage the design team found that existing mapping services offer complex solutions that are not tailored to meet black cab drivers' requirements, while they also fail to take drivers' knowledge into account, standing in direct competition with Uber, the market leader. There are many similar taxi hailing applications on the market. Many of these apps, including Uber, use heat mapping, which informs drivers about where to find passengers based mainly on demand data generated by passengers. This demand often changes quickly before the taxi reaches potential passengers. Services such as Hailo and Getts are designed for black taxis, and are similar to the Uber model. However, these services sometimes encourage the driver to travel dead miles for extended periods. In addition, they are not exclusive to black cabs, which breaks down trust between such services and taxi drivers.

For example, Hailo failed to build trust as they promised to be exclusive to black cabs and then introduced PHVs afterwards, which resulted in black cabs deleting the app. Table 6.1 highlights existing taxi hailing services and related apps. Most taxi hailing apps react to where people who are hailing taxis are located. Therefore, there is an opportunity to predict where passengers might be. Most mapping apps (Waze, Google Maps, etc.) offer complex detail, much of which is unnecessary for black cab drivers. Therefore, opportunities have arisen to provide tailored information relevant only to the latter.

	Strengths	**Weaknesses**
Google maps	Information on businesses, wayfinding, saving and customising maps, traffic information, route planning	Complex, creates dependency, slower than Waze, untailored routing
Waze	Quickest route planning, information about road accidents and police, location sharing with friends, nearby petrol stations and prices	Excessive information, more cars on the street

Existing taxi hailing services for drivers and passengers

	Strengths	Weaknesses
Hailo	Sets daily targets, connects with customers, identifies potential passengers (heat mapping)	Bad relationship with drivers by including other PHVs, heat mapping is based on the number of passengers hailing a cab and is often out of drivers' range
Gett	Connect with other black cab drivers, finding potential passengers (heat mapping)	Customers often cancel when the driver is nearing them, heat mapping is based on the number of passengers hailing a cab and is often out of drivers' range
Uber	*Cashless payment,* ***splitting taxi fares with co-passengers,*** *information on driver, feedback, information on service availability and cost*	*Drivers earn less than minimum wage, are a direct cause of increased traffic, centralised control*

Existing communication platforms between drivers

	Strengths	Weaknesses
Twitter	Direct contact with many other drivers, closed channels so black cab drivers trust it	Information about where to find passengers can be out of range, spam messages
WhatsApp	Closed channels, admin staff decide who joins the channel	Small groups of drivers, **information about where to find passengers and road incidents can be out of driving range**

Table 13. The current mapping application landscape

6.3.2.1. Imbalance between supply & demand

Following observations, interviews, and building a journey map, the design team were then able to identify 'as-is' situations. The major issue was taxi drivers driving on empty streets. According to the interviews with drivers cited in the previous section, black cab drivers spend up to half of their time looking for passengers. Other services such as Uber, Hailo, and Gett rely on heat mapping and map algorithms whereby the driver follows the given app's instructions regarding where to find passengers. However, customers often cancel their trips while the taxis are approaching, which also causes longer dead miles, wastes both fuel and the driver's time, and contributes to traffic congestion as demand data changes quickly before the driver gets to their pick-up point.

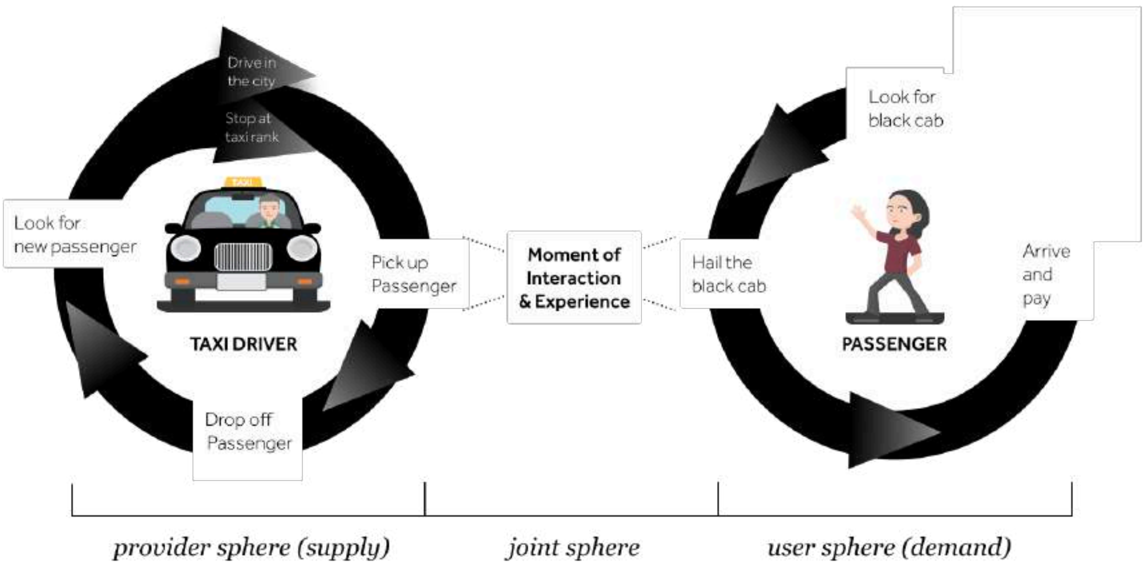


Image 47. Driver and passenger journeys: moment of interaction

In the process of mapping both drivers and passengers' journeys, the design team identified a gap, especially in terms of the time between drivers finding their next passengers and passengers looking for taxis; these are when the moments of service interaction between them are created. Figure 25 illustrates black cab drivers' typical journeys and application use, namely when they find a passenger, drop off, and find their next passengers. A user-journey map can describe possible service experiences which illustrate the user's experience (See Appendix 8). Due to the fact that transportation experiences can occur under multiple operators and applications that are needed to move people from A to B, a high level of complexity emerges. The user-journey map embraces this complexity by representing different service touchpoints that can be either physical, digital, or human as the service interface establishes the relationship between service providers and users. The following insights have been identified based on the process of defining drivers' journeys, which is also useful in terms of developing the service proposition.

The following insights were derived from drivers' journeys:

- Drivers like to know when events are ending so they know which areas of the city might be most lucrative at certain times of the day;
- Drivers have particular preferences for where they like to find passengers, such as hotels, train stations, or department stores;
- Drivers like to have basic traffic information, which can help them navigate congested areas;
- Drivers only want this information to be shown within a half-mile radius or five minutes away;
- Drivers also already use a number of applications to do their job, so they don't want to have to use another screen-based application, which they'll have to switch to every time they want to use it.

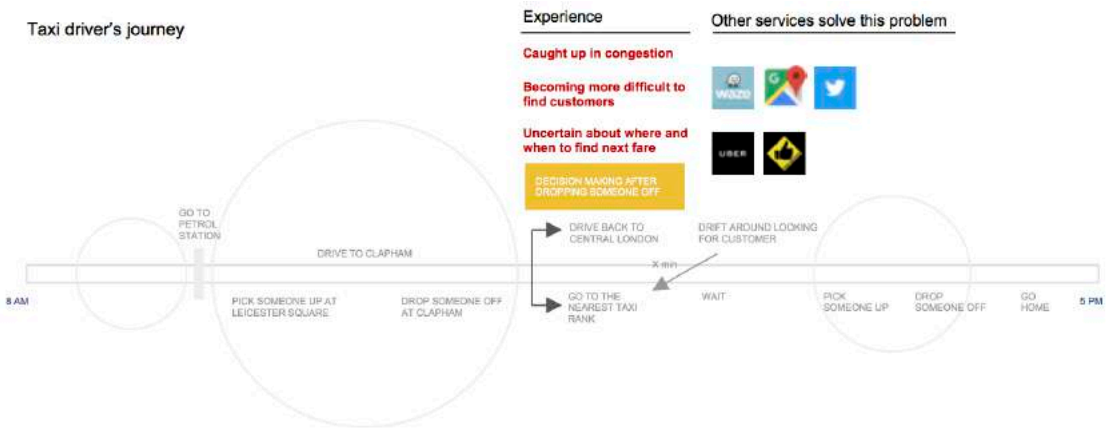


Figure 25. A taxi driver's journey

Based on the insights generated, the design team was able to frame key problems during the ideation stage, which was useful in terms of building a unique service proposition.

One key problem was that drivers cannot *predict* where there will be a higher chance of picking up their next passengers without drifting for a long time on the road. This means that picking up potential passengers on the street relies substantially on luck. Drivers need to receive information about potential passengers at the time and place which are relevant in the context of their locations and needs.

Second, there was a *disconnection* between drivers and passengers compared to other services such as Uber. As black cab drivers work independently, they have no data, knowledge-integrated platforms, or community, peer, or support groups. Lastly, drivers want to receive the information they require in an efficient manner based on their specific time and location.

- Disconnected/Connected (support/peer groups, utilisation of black cab drivers' knowledge, thereby empowering & connecting drivers)
- Unpredictable/Predictable (organises correct information at the right time and location)
- Complex information/tailored delivery (relevant information and knowledge delivery at the right time and location)

In contrast to Uber drivers, black cab drivers do not use a combination of apps which match drivers (supply) and passengers (demand) in their service platform. However, black cab drivers usually find their next passengers by being hailed on the street or from taxi ranks where passengers are likely to be waiting for cabs. As described in Figure 26, pollutant issues could result from imbalances between the level of *supply* and *demand*.

The greater gap between supply and demand means more pollutants are likely to be created. The optimisation of this gap between the two spheres, where the value is created at the moment of interaction, could create a better service experience for users, and at the same time reduce pollutants. This means that the service is experienced at the moment of use as being at the right time and space and in sequence. The value is therefore perceived when the customer's goal is accomplished through use of the service. The value here has to be constructed and perceived differently by various actors. In other words, from the customer's perspective, the service's value can be expected and imagined beforehand, and perceived during use. In the process of using the service, the traditional nature of maps/mapping, such as identifying location, becomes a secondary value, but the experience (cost & time) in the systemic nature of the service becomes central.

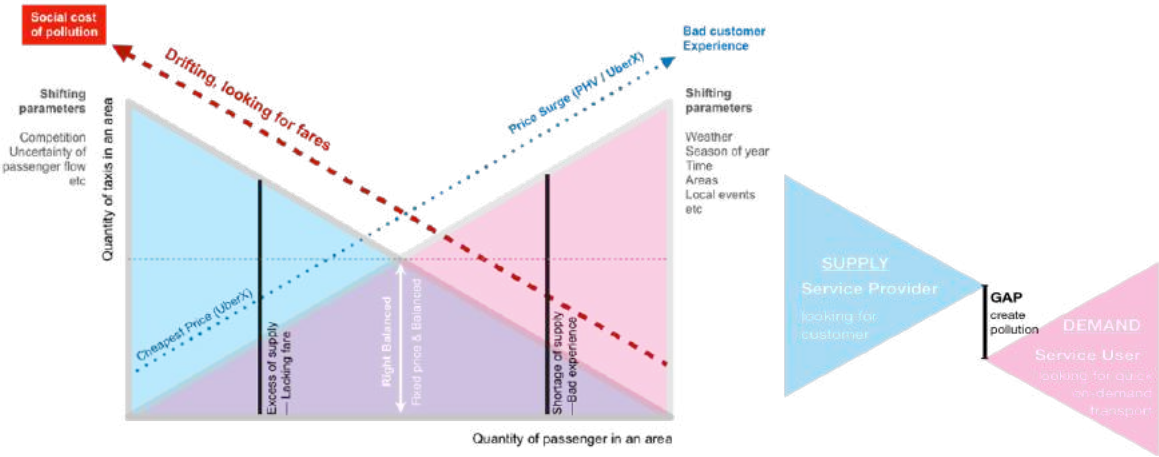


Figure 26. Supply and demand dynamics in PHV

6.3.3. Phase 3– Service development (Prototype and delivery)

The previous two stages' results led the design proposition, which had been broadly scoped to develop the following process, using the tools and techniques outlined below. From generating the idea of service opportunities, the design team developed the service proposition iteratively with users, which involved co-creating and working collaboratively through the use of service design tools. The research approach and methods, such as stakeholder mapping, constructing the user's journey/storytelling, service interfaces, touchpoints, service prototypes (experience prototype), and service blueprints also led to a business model (service value proposition), which is detailed in following section.

The service blueprint gives a visual representation of the service process, while the touchpoint represents the underlying actors/organisational structure, also presenting the relationships in simple visual form so that anyone can understand them easily (Bitner, Ostrom & Morgan, 2008). This was highly useful at the stage of service concept and development.

It was necessary to investigate the way in which the service system could be realised from an implementation perspective, focusing mainly on the observation and understanding of users. Furthermore, it was crucial to envision the customer experience by facilitating collaborative activity in response to the user's specific time and spatial context, wherein value is co-created. This means new service offerings and potential interfaces sought to translate the complexity of the existing service system not only by improving the user experience or its touchpoints, but also by offering a way to improve and realise the service system through the capacities of service-design tools and methods. This is in line with the concept of value co-creation (Vargo & Lusch, 2004; Sphorer et al., 2007), which lays out how a resource (e.g. people's knowledge, skills, technology and data) can be integrated, interconnected, and exchanged within a systemic service, thereby maximising the value of the service; this was significant in our case study.

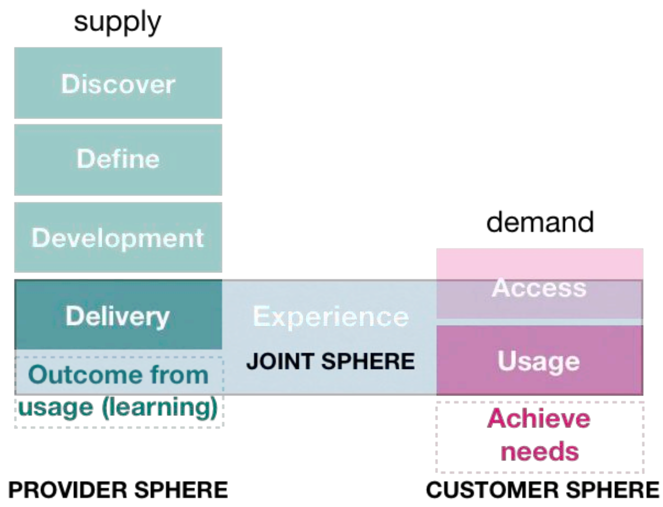


Figure 27. Service spheres where value is co-created

This means that the value in the joint sphere can be co-created by both drivers (supply) and passengers (demand), which in turn addresses supply and demand imbalances as shown in Figure 27. The design proposition was then intended to provide a unique service backed up by tailored open-data and real-time data using drivers' peer-to-peer input, which utilised real-time data about traffic, road events, and the speed at which taxi ranks were moving (knowledge), so that drivers could make informed decisions about where to find their next fares, and thereby reducing the amount of drifting time. This tailored information, which was intended to be useful to drivers, continued to generate value and knowledge in the form of datasets, from both automated data (open data and driver-generated information) and human input (data verification by drivers and marshals). Therefore, offering this information to drivers can improve the service experience, where service design plays an important role in relation to the experience of the joint sphere. In this way, service design can offer a unique service proposition.

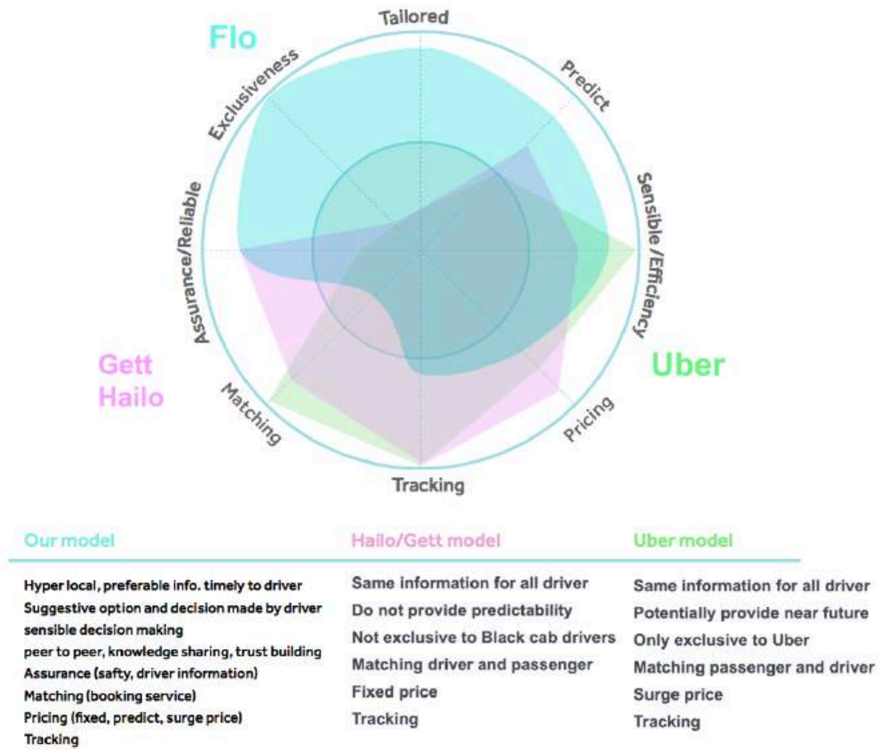


Figure 28. Service value proposition

As such, the application of data was a critical aspect of the service development process. We wanted to transform *data* to *information* and make data useful for drivers, and to turn *information* to *knowledge* by extracting insights from data so that drivers understood which situation to react to; these series of transformations on the platform allowed drivers to add new information while they verified automated data. In this way, the automated data's accuracy and relevance in terms of drivers' needs could be enhanced, and thereby drivers' needs could be met. By providing timely relevant information based on hyper-local contexts and situations, drivers would be able to reduce their drifting time, thus saving fuel while increasing the chance of finding their next passengers. In this way, multiple stakeholders such as drivers, passengers, city stakeholders, and the general public benefit in the longer term by reduced drifting time, as shown in Figure 29.

Figure 29. key benefits for stakeholders

The design team then developed a new service-journey storyboard derived from case scenarios: a series of pictures in a narrative sequence that illustrated the solution. The storyboard was used to support the explanation of the service and showed the service solution's different steps. Each driver's response and feedback were logged and iteratively applied to the final solution (Figure 30). Through iterative service prototype testing, the design team created the final-user interface based on the outcome/feedback of the new service journey, which also helped in business-model generation. This details how this service would perform and offers benefits to various urban stakeholders. Importantly, the estimated earnings and benefits for black cab drivers was measured during this stage, thereby measuring impact.

A very complex challenge had been explored while framing the problem, namely the project's core strengths. The process that the design team went through was very thorough and involved coming up with ideas, platforms, and guiding principles, and then iterating and testing, after which the business model was developed. In this process, the design team did not simply create a copy of the Uber app but rather a service platform which was transferred to the black cab business, offering useful information such as how many people are at a given location and for how long they have been waiting. Ultimately, turning the proposed business model into an application for the black cab market was a particularly competitive idea, according to feedback we received from professionals in the field.

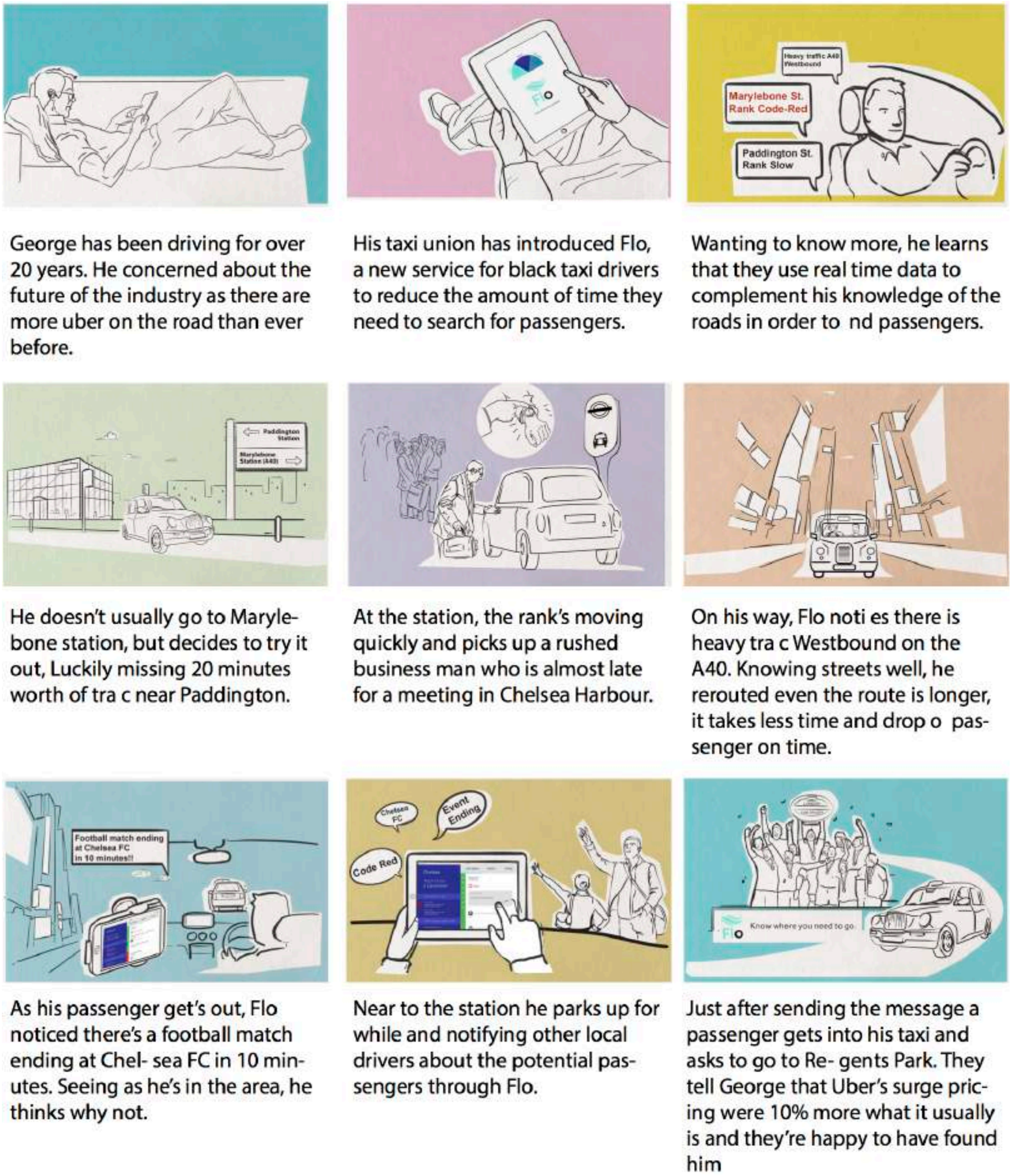


Figure 30. New service journey storyboard

As shown in Figure 31, the service platform utilises three data sets to assist cab drivers to be more efficient, which in turn aggregates data and insights from drivers. The platform uses location data from other cab drivers at taxi ranks to let drivers know at which nearby taxi ranks they're likely to find their next passenger. Data is mainly in two parts: automated data from an existing API, and human input and confirmation to support automated data accuracy while correcting unpredictable road information. This provides the driver with a number of data sets and information from peer-group drivers in order to make driving decisions. These will be based on data concerning nearby *taxi ranks*, *road conditions*, and *event* updates.

All of the data and information provided on this platform will be hyper-local and potentially use other inputs such as information from taxi rank marshals or other drivers over Twitter. The platform merges disjointed data onto one platform. Drivers will receive information from the platform based on their current location, but also their preferred location in terms of where to potentially pick up passengers. It can be rendered as a voice, presented on digital screens, or sent via text notification. Hence it not only exists as its own application, but rather is intended to be an application programming interface (API) to be adapted into existing taxi-hailing applications. This allows for the greatest reach as well as identifying who is using a number of different existing hailing services.

Figure 31. Service features such as the integration of resources by use of automated data, drivers' knowledge input, and human verification

6.3.3.1. Potential impact on stakeholders

It was also critical for the design team to identify clear service benefits for drivers in terms of finding passengers more efficiently, driving less, and thereby saving fuel. The design team calculated that if a driver spends an average of £50 a day on fuel and half of that is wasted without carrying passengers, then Flo (our product) could potentially save drivers £9,188 a year (Figure 32). This would benefit passengers by increasing the supply of black taxis where they are most needed, potentially reducing queues at taxi ranks. Furthermore, the higher the use of the service, the greater benefits to wider stakeholders. For example, policy makers could reach decisions about roads through understanding the data generated by our service. By reducing the time black taxi drivers drift on the road without passengers and nudging them to other areas in the city, pollution hotspots can be reduced. This is the greatest benefit the service can have on the environment.

Image 48. Service Design Network 2017

The service is based on a subscription model and will be a premium service for black cab drivers. The service can reach its users by establishing a partnership with the four taxi unions, who, combined, represent the majority of black cab drivers, advertising in taxi magazines and offering benefits for those who use our service. Revenue will be derived mainly from those who buy the premium features. The free model allows black cab drivers to set their preferred locations for finding passengers such as hotels, airports, or tourist destinations, alongside offering access to basic traffic information.

The paid model allows a much wider choice of areas to pick up passengers, allowing drivers to prioritise their choice of location and giving them the ability to adapt to destinations manually, while they can update their personal preferences to a higher priority. The premium model's value is based on treating the driver as an individual and allowing others to hear their thoughts. The paid model also provides analytics based on drivers' own driving habits. This information will let them know when to take a break or finish work, help them manage their own time, and set their own goals. The service model is intended to foster collaboration between drivers and not just to help them compete against each other like Uber does. Drivers can share information, thereby benefitting each other.

Figure 32. Cost calculation model

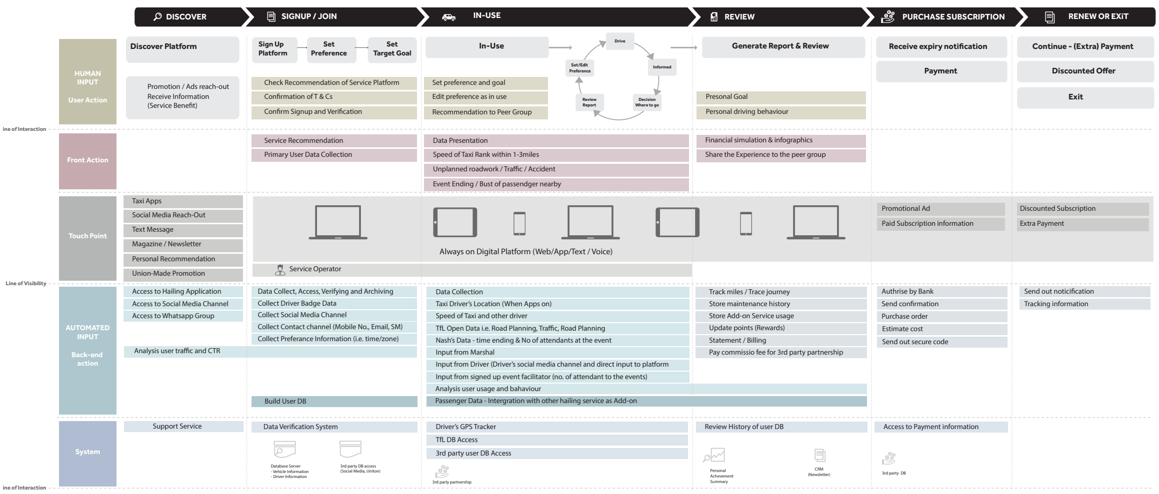


Figure 33. Service blueprint (see appendix 10)

6.4. Summary of project

Through the project, service design as a methodology offered the tools to deliver an optimised, complex service system that offers better experiences. This involved an integrated approach to the design of human-centred service experiences, and allowed us to create a technological system via a collaborative process, which means that this form of service design involved a holistic approach to design and optimising the experience of people and systems and required the integration of resources, as well as being multi-disciplinary through its systemic orientation.

In short, service design methods and tools are able to capture many aspects of the actors/stakeholders involved in the enabling of service use. The representation of service in service-design tools, such as service blueprints, can help us to incorporate service components, whether physical or digital elements. It also enhances the capacity to understand users' needs while developing an empathy for their specific situations, and helps in developing an analysis of the context of use in terms of the broader service system. Hence, these tools capture the elements that are important to users, such as the interaction between actors and the context in which value-creation takes place. This means that service design, with a broader focus on the design of the service system and its tools/techniques, enable an understanding of users and their context.

Chapter 7. Discussion

7.1. Introduction

This chapter compiles research findings from the three research activities presented in Chapters 4, 5, and 6 from the perspectives of service opportunities, the service system, and practice, respectively. This chapter discusses not only the findings of the research questions outlined in Chapter 3, but also demonstrates a framework outlining the value system that would be useful for practitioners both in geospatial service and the service design field who may be involved in the mapping service ecosystem. It specifically discusses (1) the challenges and opportunities within each service system in mapping, aligned with the four service system categories (i.e. businesses) identified in Chapter 5.

The chapter also suggests (2) that the service ecosystem allows all players to co-create value through sharing resources, therefore maximising the value of the available resources (technology, skills, knowledge, and so on). By considering the important role of value co-creation in light of service science, the chapter discusses how the relationship between players in co-creating value echoes how the ecosystem itself co-creates, shares, and delivers value to final users. It also discusses (3) how service design capabilities can assist value-creation in the service ecosystem. The chapter finally discusses the implications of both the theoretical and empirical contribution of service ecosystems to digital mapping research.

7.2. Nature of maps, the shifting paradigm

Since technology began to affect maps and mapmaking, there has been intensive theorisation in the study of cartography so as to better understand the changing nature of maps. To recall, as was discussed in the literature review, maps are not only products or artefacts that exist frozen in time and location; rather, they develop as a process, emerging through time as mobile objects (Dora, 2009) with a fluid meaning that is dependent on the contexts in which they appear.

This view represented a significant development in the field of critical cartography and neo-cartography, since it focused on the changing form of maps and the power shifts between mapmakers and users. As was discussed later on, voluntarily crowdsourced efforts became a valuable asset since the way users use maps produces a tremendous number of valuable geospatial datasets, such as the notions of *prosumer* (Ritzer and Jurgenson, 2010) and *citizen sensor* (Goodchild, 2007). In effect, this represents a form of free labour for maps/mapping and GIS service providers, since it allows them to produce empirical geospatial knowledge. These lines of inquiry have been further developed in relation to big data (Kitchin, 2014), the city dashboard as a meaningful data indicator (Kitchin, Lauriault and McArdle, 2015b), and geo-visual analytics (Dodge, 2017) that discuss the value of automated geodata and its potential application for maps and geospatial data as focused on features of maps, such as a media and assets.

These studies, however, have not explicitly investigated what value is created after the point at which the map is used, or how the mapping service is experienced by users. While free resources (open data) and the labour of users (crowdsourced geodata) have great *potential* as resources, they have no value until they are meaningfully linked, shared, used, integrated, and rearranged. Geospatial Data streaming (eg. APIs) is new form of fluid mapping in which the map is transferred fluidly into containers, such as platforms, in which the various datasets with locations are linked and rearranged depending on the how the interface of the map platform rearranges these interactions with technology, people, actors and the surrounding system.

As this study has argued through its investigation of literature and reviews of samples of maps, nowadays maps should be understood as mapp*ing*, as dependent on context, as experiential, performative, intangible entities with an ontology of becoming, rather than that of a fixed essence.

Both maps and services conceptually share these characteristics and nature. In other words, both are experiential, with an intangible nature, which implies that their value is only created and perceived when they delivered, used, linked and shared at particular moments in spatial, temporal, and other relational contexts.

The value of maps and services is thus context dependent and requires a new form of interaction that configures the relation between people, technology, knowledge, and organisation, each of which is involved in the surrounding system and environment. In this way, the meaning and value of maps is rearranged and co-created by many actors, all of whom are involved in the system jointly. These considerations are in line with the parallel idea that will unfold below, namely, the articulation of the service (eco)system and service design as a realisation of service systems from the perspective of practice.

It is also evident that the development of map/mapping services has evolved at a sharp pace given technological and service-ecosystem changes. Smart technology nowadays allows everyday ‘things’ to connect and interact with individual users through smart devices that provide specific contexts, times, and places/locations. These technological innovations and ecosystem changes offer the potential to drive economic growth, while the mapping industry has itself started to look at the possibilities of creating new service models (i.e. business models) and value propositions that are disruptive of the existing map and mapping industry.

As technology in mapping is evolving, extending, and disrupting the established market and its business model—one of which is the digital mapping industry (i.e. mapping platform enterprises)—there is a need to understand service opportunities in light of this technological shift as well to work out what we need to understand in order to achieve new service opportunities. Since the nature of maps and mapping is more relevant from the service perspective, as identified in previous chapters, it is necessary to understand service innovation as influenced by technology, and the service ecosystem from the service-dominant view, while at the same time extending the idea of cartography.

7.3. Unfolding paradoxes in the digital mapping industry

While maps and mapping have been around for thousands of years, their digital expression and usage (digitalisation) has dramatically influenced many areas over the past few decades. Geospatial Information (GI) has been enriched by new technologies, while its applications for both consumers and companies are growing exponentially. Thus far, the study of spatial and locative technologies such as GNSS (Global Navigation Satellite System), GIS production, interactive mapping tools, and API has focused on issues related to the technological impact of mapping (free tools and new datasets, such as OSM) and the dynamics of the existing industry such as Big Data, open data, 3D, AR, and so on. However, there is a lack of attention to the perspective of service users.

The series of significant breakthroughs in the mapping industry has been largely driven by the march of technology (Sun & Park, 2017). This has enabled a rapid increase in data in terms of magnitude, volume, variety, velocity, veracity (accuracy), validity, and high-resolution coverage, as well as in the speed of sharing of information from a range of sources, including mobile applications (Apps) and remote sensors embedded in infrastructure. At present, most devices have experienced a proliferation in the amount of data that is geographically related and generated almost in real time, in terms of its collection, storage, and transmission, all at a low cost by sensors and tools—whereas beforehand many sensors and systems were isolated and not location-aware. Furthermore, location-aware technology such as Big Data, Cloud, IoT, ICT, and machine learning are now becoming ubiquitous and invisible while also easily integrated into other GIS-related solutions or applications.

However, these geospatial data can be easily shared, which helps many applications, software, and the development of technological tools at a much faster rate, but this has been exclusively within the GIS and digital mapping industry. UK smartphone penetration rate is over 85% (Deloitte, 2017), where 41 million people continue to contribute in terms of the creation of a new dimension of explicit data based on the almost instantaneous sharing of details regarding what is happening on the ground. Accidents, events, or disasters on social media feeds are instantly geographically tagged on crowdsourced map-platforms (see the OpenStreetMap project, Twitter). This also turns anyone who uses mobile phone and mapping functionalities into citizen surveyors. Furthermore, the quotidian use of Oyster cards on the Tube or mobile taxi booking services means we normally do not consider these to be associated with geospatial information that allows every single user to contribute to the generation of valuable and implicit geospatial data (Goodchild, 2007; Kitchin, Lauriault and McArdle, 2015a). This has traditionally been the realm of cartographers and GIS professionals. Many of these cartographic-related skillsets or knowledge have been the exclusive legacy of traditional cartography and GIS field, but this has now opened up to and been shared with many other stakeholders/users, whether professionals or amateur. The technological impact on how we engage with maps and geospatial data means that this shifting dynamic and phenomenon should be addressed from a service perspective.

Importantly, this (technical) paradigm shift significantly affects many corporate businesses and their partners, whether the nature of the business or service is trade in geospatial data or GIS solutions for transport, planning, utilities, insurance, or public safety. This has changed the balance of power between players in the service ecosystem in the established industry by encouraging *new players to reshape the geospatial industry*. Significant opportunities have arisen, especially given the scale and speed of new service development—as generated by serious new players who have changed the wider relationship with the maps/mapping service ecosystem and how we engage with locational services, both socially and professionally. For instance, traveling to a given place, meeting people, finding a location, and ordering a taxi or food is a new service offering that outshines existing services in the established market.

The use of these location-related services gives us geospatial data with context. It captures the specific location of people, what they are doing, and their environment, while GIS provides the tools to capture these data, analyse and manage them by revealing insights based on visible patterns. The integration of geospatial data with other data sources delivers meaningful results in the form of maps, such that people can make sense of data by turning it into information and thereby knowledge and wisdom, as explicitly articulated by the DIKW framework (Ackoff, 1989). In this way, new opportunities and new service opportunities are unlocked, allowing businesses to play a new role in the established geospatial market, meaning new business entrants propagating GIS into new spaces. Nevertheless, this phenomenon and the associated opportunities should be viewed as not only something derived from technology, but also examined in its broader context. This means geospatial services (digital mapping) and geo-technology industries should consider what outcomes can be created for users as a result, rather than emphasising what we do with the technology.

7.3.1. Public sector opportunities

As the rapid growth in data is of increasing importance for the geospatial industry, geospatial data has come to play a critical role in people's everyday services, especially in relation to infrastructure and government services. In the recent Geospatial Market Report (2017), the global GI market was estimated to be worth $71.6 billion by 2025. Given increased smartphone penetration, the global location market is expected to grow by 34.07% (Srivastav, 28 Dec 2017). This growth will be further boosted by other mapping applications—such as Google Maps, Here Maps, and Apple Maps—which offer various location-related services (see Appendix 2). According to a description of the study (Research and Markets, 2017), the location service falls under the IoT concept, which allows devices to be connected, monitored, and communicated with regarding their geographical locations by sensors and location technology, so that service providers can collect a range of data over their networks.

This is a mature industry serving large businesses such as the public sector, energy utilities, and property-related markets, which see value in connecting geospatial data in relation to people, places, and things. More businesses are trying to leverage live location data, whether open or crowdsourced, and have also started to represent IoT objects likes mobile phones, home appliances, vehicles, and people. The combined geospatial data (GIS) and real time IoT data mainly incorporates spatial awareness and can be connected to the cloud. Local government has adopted GIS-related services as a means of reducing costs when they have been subject to government funding cuts (Coote, Feldman and McLaren., 2010) and also in accordance with government initiatives, such as open data to support ease of sharing, interpretation of geospatial data, and system integration via cross-organisation collaboration, even witnessing the involvement of third parties in public-service provision (i.e. London DataStore, TfL collaboration). These factors potentially increase the opportunities for geospatial product and service suppliers who can offer GIS data-based services that facilitate cross-organisation (stakeholder) collaboration, thereby reducing the cost of managing public services (i.e. Windsor and Maidenhead council services, waste management, etc).

7.3.2. B2B data servitisation

In the business-to-business case (B2B), enterprises who offer geospatial data and solutions are against such open resources, arguing that the idea of open data does not necessarily mean 'cost-free'. This is because existing business models focused on selling geospatial data have gradually lost their market share, and hence face competition from companies utilizing open data as their business model (open LiDAR data). Suber (2013) and Kitchin (2015) have raised concerns about open data and its possible monetising models. They identify different potential funding sources for open access endeavours; however, this is not the only way to survive within the open data and open access paradigm/movement.

Since the evolution of web mapping (such as Google Maps), most existing business-to-business type enterprises nowadays emphasise five types of service system categories as their business model as they have tried differentiate different types of geospatial data and data-based products and services. These range from: Geographic Information (GI) Products; GIS product/service provision; GI products; other sources of data integration for customised GIS services; and consultancy for those involved in GIS product development. These products and services include potential clients (customers) who may fulfil certain criteria with location profiles, wherein data intermediaries add extra value though the integration and analytics of other datasets (i.e. credit checks, income, etc.) as a means of differentiating their services from others in highly competitive markets. (i.e. Case 2, GeoInformation)

One recent improvement made by some of the new GIS players (i.e. RoadTracer, Mapfit) is the automation of new geospatial data generation and mapmaking processes, namely through the extraction of details from road networks facilitated by high definition aerial imagery interpretation, as well as real-time data sources from thousands of IoTs, commercial datasets, and validated open data at half the price of Google API. These have expanded to business intelligent solutions embedded in advanced geospatial data and its visualisation (i.e. tableau, LiDAR), but it appears they play a data brokerage role rather than offering a comprehensive data-based service.

Whilst the production of live- and high-precision geospatial data sustains many enterprising applications, it also disrupts the existing mapping/GIS industry. More businesses have started to leverage real-time geospatial data into their service solutions with the aid of automated algorithms, so that they can process large volumes of geospatial data more speedily and efficiently. This technical capability is ontology-based geospatial data integration, meaning that it involves the use of ontology(s) to effectively combine data or information from multiple heterogeneous sources; and its contextual relationship potentially increases GIS to a new level of accuracy and service possibility. Furthermore, it has high potential for areas such as surveying, traffic, congestion, and logistics management, all of which will potentially support ride-sharing companies and autonomous vehicles in the very near future, thereby encouraging innovation in every domain in the GIS industry.

None of the established large enterprises, such as Google Maps, Apple Maps, MapHere, or TomTom have been fully able to achieve contextual relationships, although they have been trying to embrace large-scale accurate digital representation on the ground and in the built environment by focusing on semantic representation rather than facets of the human dimension underpinned by behavioural perspectives. This requires a deep understanding of how people relate to digital mapping services and the data generated by the use of these maps, while determining how we can extract insights and thereafter draw from that data.

In this context, analysis of geospatial data and its visualisation plays a critical role in the GIS market. There are competitive advantages for professionals in cartography and the GIS field who communicate information on the *art and science of where*. It is important to recognise the value of communicating geospatial data so that we can generate valuable insights, reveal data patterns, and create data storytelling. Intrinsically, people understand the importance of visual discovery through mapping. However, geospatial data is less useful without visualisation (AGI, 2018). Therefore, the translation of geospatial data into useful insights by offering visualisation tools or related services (e.g. Case 3, Whereabouts London) represents a substantial opportunity.

7.3.3. Towards a consumer-facing service

The previous section discussed opportunities raised by the capacity of technology, signifying that the established Geospatial industry players have to understand how new entrants in the field have shifted from being geospatial data aggregators/providers to data renderers and service providers (i.e. a process of servitisation), which means that new players seize opportunities and demand a focus on value co-creation, improved customer experiences, and intimately built trust.

This signifies a power shift away from existing players to new players.

In addition, a central shift sees the value of customer experience, underpinned by the way customers perceive value, become the focal point of understanding with regard to how value is created during the use of an application, product, or service.

This is not only a consideration about technology, but also about how issues around data quality, clarity, and interpretation can replace the traditional manual verification of cartographic and geospatial data processing, and also underlines the importance of recognising the capacity of geospatial data and value-added services to deliver a product to end users. However, neither map representation (i.e. indoor mapping, 3D or Augmented Reality mapping) nor trading geospatial datasets are currently the subject of substantial attention in the traditional GIS field. What is more important here than maps themselves is the use of geospatial data in the context of customer needs at a specific time, cost, and sequential context. In this way, businesses—from those trading in geospatial information to those focusing on driving innovation—need to be examined on their own terms, if we want to see more than simply a big set of data.

This points to a parallel idea about the current dimensions of the mapping industry and its transitional location, sustaining the market through technology and disruptive innovation that has the power to change the entire industry, and at the same time associated with a range of disciplines from scientific representation to communication as well as data interpretation and its uses. This perspective has also led to ideas about the 'de-professionalisation' or 're-professionalisation' of cartography (Sun and Park, 2017; Crampton 2009), something that traditional cartography (or traditional GIS) has been debating for a long time but has not yet clearly examined.

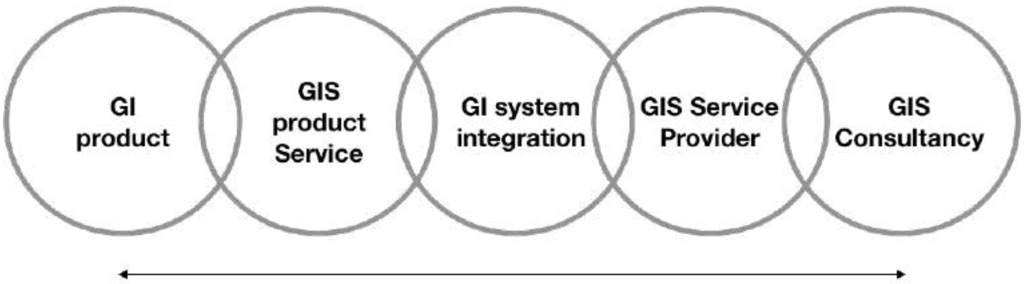


Figure 34. Major Geospatial Industry service areas for B2B (source: GeoBuiz, 2018).

Geospatial information and its associated services became dominant across many business sectors through consumer-facing applications. While most of the enterprises emerging from traditional GI focused exclusively on the B2B commercial market, their common path is to monetise geospatial data alongside the additional services discussed earlier, such as consultancy and customised data (acting as intermediators).

The range of players in the Geospatial industry shows the extent to which the explosive increase of consumer-facing applications and new entrants in this area have brought about new business models that exemplify both new revenue opportunities and also a threat to the established GI market. While traditional GI players have been associated with high investment costs when setting up companies with long procurement processes, new players aggressively develop consumer applications, realised with the aid of advanced technological capabilities and associated by-products, at a considerably reduced cost and even quicker than before (e.g. Case 4, Citymapper, Uber, Airbnb, or Deliveroo).

Digital mapping APIs such as Google Maps and Bing Maps are apparently free at a certain level and have already stretched across the field of several established industries. They act as transit, taxi, food, hotel, and logistics services, which appears to have increased competition for services and businesses. Additionally, there is a growing number of startups, SMEs, and paid subscriptions for the API map offering.

Hardly any of these consumer applications have a commercial orientation and many of them do not charge their end-users directly, while billions of users use these mapping-based apps (Waze, Google, Citymapper etc.). These applications—such as geospatial data visualisation tools and APIs—are based on either selling software as product licences or via subscription fees based on data usage after some free usage period. However, many online geospatial maps (data visualisation with new datasets geospatial data) or public bodies or research centres (i.e. UCL bike maps, OSM, Whereabouts London) are completely free and do not have a direct financing model (Kitchin, 2017).

This shift towards consumer-facing applications and the transformation of geospatial data in terms of its public availability have led to challenges for these enterprises, SMEs, and startups in terms of finding alternative means to monetise themselves in the absence of direct financing models. Thus, these applications/platforms cannot be monetised in and of themselves. The growth of consumer applications and the variety of existing business models—paid, subscription, licence, usage—continue to affect the existing B2B GI market. New players have entered the consumer market, as well as aggressively taking hold of the B2B market with challengingly low costs and innovative business models that can be a threat to the existing players, while governments release open data via open initiatives (i.e. LiDAR, DEFRA, marine data exclusively specialised for the GI industry but not available to the public).

The AGI (Association of Geographic Information) highlights that the expectation of 'free' resources is widespread in the B2B geospatial market, as opposed to the consumer-facing B2C market. Open data (free geospatial data, open source tools) has become an alternative to paid resources, while open-source data is not strictly free as business models are based on the provision of services instead of licensing and subscription models. This shift has been highly disruptive to the traditional geospatial model (AGI, 2015).

As such, digital, online, or free-of-charge open data, as well as associated platforms connected to these data, cannot be servitised directly. The challenge for these players is to maintain a continual finance stream, which can be uncertain, threatening their existence. This issue has been raised in relation to GeoinformationData (Case 2), namely that a government agency needs to offer sustainable professional data services to survive in a highly dynamic environment in the digital mapping industry, with the skills to adapt and adopt changes almost immediately. Therefore, there are practical questions about how to sustain open data, open access platforms, and existing players in the geospatial and digital industry, thereby allowing them to continue to operate.

In the case of consumer-faced geospatial businesses such as CM, Uber, or Foursquare, free-to-use services means users act like prosumers (Ritzer, 2010), providing a free resource, namely generating valuable data and extractable knowledge while they consume the free-to-use service. For example, most taxi applications are able to harvest specific data through map-embedded apps, offering personalised information while users ultimately provide empirical and historical data about their search inquiries, taxi transit data, pick-up and drop-off locations, or other transport transit through using the service. This accumulated customer service-usage data can be re-used by service providers. Companies further upgrade existing services based on insights extracted from the service-usage data, while also being able to expand services and develop new service opportunities associated with the original application. For instance, Uber expanded from a mobility service into UberEats, a food delivery domain. And Citymapper, a public transport information service, morphed into SmartBus, an affordable shared taxi-riding service that outdid Uber through their analysis of service-usage data and knowledge. Moreover, these data are highly valuable to service providers in terms of building strong data partnerships with third-party collaborators who have shared interests in relation to users.

In this way, the sharing of resources between parties—mainly customer data generated by using a service—can add additional value to a service provision by combining multiple sources of data that represent service usage patterns and locations. Therefore, having more resources can provide greater value-added services to the end-user more efficiently. Maps and mapping that are embedded in applications that provide information in the context of location-based semantic ontologies have switched to focussing on time and cost.

7.3.4. Model of service system (business mode) collisions

While government and government-owned national mapping agencies such as the Ordnance Survey (UKMasterMap) and Royal Mail (postal address data, crown service) have location-related data and services, their service for the general public is a part of open data initiatives or paid-for data. They started to expand their value-added service, for example by selling geospatial data with data-visualisation platforms (GIS platforms). These services, however, are similar to other established GIS enterprises currently operating.

From the perspective of GD type companies, this will challenge some similar, established service models, while individual app developers or non-profit organisations receive benefits in terms of accessing data, leading to cost savings and quicker access to the market. Besides, new open data (i.e. LiDAR, DEFRA, marine data) may also present a challenge to the established geospatial industry, especially from firms oriented to selling geospatial data for other firms.

Nevertheless, there is still value to government open data and its servitisation for the sustaining the wide service ecosystem. This is a consequence of the process of ecological development process in the service system. As we have seen in the process of the continuous development of technology, from paper maps to digital maps and three-dimension augmented maps, the established way of using and disseminating of maps/mapping were reshaped by new players. These new actors opened up new spaces and opportunities by allowing new entrants to stretch the new areas of opportunities in the service ecosystem. As GD highlighted, since governments' open data is the same kind of data, these will gradually impact their business. As yet, however, these open data cannot simply replace what GD is offering in terms of the level of accuracy, as well as the coverage of areas. More importantly, open data cannot provide the same level of bespoke service as they offer to customer needs.

In this sense, it can be seen that as the government continues to release new types of open data resources, this raises the probability that new entrants can participate in the service ecosystem with the least resource barriers. Consequently, this will likely extend the boundaries of the established service ecosystem. Thus, open data stimulates a revitalisation of the established market, rather than a disruption.

7.3.5. Open, shared, paid, and closed geospatial data

There is huge interest in 'big data' and 'open data'. Many people will be aware of their importance and possibilities. However, there is some confusion about the orientation of data, namely whether they are commercial or personal data and either 'open' or 'big'. The Open Data Institute (2016) has tried to offer clear definitions of different data types, ranging from 'open' or 'shared', to 'paid' and 'closed', with associated examples providing a good understanding of the current geospatial realm, especially in terms of the challenges and opportunities arising from current geospatial industry dynamics.

There are various types of data resources available across the spectrum of the geospatial industry. The following diagram (Figure 35) has been elaborated from the ODI open data spectrum and describes the broad concepts of open data. Based on the case study findings, there are four types of geospatial data.

The first, ‘open’ is commonly treated as big data with the government deemed to control what is open and what is not. In the case of the geospatial context, TfL’s public transport timetables and air pollution levels are listed in the case study section. These are publicly available, which means that anyone can access them and download files in any format as long as the user agrees to the open data terms and conditions. Any forms of data related to personal identification are strictly closed, although there is high potency of useful insights that can be extracted.

The second, ‘shared data,’ are not data overseen by government but those controlled by commercial enterprises and non-profit organisations. Access to and use of these geospatial data is permitted under limited terms of use and includes Open Street Maps API or social media feeds that have location tagging, such as Foursquare’s Point of Interest API and Flicker datasets, which contain a list of photos and videos licensed under the Creative Commons copyright. In this type of data, the photographer or videographer is credited for the original creation.

The third, ‘paid data,’ is often confused with ‘shared data’. These are released to customers under authentication through contract, which means that the user should have paid first. Most of this geospatial data provision offers either different levels or a certain period of data access that will expire after the agreed period. This type of geospatial data is typically a GD-type business model, which has some conflicts with similar contracts between government-owned corporates and private organisations who used to offer similar types of geospatial data to their customers and clients.

The last, defined as 'closed data,' potentially offers the most valuable insights and knowledge at completely new levels, meaning that businesses can extend new service opportunities. This is because these data are strictly available inside of the organisations who are able to collect, store, manipulate, and analyse geospatial data. This is connected to service usage, and therefore to particular users, meaning that this data can be turned into useful insights, knowledge, and organisational assets, depending on an organisation's human-resource capacity (i.e. data scientists or engineers). Moreover, some of them trade users' data with collaborating organisations with whom they share a purpose and resources, such that the user will ultimately be the one to experience a better service provision. For example, Citymapper sends certain users' data to Gett or Uber under data partnerships so that the user is able to decide on the most suitable transport choice for their journey. Access to these resources (open to closed data) is determined by the arrangement how organisation (actor) participates in the wide service ecosystem and the collaborative relationships with other players—collaborators or even competitors—within the given service system.

That is, the relationship among players can determine how value is co-created in the participating service ecosystem as well as to configure the resources in a given service system. The following section therefore discuss further detail.

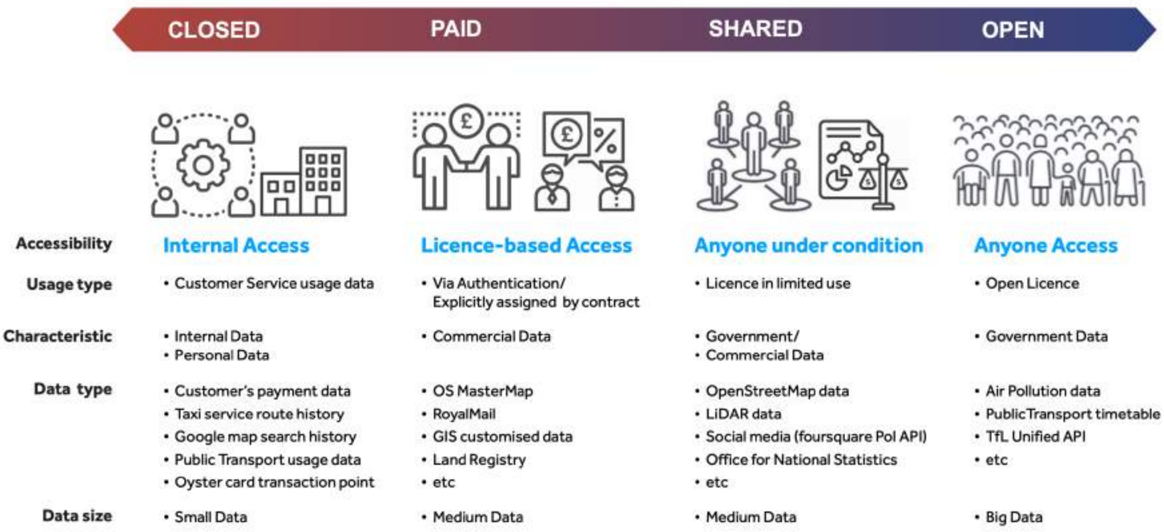


Figure 35. Geospatial data spectrum

7.4. The service ecosystem: A value creation catalyst

This section discusses the relationship dynamics between actors and their interaction in the identified in map/mapping service system, that is, the collaborative and competitive relations and actions needed to generate mutual value and to increase overall value.

Service systems have been defined as “configurations of people, technologies, organisations, and information that create value for all involved, achieving positive economic, social, and environmental outcomes” (Spohrer et al., 2007). In addition, the service system integrates knowledge, skills, resources and technologies across the system to increase value (Vargo et al., 2008). These key discourses, developed by Vargo and Lusch (2004), Maglio et al. (2009) and Vargo et al. (2008, 2015), have extended the Service-Dominant logic as a way to conceptualise the service system and have increasingly been deployed as a way of thinking about value co-creation across a wide range of fields.

Whilst Service-Dominant logic defines value co-creation as experiential and focused on customer experience (Grönroos and Voima, 2013), the consideration of the *human dimension* and the relational aspects between individuals relates to the necessary connection between the creation of value, on the one hand, and users’ experiences of the degree to which the service meets the demands of their projects, on the other. The term ‘service ecosystem’, which is defined as “a relatively self-contained, self-adjusting system of resource-integrating actors connected by shared institutional arrangements and mutual value creation through service exchange.” (Vargo & Lusch, 2016, pp. 10–11) emphasises the role of context and identifies the particular interactions and energy flows of mutual service provision.

These views underline that the technology, infrastructure, institution and individual actors that are tied together in the ecosystem act as catalysts, connecting potential participants and stakeholders in the service ecosystem, thereby maximising the value of the technology and resources (i.e. the knowledge and skills of individual service systems) that each can provide to another. It can be difficult for people to understand the maps and mapping service ecosystem, due to the cutting-edge influxes of technological influences in this fast-moving digital industry. As a result of the four case analyses, a need was identified in terms of developing the frameworks necessary to understand the current dynamics of those actors involved in the service system. This will allow the participant to achieve a higher level of understanding with regards to how each player in the service system operates, collaborates, and utilises resources in a given system.

The four case studies collectively present the vital role of the availability and transferability of shared resources, that is, what is available to share and transfer from one party to another. Each of the four service systems has its own arrangement of resource integration, which means that the technology, knowledge, and skills are tied together and integrated in the surrounding ecosystem. This also enables actors to collaboratively share their resources and determine the value of their co-creation activity as a means to 'becoming' a new resource for value creation in wider service system (Zimmermann, 1951).

In the four of service systems identified in the case studies, the most common and basic principle activity among the four service systems was the utilisation of information from the data infrastructure that was managed by a government agency. The data infrastructure managed by government agencies is made up of the various types of datasets and organisations which store, maintain, and manage the data assets and provide guides for how to use these assets. Open data—such as TfL open data, Ordnance Survey, and statistical data—were commonly used as data infrastructure in the four types of map service systems (cases 1, 2, 3, 4), all of which can be used to provide services to other organisations by providing the data necessary for their service offerings to end-users. One of these organisations not only provides the data and information, but also made geospatial data assets available in greater, scalable detail (case 2. GD), while another collated all of the available data into their service platform in order to generate better data patterns and insights, so that they could offer new services to the end-user (case 3. WL).

This means that the each of service system in maps/mapping exists in its own right but also cannot exist in isolation, since it can only sustain itself *interdependently* through the institutional arrangement of resources that are mutually beneficial for participating parties in the wide service ecosystem. In this way, the value of resources—technology, knowledge, skills and anything enables the action of achieving aim—can be maximised, thus influenced by specific resources of service providers as well as contextual factors that are relative to each of system and its multiple levels of interaction, a network of relationships which is not fixed (i.e. value in context), in line of service ecosystem view on value creation (Valtteri, 2017; Chandler & Vargo, 2011)

In systems with such a dynamic, the data infrastructure acts as a foundation for all. Consequently, a robust data infrastructure should be designed to be as open as possible, so that the all actors can benefit from using it and be part of system, thereby supporting the wide service ecosystem while also enabling it to maximise its value from the collaborative activity between service system participants (i.e. organisational actors). On this view, the use of the same data infrastructure, technology, and service platform means that the participants in the service ecosystem can easily become part of multiple networks and be involved in the organisation's value creation activity, while they also share information and access to the data assets, which is only possible if access is granted by the service system owners in the wide service ecosystem.

Moreover, this view also implies that geospatial data is an essential resource that constitutes data infrastructure, and thus supports all types and sizes of service systems, by stimulating all actors to participate in and to accelerate innovation. This creates value for the service economy, especially start-ups and SMEs, who are less resourced and can potentially take advantage of participation in the service ecosystem through the configuration of resources.

New entrants can benefit by remaining in any part of the network within the service ecosystem, especially since the access to other parts of the network that this would allow is likely to lead to progression in value creation, particularly when similar institutional arrangements guide. In particular, this process can be effectively performed when participants reply using the same technology and data infrastructure towards the same end.

This means that 'real value' can be co-created by joint efforts amongst actors and integration of resources (Valtteri et al, 2017), the configuration of the interaction between various stakeholders and the service exchange between them, and the interaction of several actors involved in the value creation (Siltaloppi, Koskela-Huotari and Vargo, 2016). The service ecosystem utilises the dynamic system approach to further our understanding of these interactions.

In this way, when participants within the system maintain the requirements for the similar data, system specifications, formats and platforms, they can easily move to another service system network, thereby increasing the chance of collaborative activity with the other actors in the service ecosystem. This indicates that the service ecosystem is formed by people, resources, and various types of organisations, which interact at various stages, working together as a system to generate value creation in a new way.

Therefore, this study also argues that the human dimension and its context is essential to the development of value creation in a service ecosystem, especially in relation to maps and the mapping service system, and with particular regards to what needs to be introduced during the design process of this service system in terms of re-configuring the resources and experience to support service innovation.

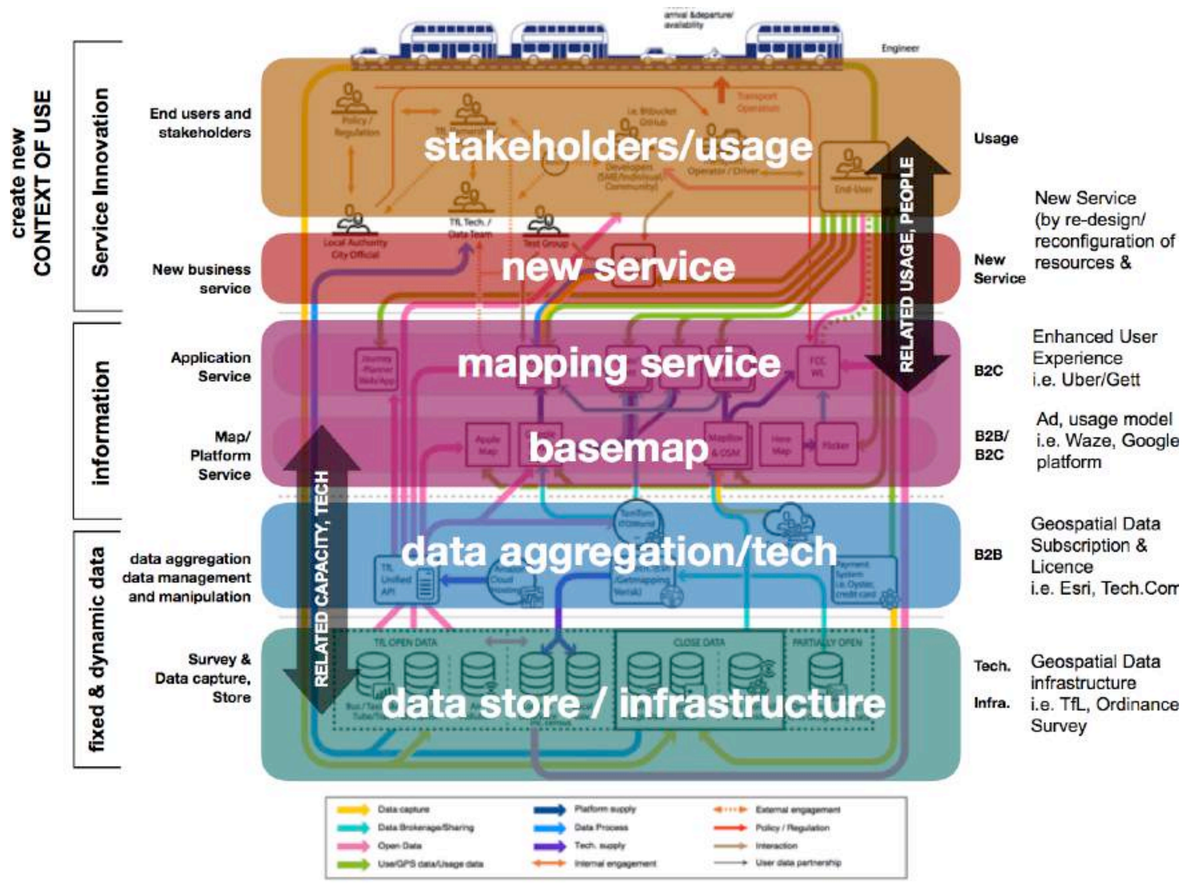


Figure 36. Mapping service system levels

7.5. Practice perspective

The review of service-system studies identified that value is always co-created when the service is used and experienced by users at the point of service delivery. Both mapping and services share these characteristics and nature. In other words, each is experiential and intangible, which implies that their value is only created and perceived when they are delivered, used, linked, and shared at particular moments in specific contexts.

The review of literature and maps sample analysis conducted in Chapter 4 identified that nowadays maps and mapping are abstractions from the service system. Consequently, the design of maps can arguably be seen as the design of service systems. The S-D Logic also supported the view that value is co-created in the joint sphere as a space for value co-creation, where service providers and service users collaboratively interact together (Ramaswamy, 2011; Vargo & Lusch, 2011; Grönroos and Gummerus, 2014). In this way, maps are the site at which value is co-created, experienced, mutually expanded by all actors.

Since mapping and service has a shared ecological meaning, the value co-creation under discussion is context dependent, relational, and requires a new form of interaction that configures relations between people, technology, knowledge, and organisations, all of which are involved in the surrounding system and environment. In this way, value is rearranged and co-created by many actors, each of which are involved in the system. This means that value-creation in mapping is more than an action or activity, but is dependent on the abilities of service systems for the integration, maintenance, and interaction with their surrounding contexts, as well for the influence of relationships with associated service-system components.

Since maps have now become processual in their nature, and the streaming of geospatial data can now be treated as a form of mapping, service design can involve design of data streaming for particular users in particular times and sequences. This means that service design can be treated as the design of experience, interactions, and new resource integration. Therefore, efforts should be made to capture the usage of data in the service system, the involvement of the efforts of each actor, and the integration of resources (i.e. experience, skills, and knowledge), in order to further value-creation in mapping-service development.

The emergence of service design has been recognised as adding significant value when it is applied in a complex system (Design Council, UK.) It is also involved in integrated approaches to the design of human-centred experience, including socio-cultural, economic and technological systems. This means that service design implies a holistic approach to the design of experiences and systems. This requires the integration of multiple design disciplines in the development of a systematic solution, which has capacity to offer a range of multidisciplinary tools and methods that are used to identify, define, develop, and deliver innovative services. Service design is intended to optimise a complex system and to stimulate disruptive innovation, thereby delivering new levels of value for multiple stakeholders. This is particularly evident when the service design involves human interaction and reformulates problems via design-based solutions and user-centred service systems that fulfil users' desired purposes and services.

To design service systems in mapping terms involves reflecting on the central and unique role of individual human beings, whereby everyone should be involved, thus deepening the understanding of how people use service systems and what needs to happen during the design process in order to reconfigure the service system in a mapping context.

Service designers can use tools and methods derived from the service design discipline so that the field of service design can better interpret and re-design the service system.

Through the design case study described in chapter 6, service design in particular appeared to produce value in following way.

Capacity to understand how people interact with service system

Service designers fulfil multiple roles as part of a complex system: they disclose possibilities, resolve issues, and develop strategic approaches. In addition, they are adept at explaining the nature of the problems faced; communicate their understanding of complex structures; and implement the proposals that have been agreed upon (Moritz, 2005). Through conversations with a range of different entities—such as local authorities; providers of geographical information; technological services and other experts—service designers deal with and evidence environmental and social concerns.

In this process, the visualisation of specific actors (e.g. stakeholder mapping and users' journey mapping) and its narrative (e.g. persona, storyboard) represent relationships as holding between person-to-person, person-to-system, and system-to-system in the surrounding system. It also allows a touchpoint matrix to be built, which illustrates the characteristics of the system, connected actors and the context, thereby identifying problem areas and opportunities in a much more systemic manner. In this process, the skills required to construct these visualisations not only facilitate these relational representations, but also build upon the ability to collect, interpret and transfer the experience of involved actors into tangible representations in a meaningful way.

In this way, the service design involved maps and mapping services does not stay bound within the field of visual representations, but also reaches out and draws upon a variety of materials from a number of different sources, all of which can be put into practice and upscaled in response to concrete problems in physical locations.

There is also a **collaborative process that requires the co-creation of value through a human-centred approach** so that service design is able to optimise a complex service system through resource integration, thereby driving disruptive innovation.

Service design is a way of conceiving interpersonal behaviour and articulating problems. It facilitates dialogue and collaborative activity through either allowing actors at an early stage of service development to observe behaviour of involved stakeholders in the service system, so that they are helped to develop a holistic understanding of their needs and desires.

Service design develops solutions that allow its services, which place the user at the heart of its practice, to meet the wishes of a broad range of stakeholders (Brass & Bowden, 2009; Ostrom, 2010; Segelström, 2010). As Ostrom puts it, service design is a "collaborative, cross-disciplinary activity involving the orchestration of clues, places, processes, and interactions that together create holistic service experience for customers, client, employee, business partner or citizen" (Ostrom, 2010, p.17). Furthermore, service design takes a holistic approach to the way in which systems and user-experience are designed. This requires an interdisciplinary attitude so as to reach appropriate goals. In this sense, the role of actors involved in the service system extends their role to the participation in the co-creation process, from the providing information and the service design tools helps, to jointly developing the desirable possibilities. With this in mind, we can highlight respects in which service design has made a major contribution to map-based services.

This capacity emphasises the human-centred process in order to identify specific operational and customer needs.

Once we see that the creation of maps is an act of co-creation, we can recognise that service design encourages collaborative projects, owing to the distinctive way in which it draws together resources and procedures, such as blueprints and stakeholder or user-journey mapping. These methods are open, interactive and transparent, which help designers to be more communicable, accessible, participatory and holistic. When held up against more traditional methods of design—such as task analysis, sketching and modelling—it is clear that the more compelling approach advances the participation of users and creative collaboration across disciplines. This view falls in line with the "mindset and an attitude about people" (Sanders & Rim, 2002, p. 1.), which turns the concept of design *for* people into design *with* people. By virtue of the discipline of service design, developments in map-service can further promote the involvement of different levels of information in map-design, as well as encouraging further engagement, by finding ways to represent the high level of complexity of systems and networks. Since these are central to improving user-experience, they are a central area of concern for designers.

Therefore, the rationale for exploring service design in mapping lies in the theoretical explanation of services while also defining service systems in terms of maps/mapping. Furthermore, service design provides a highly appropriate way to utilize resources and facilitate engagement with stakeholders, thereby involving them in the value co-creation process.

7.6. Towards a new framework

The development of the service ecosystem in mapping depends on the given industry. Since the geospatial data and mapping industries have been wired into the digital space, the mature level of new digital business models in mapping are based on their capacity to deal with the abundance of data and how each map/mapping service system is sustained within the wider service ecosystem.

Each service system is connected to another service system and responds to the specific situation and context. The use of digital mapping services and products (i.e. service systems) generates a huge amount and variety of data so that its collection requires technological tools (i.e. software), platforms and human skillsets to interpret and visualise it, which is beyond the capability of automated software.

Methods of creating new business models and service should be organised within the service providers' service networks, which aim to serve customers and service providers themselves. The technological shift in mapping—such as the variety of new types of geospatial data generated by smart products, the IoT and digital networks—play critical roles in weaving the new relationship between data, people, places and things as the new fabric of digital infrastructure and service networks potentially leads to new business models and additional map/mapping services.

Although the established ways of operating and developing mapping products and services have been repeatedly challenged, we also have little empirical understanding of how recent changes have disrupted service innovation in mapping. Consequently, the framework developed in this research potentially provides useful insights regarding the current mapping service system, given the reconfiguration of current resources and actors. In this way we may be able to imagine future map/mapping service (eco)systems.

Building upon the findings, the final framework illustrates the service ecosystem in map/mapping as presented in Figure 37, which demonstrates the interaction between different players, service systems, technological progress and the relationship between the resulting map/mapping service ecosystems. This framework recognises the different areas of opportunities for maps/mapping services' development, and these approaches significantly differ from one to another. One approach is driven by technology in which opportunities arise from the capacity of technical specification and feasibility. It is also an area of improvement for service design to fully operate in the system. Another approach is people oriented, entails the understanding of users and a holistic view of the complex system, in which the service design has strong competence in the area.

It will be particularly useful for service providers to consider different actors, relationships and ideas in the system, thereby generating valuable insights. As a collaborative process, it can build an understanding of a data service ecosystem across different stakeholders; in this way, the end product acts as a communications tool to support engagement across the service ecosystem.

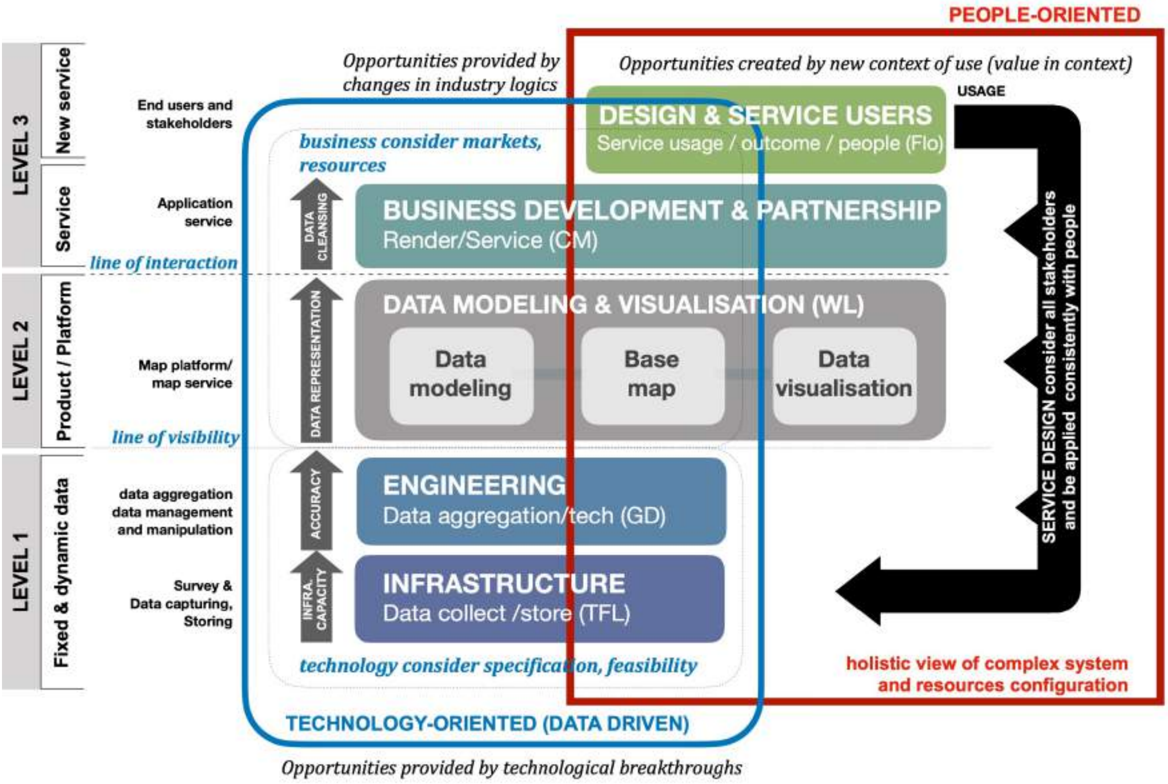


Figure 37. The final service ecosystem within a map/mapping framework

The development of digital map/mapping services (i.e. service systems) will be described at different levels of the service system. At the lowest level is infrastructure; followed by the presence of the given system or product/service that enables the collection; and finally, by storage and usage-oriented data, whether these are open, shared, paid for or closed datasets. The specific contexts of this data collecting, modelling, and rendering will clarify the service, while having the potential to lead to new map/mapping services.

The lowest level of this mapping service system is *data infrastructure*, wherein the data generated from the use of the given infrastructure is stored and collected. This level is often tied to the physical product or platform which consists of location-aware sensors or physical objects (e.g. buses, tube trains, buildings etc.). In this space, government agencies are responsible for managing and ensuring access to technology, physical products and services, and also the relationships between them. There are important considerations concerning this data infrastructure level: for example, the data generated in this system should be compatible with other systems as well as being easy to connect to other physical and digital platforms, while having the capacity to manage an abundance of data through hosting or cloud storage. In this way, the recipients or beneficiaries of this data can easily formulate and manipulate it.

This means that the sensors on the physical system are wired to a network of information and service components that communicates and processes data (resources), which is integrated with the environment. On this approach, the digital and physical objects are tied together. In other words, the openness of the data of this infrastructure its data is dependent on its capacity. Two types of activities are essential at this level: firstly, the data infrastructure needs to generate various types of data and information; secondly, these data should be presented in a standardised format that is common to the service ecosystem so that any actors can utilise these data without being siloed.

The following stage—defined here as *data engineering*—is where data aggregation, management, and manipulation are processed. At this level, various types of data can be remixed, whether fixed or dynamic data from government, open or third party data, either collectively or on their own. These data are collected, analysed, and transformed into a new dataset which potentially reveals useful data patterns or insights, mainly for business purposes or further usage within a given firm. This level uses infrastructure data but also provides technologies and techniques to the infrastructure side for mutual benefit. Furthermore, this stage mainly uses software or tool-based platforms which integrate various types of information into their cloud-based platforms in order to assist users in extracting, analysing and presenting data to meet business users' needs. These are known as “Infrastructure as a Service (IaaS)”, “Software as a Service (SaaS)” and “Platform as a Service (PaaS)”. This stage focuses on making data usable for other third party businesses. Any services or products resulting from this process, however, are not visible to end-users.

Modelling and visualisation platforms/products comprise the second level. At this level, the dataset available from level one is analysed and presented in the mapping application for both third parties and end-users. This dataset and its application are connected to physical smart products (i.e. mobile phones). Each connected device can be understood as a hub that generates new datasets and networks with rich data indicating specific times and locations. While data is being consumed, it is also produced simultaneously via the smart device through the given mapping platform (i.e. Google Maps). Therefore, the basic data information potentially turns into new knowledge (i.e. smart data). In this way, the digital platform and physical object are fused together with the intention of selling the use of a service or product (i.e. applications), instead of focusing on the application only. The masses of data (i.e. Big Data) collected by smart devices should be analysed in real-time using information extraction methods and intelligent algorithms to generate new knowledge. The real-time data collection here is very important, otherwise the reality is not shown and customer needs cannot be satisfied.

The third layer consists of the *service platforms* (B2C/A2A). These platforms enable the individual user to connect to both digital and physical services directly. This level utilises the base map platform as a common platform to provide real-time information to meet users’ needs or to connect users to other services (i.e. applications). Furthermore, the *service platform* gains a great deal when it connects users to other users, or a user to another service, through shared resource integration. This allows service providers to optimise various types of information, which can then lead to the creation of new digital services or business models. However, to make this work the information and service systems should be connected to the digital mapping service ecosystem, allowing the companies to use, combine, and transfer their resources (i.e. knowledges and skills) through mutually beneficial partnerships. During participation in the wider service ecosystem, the service provider integrates a collection of processes, applications, data, and technologies including software, hardware tools, methods or users. When these are implemented together, they are able to consolidate and connect the resources into seamlessly integrated service system components that allow service exchanges, while reformulating information and knowledge within the firm. These activities are connected in the application platform and it is necessary to analyse which and how users benefit from deploying the service.

The mass of usage data that is collected by smart devices and application services should be analysed in real-time with intelligent methods of extracting information and algorithms to generate new knowledge. Real-time data collection is critical, so that customers' needs can be made visible and accomplished. Building on the S-D Logic premise, one of the key elements is *usage* orientation in the mapping service system. The value creation in this service system needs to focus on the specific *situation* and *context of use*. The service usage and users' activity should not be interrupted, but should be completely understood at their specific times and situations in order to integrate the given user's value-added activities as a means to create a *new context of use* in terms of service development. More service users engage with the service and there are more participants in the service ecosystem, meaning that only single providers with their classic service provision are no longer in focus. The focus should be on the users, their *expectations* and *experiences* as perceived at specific times and spaces through the appropriate integration of resources.

To do this, the design of service system in mapping should reflect the **human at the centre of the system**, since they play a unique and central role, taking action based on their experience of the system and its technological features. All actors should be involved in this space and should understand how people use and interact with the service system and reconfigure it in relation to mapping in the context of service innovation.

While the other four steps are technology-oriented and self-sustaining, they are also slightly isolated from one another. Consequently, this user-centred approach can be adopted more flexibly and holistically while engaging with people and creating new services on scale, rather than looking at the available resources which are mostly driven by technological advancement.

In this way, human-centred approaches – especially Service Design – has acknowledged this dynamic and can provide useful approaches and tools to interpret and re-design the mapping service system.

Chapter 8. Conclusion

This thesis extends the theoretical understanding of digital maps and mapping from a service system perspective. It advocates service design as a means of providing methods to assist the implementation of digital maps, while also outlining a framework that not only enables participation in mapping service systems but also assists practitioners in the re-design of service (eco)systems through the reconfiguration of resources using collaborative approaches, thereby maximising value co-creation. This chapter concludes the thesis, detailing the contributions to theory, methods, and practice that have refined and consolidated value co-creation in service (eco)systems in maps and mapping models, while relating these contributions to practice. In closing, this chapter delineates the limitations of the thesis and discusses directions for future research.

Section 8.1 briefly reviews the research activities of the thesis and discusses how its findings have implications for evolving knowledge development in established theory.

Section 8.2 highlights the findings of the research activities and demonstrates how these findings and the study's outcomes have the potential to be implemented practically, identifying possible beneficiaries of this implementation.

Section 8.3 points out some of the limitations of this research project. It is important to remain aware of the conceptual and empirical limitations, especially if the findings are to be applied in a practical different context.

Section 8.4 suggests some future directions that could be pursued in light of the findings of this doctoral dissertation.

8.1. Implications for cartography, service systems and service design

Advances in digital technology have altered mapmaking and the ways maps are used so fundamentally that their value as artefacts has been profoundly altered. As yet, there is no substantial body of theoretical and empirical understanding as to how these changes have created disruptive innovations in the established maps/mapping industry, nor has there been to date any substantial interpretation that is deeply engaged with the emergence of the service economy.

This study has offered a comprehensive review of how the new mediatisation of maps and mapping has fundamentally, and rapidly, transformed the generation of geospatial data and information. This thesis has identified transformations in the spatial behaviour and knowledge of users with regards their understanding of the nature of maps; processes and forms of the creation of maps themselves; as well as the development of the understanding of maps as a service system, rather than a skilled process conducted by a traditional specialist (i.e. GIS, surveyors etc.). The proposed research aims objectives were accomplished through three research activities by which evidence was compiled the key impacts of this study were detailed:

In the first study, technology is the primary driver of change in mapmaking mechanisms as a whole, suggesting that both the ontological and epistemological understanding of mapmaking has shifted. These changes include the following:

(1) Technology drives users to be involved in the mapmaking process, resulting in permeable boundaries between mapmakers and mappers. Consequently, the role of the user has become more democratic and critical in the mapping process;

(2) The complexity of data and the capacity to transform data into information, knowledge and experience has opened up new ways to utilise maps as participatory platforms, thereby

enabling engagement and interaction with stakeholders who are interconnected with various resources;

(3) Maps have become a service system. The outcome of the process of value co-creation between users and other key stakeholders has opened up opportunities for new services and new mapping experiences;

(4) The expanded usage of maps has become diversified and highly personalised, while the user's experience has been significantly enhanced; maps are now used for service components and new service offerings through accumulated data generated by the usage of maps.

Together these developments have the consequence that when maps start to function as participatory platforms, they also become value co-creation systems, meaning that design in mapping becomes the design of service systems. For this reason, cartography seems to have become obsolete, leading to a de-professionalisation or a re-professionalisation around which new disciplines are required. This indicates a great area of potential for (smart) service systems, thereby creating a space for cartographic theory to inhabit a new area from the service study perspective. This study argues that maps/mapping have become a service system facilitating value co-creation. In particular, the study demonstrated four different types of service opportunities, challenges, and the relations between them, while also highlighting key stakeholders involved in the wider service (eco)system.

Whilst the study of service systems provides an appropriate angle from which to understand maps and mapping in the context of the technology and service economies, the literature on S-D logic highlights that although services must ultimately be experienced by the customer (Vargo and Lusch, 2008), the service provider supplies the focal point of value offering (Strandvik et al., 2012). In this way, the literature downplays the role of the user in perceiving value, emphasising instead that value is created through co-creation. The concept of how such an ecosystem is constructed has been analysed by many authors from various perspectives, but most of these analyses are theoretical in nature with no clear material implications.

In light of this, the case study in second research activity demonstrates four different types of service system and business models in maps/mapping and offered empirical evidence regarding how service opportunities are developed in each type of service system. It identified how "value is always uniquely and phenomenologically determined by the customer", which contributed to addressing gaps in knowledge where the recent service literature confirms that there is inconsistent understanding of value and value co-creation (Grönroos and Voima, 2012).

The second study also offers a view of various approaches as well as considering various types of innovation, such as that driven by technology and markets (e.g. Vargo et al., 2015). In particular, this study argues that these innovations cannot be separated from the surrounding system and multiple actors who act to co-create value (e.g. Siltaloppi, Koskela-Huotari and Vargo, 2016). This view essentially claims that value creation is shaped by the characteristics of a wide range of systems as well as specific actors.

This means that value can be co-created by other resources. The configuration of the interaction between various stakeholders; the service exchange between them; as well as the interaction of several actors involved in the value creation can also be co-created in these ways. The service ecosystem utilises these dynamic system approaches in order to understand these interactions.

This indicates that the service ecosystem is formed by people, resources and various types of organisations. These actors work together as a system to create value in a new way. In light of these considerations, this study also argues that the human dimension is essential to the development of value creation in a service (eco)system, especially in relation to maps and mapping. As Larson (2016) has argued, the design of a service system reflects the central and unique role of individual human beings, even though a deep understanding of how people use service systems requires a broader view in which all participants are taken into consideration, as well as what needs to be introduced during the design process in terms of re-configuring the service system in service innovation in mapping context. Service designers can bring useful tools and methods of service design so that their expertise can help to improve interpretations of the service system and lead to improvements in its re-design.

In this sense, the third study incorporates these various concepts into one interpretation, focusing on practical implications. It provides a description of the service designer's role within the design project. In this way, the contribution of this study is to extend service design further into the service system, thereby extending its territory and also pushing the boundaries of service design discipline into new areas. Obscure and highly abstract level of ideas of service systems and their implications can now be more precisely segmented into more specific and meaningful categories. The empirical literature on cartography, service systems and service design use terms and concepts related to their respective domains, but in this study important conceptual overlaps have been identified and matched with other relevant concepts.

This review has covered the fundamental of nature of map changes from a service perspective, while underlining the potential that service systems have to contribute to maps/mapping, aligned with the principle of value co-creation in the service system. Additionally, it included an exploration of the role that service design has played in improving value co-creation as a useful tool and method of understanding the human dimension. These considerations have led us to propose a redefinition of the designer's role, namely as a facilitator of value co-creation in the map service system.

In this role, when service designers design maps or a mapping service, they are in effect designing service systems and thereby take a human-centred approach in the facilitation of the engagement of key stakeholders in the complex service systems. This view is connected to the observation of both the de-professionalisation and re-professionalisation of the discipline of traditional practices and practitioners, such as design and development in cartography, and the geospatial service system. Therefore, the study of the service system extends cartography into new spaces wherein the study of service design may contribute to the realisation of the service system. This will extend the boundaries of both cartography, service systems and service design into new territories.

8.2 Applications in practice

Despite a number of empirical and industrial interactions with maps and mapping supported by technological advances, there has been little focus on the value of maps/mapping services and how these challenges take place in existing social and economic contexts as well as in established business models (i.e. service systems). Different forms of geospatial data and mapping services operate as both sustaining and disruptive innovations that are deeply implicated in the emergence of the service economy.

The thesis also recognises that the scant empirical understanding of the way in which actors participate in service (eco)system means that the labour in the production and practice of the development of mapping service systems is not clearly articulated in terms of service studies. It is important to highlight the link between service systems and service design in the activity of value-creation. It is also valuable to underline the practical capacity of service design, so that its method can be better understood and realised by firms (e.g. digital enterprises such as Uber) who require a clear understanding of dynamics and business hierarchies in competitive industry, thereby offering a better understanding of service strategies rather than relying only on service designers.

The case study findings have practical applications in three ways.

First, they serve as examples in context, providing specific and comparable descriptions of four types of existing service systems (i.e. business models) in maps/mapping across four firms. They illustrate both the service ecosystems of these firms—highlighting both business models and opportunities—while also drawing attention to some of their inherent challenges.

Second, they demonstrate the value exchange between four identified types of service system and the value co-creation between different type of users, service providers, technology or platform partners, and potential beneficiaries. This demonstration involved descriptions of the ways these actors related in the maps/mapping of the wider service ecosystem.

Lastly, they describe how service design competence may lead to increases in or improve value of co-creation through the interpretation of a service system. It also demonstrates the constraint and area of improvement in order to fully engage with given system and to collaborate with other discipline, thereby value can be both maximised and realised.

With the framework and complementary documents detailing all actors and their relationships in the service ecosystem, this study is particularly valuable for small firms such as start-ups, SMEs and/or organisations seeking a more strategic use of resources who are aiming to redesign or leverage existing services in different ways.

8.3 Limitations of the research

8.3.1. Scope and depth

Although it is exploratory in nature, this research is broad in scope due to the subject under study. Cartography has been a topic studied by many notable scholars in geography and the humanities more generally through both academic and practical endeavours. In addition, service studies have also played a role in the fields of business and marketing. Although there are boundaries of scope and depth in every study, this study has attempted to satisfy its research questions and achieve worthwhile answers. The literature review undertaken at the start of this study sought to understand the nature of maps in the context of digitalisation in the service economy.

The review of cartographic study focused primarily on the theoretical understanding of cartography and how the dissemination of cartographic information to users has been impacted by technology, as well as the effects on dissemination caused by the service economy. In light of this, the study of service systems and service design offered an appropriate angle from which to understand the nature of maps/mapping and ways in which these can be realised in the creation of real value.

The theoretical contributions of service science studies have been recognised in the literature on marketing and business, especially in relation to value creation and customer value, while service design has more recently been recognised in the designing of services, with its systemic orientation whereby service designers potentially play a crucial role in allowing the customer to perceive value in various fields. Therefore, the literature review focused primarily on value creation in mapping from a service system perspective and identified major elements of the understanding of the nature of maps influenced by technology and digitalisation, rather than relying on a digital platform or digital enterprise perspective. The main theses derived from the literature, alongside the concept of value creation, were used to analyse map samples as described in Chapter 4.

Further details about the contribution of this thesis could be added by reference to the particular disciplines of study. There are, however, few studies that require us to take full account of the role of service designers in the development of service opportunities with regards to certain activities. A detailed and systematic exploration of all these activities is beyond the scope of this thesis. There were, however, notable differences between each case group, and the research activities contributed to the identification of the potential role of service opportunities, as well as the contribution of service design.

The findings from the interview respondents and related observations may not amount to ‘objective truths’, and also rely on a number of influences. The case study and design case study is based on rich data collection and has led to many interesting and appropriate insights; however, it would be much more beneficial to understand the context and relationships between the cases, rather than focusing on the resulting evidence of the fundamental issues.

The data analysis and the depth of analysis may require more application of phenomenological research methods, which may lead to new discoveries. Such an approach might be pursued in the future.

8.3.2 Research design

Through the qualitative case study approach, which uses an exploratory research aim, three sets of research methods have been set out. The first study used content analysis to identify the fundamental dynamics of the changing nature of maps. At this stage, 60 of the 250 map samples were collected and analysed in the context of the service system literature. This demonstrated both the ontological and epistemological status of the changing nature of maps, which led to the initial framework development to assist with contextualisation, which was highly useful for this stage of the case selection in the main body of the research, namely the case study.

The main body of the thesis pursues the second stage of research through the examination of four case studies. The case studies sought to identify certain types of maps/mapping businesses (i.e. service systems). This task presented opportunities and challenges of its own, in relation to the development, in each case, of mapping service systems while identifying their relationships. The approach used in this study was developed mainly on the basis of case study principles (Yin, 2003). The case study method means that the findings arising from this study may not be generalised to other contexts and situations without considering the ways in which the original case is unique in its own right.

The case study method was appropriate in terms of combining both beliefs and observable phenomena with sufficient depth and breadth in order to meet the case study aims. In this way, it was more feasible to ask and observe, rather than to pursue deductive hypotheses testing, which commonly involves altering variables and measuring the effects of these changes. Participant observation as part of the case study data collection also provided a much deeper sense of what is actually happening, without the researcher interfering and/or influencing the participants and context. This was particularly important in this case, since this study involved complex contexts and phenomena.

Interview groups and field observations for four cases provided a deeper view and understanding of the context from a variety of information sources and perspectives. In all, four firms were directly represented in four case groups, while many more professionals with major firms whose experience spans decades provided information indirectly. These participants were able to express their relevance to the identified case group. The view from each group, as well as their interactions and relationships with other firms within the wider maps/mapping service ecosystem, were therefore well represented. The study tried to identify the relationships and interactions between key actors/stakeholders connected to this study topic. In addition, each case's service system diagram, as illustrated in the case study, relays the current service ecosystem in maps/mapping terms, which is also highly useful in the demonstration of service exchanges and mutual benefits, hence deepening the findings in terms of further contextualising study three.

In order to extend the conceptualisation and implication of the service system dimension beyond the main body of the four case studies, the collaboration with TfL as a separate design case was conducted using a more participatory case study method. This approach offered insightful reflections on the researcher as a participant observer and also practitioner to a certain degree. In this way, the design case study provided an opportunity to approach a wider range of professional practitioners and researchers in the service design field, at both a theoretical and empirical sampling level.

In general, given the time and resources required during the period of doctoral research, the study has reached a sufficient level of depth, rather than generating endless detail. Although the design project was not actually implemented in the market, its potential effects have been measured by professionals in the field through Service Design Network 2017, who pronounced service design project the winner in the category of business innovation in private sector. As a result, the thesis provided substantial insights and met its research aims and objectives under the participatory case study method.

The researcher's own observations, in addition to publicly available data/information, contributed to the breadth and triangulation of the findings. The study would have benefited from more contributions if the service design project was actually implemented and tested in the marketplace, thereby offering the opportunity to demonstrate the results of service design within the industry, rather than pursuing a prototype-based test. However, this was not possible due to both the nature and timespan of the doctoral project and dissertation.

8.4 Future research

In conclusion, this thesis has contributed to increasing the academic knowledge about service systems, thus extending cartography into new areas in which service design can contribute to the realisation of the service system. While this study expands the boundaries of cartography, service systems and the service design discipline into new territories, a number of areas warrant further research, both theoretical and empirical.

Despite the importance of value co-creation as a recognised area of service systems, and the importance of the logic of value co-creation in the emergence of the ecosystem – which is forcefully illustrated by the empirical results here – the majority of the research literature to date has not directly considered platform enterprises, entrepreneurship or the more nuanced perspective of digital platforms, which remains to be explored by future research.

The adoption of digital platform and ecosystem approaches to understand the future of platform and digital entrepreneurship also holds promise for future research. For instance, a focus on areas of service platforms that deliver comprehensive understanding of how platforms use technology and explore ways to unlock resources that create new forms of value. This would aid find potential direction and achieve the transformation of the economic landscape (see Parker, Alstyne and Choudary, 2016). Platform ecosystem and disruption that define platforms as products, services or technologies are the foundation for an innovative business ecosystem and advanced digital technology and their rapid transformation in the area of products, service and system in established industry, while the existing study offers a view that accounts for disaffection on the part of technology complements rather than end users as the main reason for disruption (see Gawer and Cusumano, 2013; Ozalp, Cennamo and Gawer, 2018).

Especially in the new industrial era, industry 4.0, there is a focus on intelligent and smart service systems which can be applied to the many platforms and service areas. As these revolutions are mainly derived from the use of IoT, immersive technology, AI, robotics, autonomous vehicle and many other intelligent systems and platform on customer experiences, there is a great degree of expectation with regard to creating new forms of value. These expectations regarding technology and abstract strategic intent delivers effectiveness, speed and alignment in greater scales but has not fully materialised into the efficient, tangible, practical knowledge that would make it happen in a sustainable way in wide service ecosystems.

As many services today are provided by large service systems, such as information networks, ecosystems, firms and governments, these systems and organisations are simultaneously embedded in inter-organisational networks and ecosystems to increase their scale and drive complexity (Shipilov and Gawer, 2019). The success or failure of these systems depends on how they manage the dependencies on each other and the joint dependence on their external environment and ecosystem (Pfeffer and Salancik, 1978). This means that the implementation of service systems relies on the capacity to adopt multi-disciplinary approaches to understand the interaction between people, information, technologies, resources and other service system components, which in turn can enrich the value co-creation process. However, as stated in the previous chapter, the fundamental issue is created both by constraints and incompatibility between *how technology functions* and *how human autonomously beings behave* in this system when we focus on both the system and people.

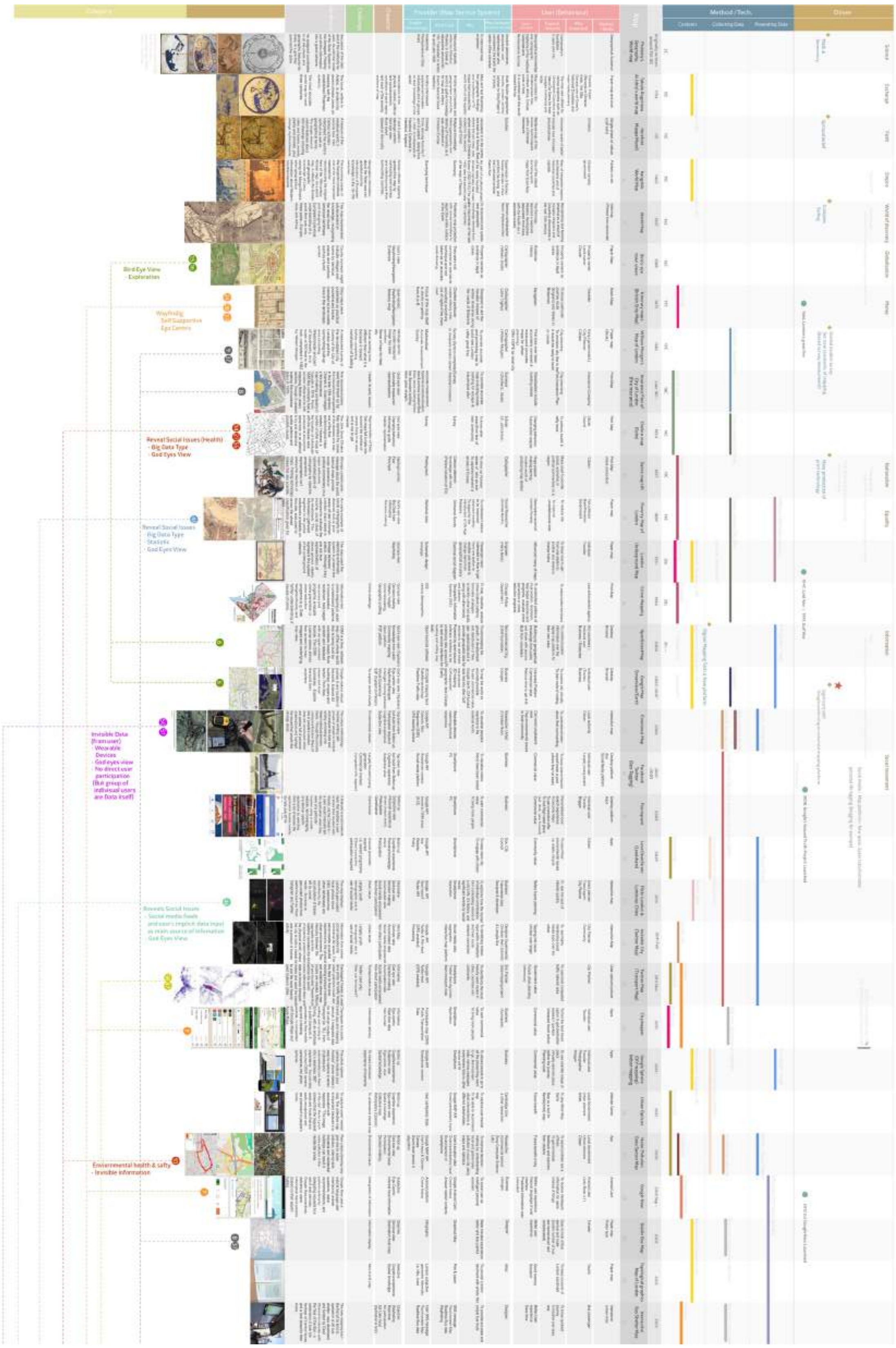
Taking these factors into consideration, future research can extend existing research and could shed light on providing a useful lens to look at the service design context. As this thesis has identified two different approaches, namely technology-driven and people-oriented service opportunities in the mapping ecosystem, the holistic view of complex service (eco)system would enable the system to become more accessible to people. In this regard, the human-centred approach to service relationship is one of the core competencies of designers in which service design has a strong competency, thus forming service design's constraints and improvements in order to fully operate in this service ecosystem, an area that has not been fully defined in existing research on service design.

Although this thesis recognised areas in service design and approaches, future research directions would provide a useful lens to address areas of improvement identified, by providing empirical results to validate the proposed framework, which can be adapted for a wider study in difference industry sectors or scales, going beyond just a descriptive representation. This also means that future research findings can be developed into a tool to facilitate the development of a service design innovation that is inherently valuable for the business.

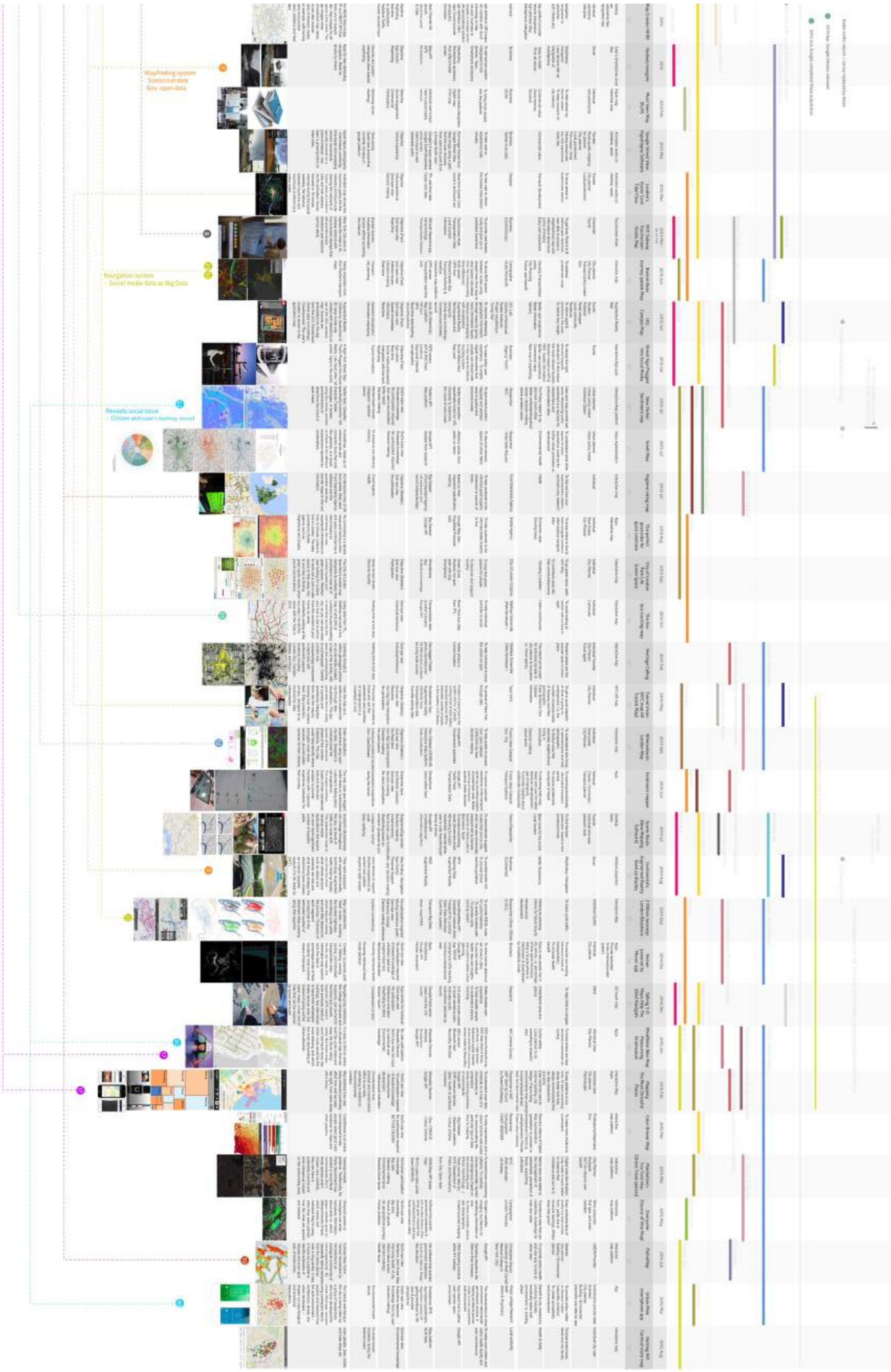
This thesis has contributed to the academic knowledge regarding service systems, thus extending cartography into new areas in which service design can contribute to the realisation of the service system. Given the importance of the digital platform in service innovation and further development of value co-creation and its real implication in the context of service ecosystems, more coherent and detailed formulation of service platforms and contribution of service design would stimulate digital entrepreneurship and accelerate innovation. Lastly, future research outputs and projects around these considerations can broaden the boundaries of service ecosystems, digital platforms and service design, which can be valuable to both academic and practical understanding of the concepts and can thus create a positive impact on the service economy.

Appendices

Appendix 1. Map sample analysis

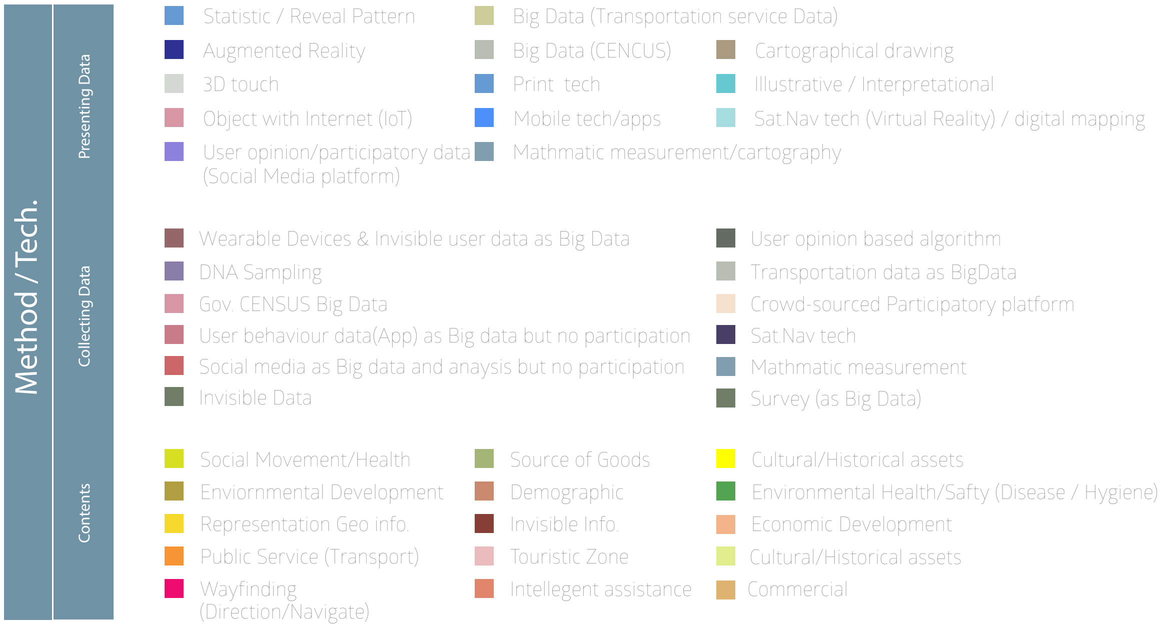


Continued from previous page

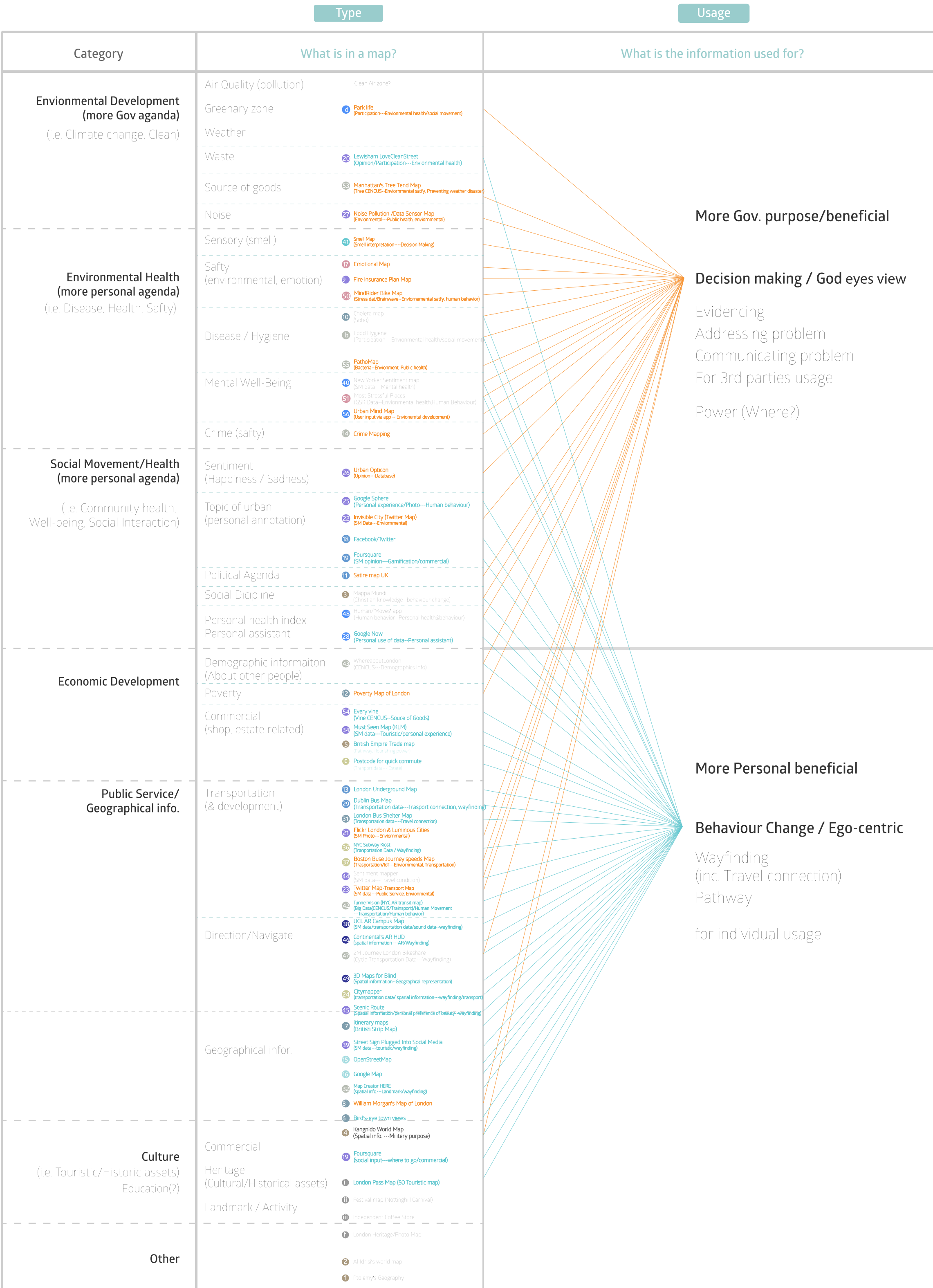


Original file available from:
https://drive.google.com/file/d/1PNVSHBJNd1tOvw09QBx3BTQQEoLGTyy7/view?usp=sharing

Appendix 2. Map sample analysis – technology type



Appendix 3. Map sample analysis (usage)



Appendix 4. Service ecosystem and players in geospatial industry

The relationship of the actors participated in the service ecosystem in the geospatial industry, which data based on the 2018 (UK only).

Type	Case	Player	To	What they do	Service	Data Type	Description
Private Org.	CM	CM/SmartRide	CM	Transfor CM user info. to SmartRide	Public transport transit / on demand mobility	Close	London-based transit app Citymapper developed service-Smart Ride, a hybrid bus and taxi service that will take riders around a fixed network in the capital.
	CM	Uber	Uber	transfer user	on demand mobility	Close	CM. Incorporating with Uber, share their user data into Uber (competitor) for the multi-model transit service although they are competitor, but CM enhance user experience by transferring user to the most relevant transport choice. By Sharing the user into other platform, CM able to understand
	CM	Gett	Gett	transfer user	on demand mobility	Close	CM. Incorporating with Gett, Google maps provide platform as base-map, TomTom provides data for navigation and traffic. They not build up their own map platform. By sharing user's destination information and choice of transport mode.
	CM	Mobike	Mobike	transfer user	on demand mobility	Close	CM transfer users to Mobilke. Same as Gett, Uber
Gov.	CM/WL/GD	Ordnance Survey		Accurate GeoInfo.	Geospatial Data sharing, selling	Partial	OS. Ordnance Survey (OS) is the national mapping agency of the United Kingdom which covers the island of Great Britain. Since 1 April 2015 part of Ordnance Survey has operated as Ordnance Survey Ltd, a government-owned company, 100% in public ownership. While OS possess a digital government monopoly on geographic data in the UK as a government agency, OS entirely reply on commercial sales of their data and product even though they play official and public suppliers of geographical information. Some of OS data is available for free of charge under OS Open Data licences that allow people to copy, distribute, transmit and adopt data which include raster and vector mapping, heights and boundary related product. (OS, 2017)
Private Org	GD	GIS (Esri, GeoInformation etc)	OSM	Financial support	GI, GIS product selling, consultancy		Esri, GD --> GIS service provider
Non Profit Org.	WL	Open Street Map		Bottom up info.	Community mapping	Open	OSM. OpenStreetMap is an open initiative to create and provide free geographic data, OSM us a community interest company, was founded in December 2004 to support and encourage businesses to contribute to and use the data.The Project based at OpenStreetMap.org is the worldwide mapping effort that includes over two million volunteers around the world.(OSM, 2018)

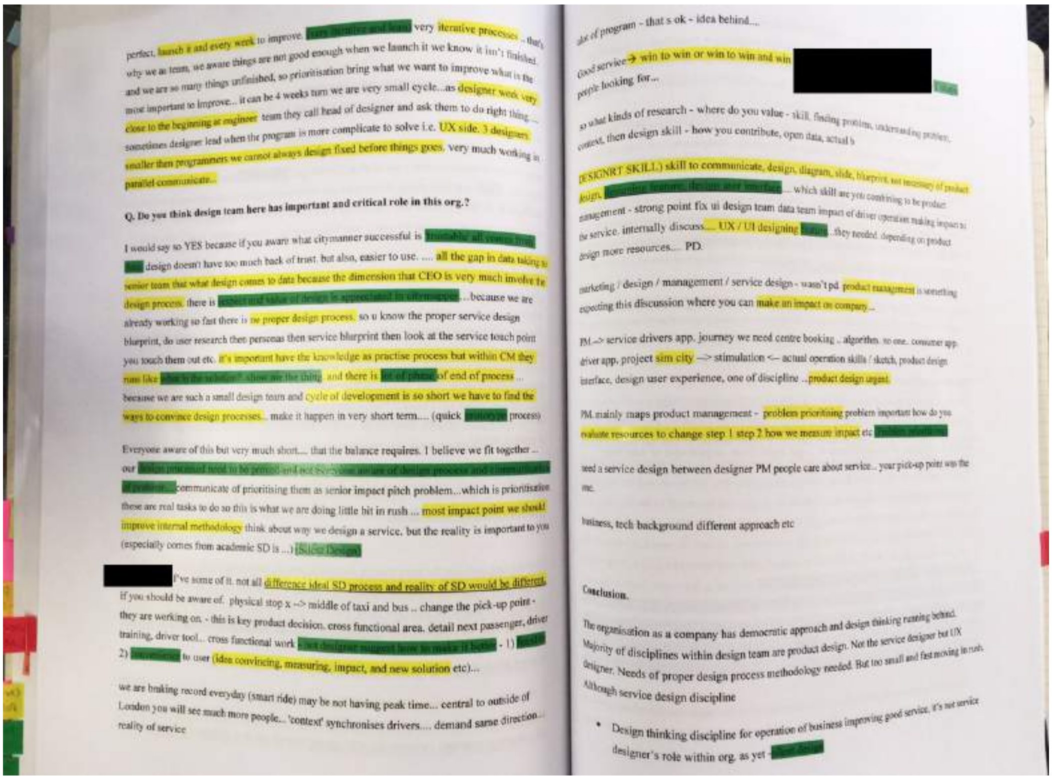
Non Profit Org.	WL	Open Street Map Foundation		legal work	Data, licensing, operations, membership etc		OSMF. The OpenStreetMap Foundation is a UK-registered not-for-profit organisation, a legal body incorporated by the registrar of companies for England and Wale that supports the OpenStreetMap Project also dealing with data, licensing, operations, membership etc subject. (OSM, 2018)
Private Org	AL L	GooglеMaps	Org. User	Platform, GI	Route planning, StreetView, maps data	Paid	Google. Google maps is one of the most well known apps in the digital maps in the word with over billions of users. Google collects its mapping data from a wide range of sources including road sensors, user contributions through MapMaker tool and local transport data among several other sources. Google Maps navigation gives users alternative routes, inform users for unexpected traffic by collecting constant real time traffic data to Google from users smartphone data. This means higher number of Google Maps users in the area, they provide more accurate traffic prediction. The apps like Waze, originally Israel company which Google acquired in 2013 Waze users feed information for example accident and traffic jams reports on their routes into apps, Google also able to turn navigation experience far more accurate. Through the historical data, Google Maps app, able to create service for traffic predictions for many different period at specific location and journey. The travel modelling technique would be able to predict certain roads in bad weather condition for example. Also they receiving traffic reports from Transport Authorities, road sensors, and other private 3rd party data provider to keep their data and information is up to dated for users.
Private Org	N/A	Waze	Ad. Com	Platform to advertise	Crowdsourcing traffic data	Paid	Crowdsourcing navigation apps. As part of Google, they collect specific location of users mainly drivers. Each users either update problem area or they being a sensors of sensing traffic speed.
Private Org	TfL	Apple Maps	End User	Platform	Map API, Map	Paid	Share the map API to other end user app platform but not dominantly used.
Private Org	N/A	Bing	OSM Community	Send Data	Mapping Service (B2C/B2B)	Paid/licensed	Bing. Bing maps is web mapping service provided as part of Microsoft of search engine and is incorporating with OSM layer to Bing Maps (2010). Bing provides financial support to OSM also provide geospatial data to OSM contributor community. Along with OSM partnership, Bing system is partially powered by HERE. Here used to be called Navteq which was a Nokia property continues to provide street data including mapping data, geocoding, traffic data and navigation for Bing Maps. Bing Map Apps is also a collection of 1st and 3rd party application that add additional feature into Bing Maps. i.e. parking finder, Facebook friend mapping, taxi fare and so on.
Private Org	WL	MapBox	OSM/FS etc cummercial service	Financial support	it used as basemaps for other servoce	Paid	American based start-up, open source mapping platform for developers and designers at enterprise scale. They provide building blocks to add location features like maps, search and navigation into any experience related to mapping. They develop service that help to other organisation by use of OpenStreetMap data, so that range of tools to support geospatial data. Through working with OpenStreetMap, Mapbox has developed several open standards for using geospatial data on the web, which are being adopted more widely. Moreover, their open source tools allow analytics companies to understand big geospatial data, drone

							companies, real estate sites property visualisation and satellite companies to process cloud free imagery and insurance companies to track the assets. (Mapbox, 2018)
Private Org	WL	Map Here	Flickr	Platform support	Mapping Service for business	Paid/ licensed	MapHere provide their platform to Flicker to be able to utilise the Point of Interest geotagging and representation of feed onto the map platform
Web Application	WL	Whereabouts London	Open to Dev.	Code sharing	Data visualisation using OD	Open	Since they build map for public but not a commercial value, they open the all code source to developer community as knowledge sharing for further developments.
Social Media	WL / GD	Flickr	B2B	PoI data sharing	Photo Sharing service (B2B, C2C)	Paid	Service and platform are open to public as free, but any Point of Interest data can be paid model (accumulated geotagged photo are used to commercially. B2B).
Social Media	N/A	Facebook	Use OSM	Financial support	Service (B2B, C2C)	Close	Use OSM mapping platform, FB support OSM financially
Social Media	CM /WL	Foursquare	use MH	Share PoI data	Service (B2B)	Paid	Use MapHere mapping platform. Share Point of Interest (PoI) data generated by no of geotagged Photo upon specific location.
Aggregation	CM	DigitalGlobe	Google	Provide Hires Earth imagery	Geospatial Data service (B2B)	Paid/ licensed	Digital Globe. Digital Globe is an American commercial service provider of hi-res Earth imagery (satellite), data and analysis. Their customers range from urban planners to technology and conservation organisation such as Amazon conservation team, NASA and so on. They used to provide high resolution imagery to Apple Map, Google Earth and Google maps. The service ranges from Satellite imagery, Flood mapping, Building footprints, telecommunication industry and many other commercial area. They support Open Data program only for non-commercial use and OSM is one of example.
Aggregation		ITO World	Apple	Geospatial Data analysis for Map platform	Geospatial Data analysis service (B2B) / Data aggregator	Paid/ licensed	TO World. Ito World (itoworld.com) is a transport information company, based in the UK that supports the OpenStreetMap project in a number of ways. It was founded in 2006. They are specialised in data visualisation and analysis of realtime transit data by use of many open data sources including TfL. They provide consulting service to SMEs/Startup as one way of service monetisation.
Aggregation	CM	TomTom	Uber	RealTime route estimate service	Routing analysis service Data aggregator	Paid/ licensed	TomTom. TomTom (TOM2) is advanced map-making technology company combined with traffic information and navigation in the physical space. The mapping and traffic data is helping many organisation in range of sectors. Uber is one of them since 2015. While Uber is developing their own navigation and mapping system for driver, TomTom is ensuring seamless in-app navigation experience, accurate arrival time and efficient journey for both riders and drivers in more than 300 cities in the world.

Aggregation	CM	Elgin	Google	Traffic, roadwork management	Geospatial data aggregator	Paid/licensed	From 2015 UK roadworks and traffic disruptions data provided by Elgin and its licensors, which include Local Highway Authorities, Highways Agency, Traffic Scotland, Traffic Wales and Transport for London.
Private Org	TfL	Amazon (AWS)		Cloud platform provider	Tech. solution provider	Paid	Amazon (AWS), also known as AWS is a secure cloud service platform offering broad set of infrastructure service such as compute power, database storage, networking, contents delivery on-demand to help business to increase functionality. System helps to build application with increase flexibility, scalability and reliability. Current customers (2018) include both public and private sector such as TfL, UK driver and vehicle Licensing Agency (DVLA), Ministry of Justice, foursquare, airbnb, foursquare, yelp and many other major players.
Government	TfL	Local Authorities	Open	Citizen data	Local authority (borough)	Open *	Open except any personal identification
Government	TfL / GD	National/Central Gov. (i.e.ONS)	Open	Citizen Data	LandRegistry / Census	Open *	Open except any personal identification
Government		TfL	Open	Service usage data	Transport data	Open **	* exc. Either personal identification & wifi, payment
Community (crowdsourcing)	N/A	OSM contributor community	-	Voluntarily contribute mapping data	Mapping platform enhancement	Open	OSM contributor community. OpenStreetMap's core technical infrastructure and data assets are maintained by a global community of volunteers. The map's contributors include local mappers and a diverse mix of small and medium-sized enterprises (SMEs), startups, large commercial organisations, NGOs and humanitarian organisations.(OSM, 2018)
Private Org.		Commercial service (insurance, etc)	-	-	e.g. Transport	Close	They do not share data with elsewhere but under strict data policy agreement, they sell insurance, or close data 3rd party as paid
Database/Portal		OSM database	-	-	-	Open	OSM database. contains Ordnance Survey Data, runs under the domation from users. As a collaboratively maintained dataset, the accuracy and completeness of the OpenStreetMap portal depends on the work of its maintainers. People can contribute to the map in a variety of ways. Mappers survey their local areas using GPS devices, photography and other tools to collect new 'ground truth' data, while others use freely available satellite imagery and desktop and online tools to help maintain the map.(OSM, 2018)
Gov. database		Office of National	-	-	Open Data	Open	crime/planning/Environment i.e. Tree/AirQuality /Occupation/Council tax etc

		Statistics					National statistics
Gov. DB		Transport	-	-	Paid licensed data	Open/ Partly closed/ licensed	Any transport, road related data is open except any data include personal identification. Not yet open the wifi usage and payment related data Data licensed by Local Highway Authorities, Highways Agency, Traffic Scotland, Traffic Wales and Transport for London.
Gov. DB		Royal Mail	-	-	Open Data	Paid for	Postcode database. Not fully open for public not can be paid
Gov. DB		Ordnance Survey	-	-	Open Data	Open/ Paid for	Basic geospatial information is open. However, GIS platform and any customised bespoke service for GI related firm are commercial only

Appendix 5. Interview scripts and categorisation of theme examples



perfect, launch it and every week to improve. [illegible] very iterative processes .. that's why we as team, we aware things are not good enough when we launch it we know it isn't finished. and we are so many things unfinished, so prioritisation bring what we want to improve what is the most important to improve... it can be 4 weeks turn we are very small cycle...as designer work very close to the beginning at engineer team they call head of designer and ask them to do right thing... sometimes designer lead when the program is more complicate to solve i.e. UX side. 3 designers smaller then programmers we cannot always design fixed before things goes. very much working in parallel communicate...

Q. Do you think design team here has important and critical role in this org.?

I would say so YES because if you aware what citymapper successful is [illegible] design doesn't have too much back of trust. but also, easier to use. .... all the gap in data taking to senior team that what design comes to data because the dimension that CEO is very much involve the design process. there is [illegible] ...because we are already working so fast there is no proper design process. so u know the proper service design blurprint, do user research then personas then service blurprint then look at the service touch point you touch them out etc. it's important have the knowledge as practise process but within CM they runs like [illegible] show me the thing. and there is [illegible] of end of process ... because we are such a small design team and cycle of development is so short we have to find the ways to convince design processes... make it happen in very short term.... (quick [illegible] process)

Everyone aware of this but very much short.... that the balance requires. I believe we fit together ... our [illegible] ... communicate of prioritising them as senior impact pitch problem...which is prioritisation these are real tasks to do so this is what we are doing little bit in rush ... most impact point we should improve internal methodology think about way we design a service. but the reality is important to you (especially comes from academic SD is ...) [illegible]

[redacted] I've some of it. not all difference ideal SD process and reality of SD would be different. If you should be aware of. physical stop x --> middle of taxi and bus .. change the pick-up point - they are working on. - this is key product decision. cross functional area. detail next passenger, driver training, driver tool... cross functional work [illegible] - 1) [illegible] 2) [illegible] to user (idea convincing, measuring, impact, and new solution etc)...

we are braking record everyday (smart ride) may be not having peak time... central to outside of London you will see much more people... 'context' synchronises drivers.... demand same direction... reality of service

...of program - that s ok - idea behind...

Good service→ win to win or win to win and win [redacted] people looking for...

so what kinds of research - where do you value - skill, finding problem, understanding problem, context, then design skill - how you contribute, open data, actual b

DESIGNRT SKILL) skill to communicate, design, diagram, slide, blueprint, not necessary of product design, [illegible] ... which skill are you combining to be product management - strong point fix ui design team data team impact of driver operation making impact to the service. internally discuss.... UX / UI designing [illegible] ...they needed. depending on product design more resources.... PD.

marketing / design / management / service design - wasn't pd. product management is something expecting this discussion where you can make an impact on company...

PM --> service drivers app. journey we need centre booking .. algorithm. no one.. consumer app. driver app. project sim city --> stimulation <-- actual operation skills / sketch, product design interface, design user experience, one of discipline ...product design urgent.

PM mainly maps product management - problem prioritising problem important how do you evaluate resources to change step 1 step 2 how we measure impact etc [illegible]

need a service design between designer PM people care about service... your pick-up point was the one.

business, tech background different approach etc

Conclusion.

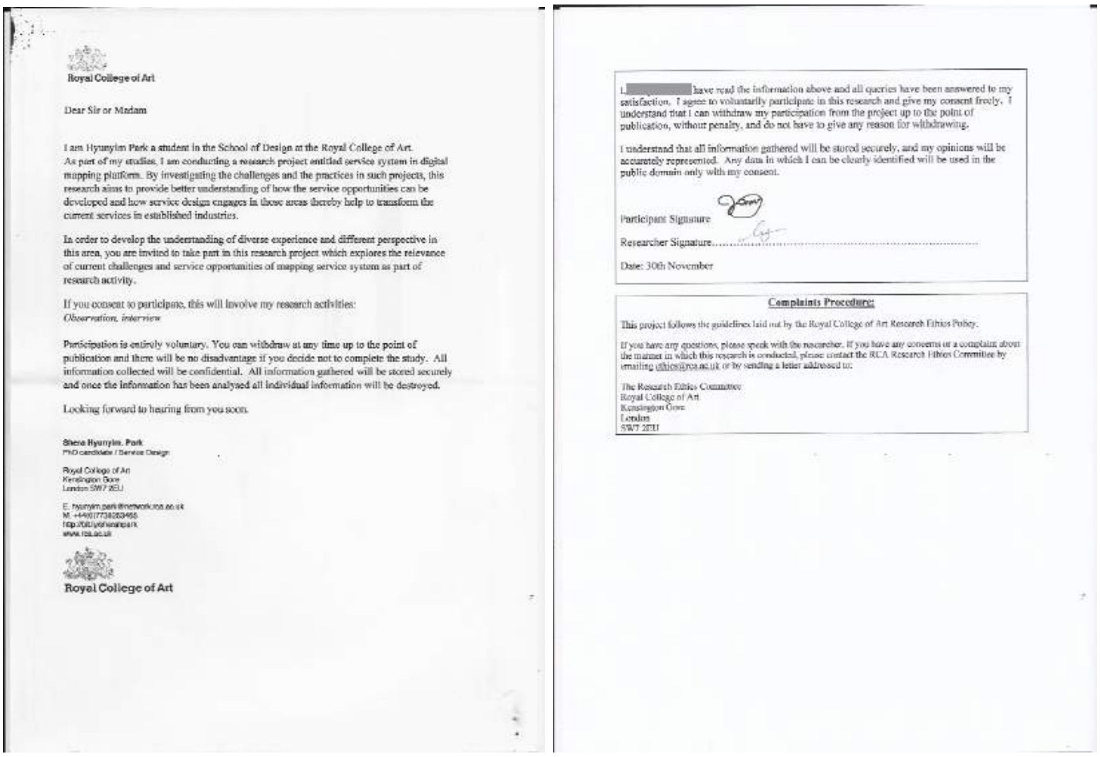
The organisation as a company has democratic approach and design thinking running behind. Majority of disciplines within design team are product design. Not the service designer but UX designer. Needs of proper design process methodology needed. But too small and fast moving in rush. Although service design discipline

- Design thinking discipline for operation of business improving good service. it's not service designer's role within org. as yet [illegible]

	B	C	D	E	F	G	H	I	J
40								6.3.3	*3 designers smaller then programmers we cannot always design fixed before things goes. very much working in parallel communicate...*
41			4. Agile development (Quick **iteration** process)					6.3.2.	*1yr team is working in SmartRide - the latest version of service - have been three iteration - first: circulate around office, 2nd: nightbus moorgate - islington , blackcab then smartride...*
42	SD	flexible, innovative		solution, problem fix oriented process			Democratic approach, collaboration, workshop		*Prepare idea - times that are quantifying? feasible, committing resources really about the execute problem. solution to fix it. do it Y or N. if we do, what comes top of priority so that's the interesting discussion also sometime very typical in CM. use picture early polish as designer (I never find it is perfect, launch it and every week to improve. (very iterative and lean) very iterative processes .. that's why we as team, we aware things are not good enough when we launch it we know it isn't finished.*
43				i.e. small scale launch, adopts, further improvement. No waste of resources					response route. for CM new brand - aggregating data --> treating it --> finishing it making sense --> now run own service integrated the apps. different activity in different schedule.
44									and we are so many things unfinished, so prioritisation bring what we want to improve what is the most important to improve... it can be 4 weeks turn we are very small cycle
45				Quick Prototype, solution first, "show me things"			SD Tool although they are not doing it all (SD aware not no time to response)	d4	we are already working so fast there is no proper design process. so u know the proper service design blurprint, do user research then personas then service blurprint then look at the service touch point you touch them out etc. it's important have the knowledge as practise process but within CM they runs like what is the solution?. show me the thing. and there is lot of phase of end of process ... because we are such a small design team and cycle of development is so short we have to find the ways to convince design processes... make it happen in very short term.... (quick prototype process)
46							solving problem		we spent nothing on marketing right so we basically invest in a team a really great team and we invest like servers and technology but I mean you know there's no capex is basically an information product and the (marketing is the product) marketing is a products as far we haven't spent on anything I mean we could, but you know I mean and so it doesn't really take that much to do these things it's more like just figuring out how to solve the problems and how do you price that you just have to do it. you have to find good people that want to solve interesting problems.
47			Testbed (user						
48	SD	5. Capacity & knov	1. Measure value & market impact, evaluate impact				?PM role but some are what SD doing		*PM. mainly maps product management - problem prioritising problem important how do you evaluate resources to change step 1 step 2 how we measure impact etc (Problem prioritising) need a service design between designer PM people care about service... your pick-up point was the one.*
49		(Inc. people & skills)							
50			3. Multi-disciplinary skillset (T shape skillset)				Multidisciplinary		*Yes, even within design there are different type of design we deliver and ideally, we are looking for good at one thing and teaching others... (T shape skillset)*
51							x		*cross functional work - not designer suggest how to make it better - 1) feasible 2) convenience to user (idea convincing, measuring, impact, and new solution etc)......*
52							T shape skills (related to Service designer)	6.5.2	*Good service- win to win or win to win and win (for stakeholderes) T shape people looking for...so what kinds of research - where do you value - skill, finding problem, understanding problem, context, then design skill - how you contribute, open data, actual b*
53								6.5.3	*DESIGNRT SKILL) skill to communicate, design, diagram, slide, blueprint, not necessary of product design, designing feature, design user interface.... which skill are you combining to be product management - strong point fix ui design team data team impact of driver operation making impact to the service. internally discuss.... UX / UI designing feature...they needed. depending on product design more resources.... PD.*
54								6.5.6	*operation skills / sketch, product design interface, design user experience, one of discipline ...product design urgent.*

CM code | ALL | Analysis(CM) | Finding (All) | Data-Digital Biz (ODI)

Appendix 6. Consent example



Royal College of Art

Dear Sir or Madam

I am Hyunyim Park a student in the School of Design at the Royal College of Art. As part of my studies, I am conducting a research project entitled service system in digital mapping platform. By investigating the challenges and the practices in such projects, this research aims to provide better understanding of how the service opportunities can be developed and how service design engages in those areas thereby help to transform the current services in established industries.

In order to develop the understanding of diverse experience and different perspective in this area, you are invited to take part in this research project which explores the relevance of current challenges and service opportunities of mapping service system as part of research activity.

If you consent to participate, this will involve my research activities:
Observation, interview

Participation is entirely voluntary. You can withdraw at any time up to the point of publication and there will be no disadvantage if you decide not to complete the study. All information collected will be confidential. All information gathered will be stored securely and once the information has been analysed all individual information will be destroyed.

Looking forward to hearing from you soon.

Shena Hyunyim. Park
PhD candidate / Service Design

Royal College of Art
Kensington Gore
London SW7 2EU

E. hyunyim.park@network.rca.ac.uk
M. +44(0)7738263466
http://bit.ly/shenapark
www.rca.ac.uk

Royal College of Art

I, [redacted] have read the information above and all queries have been answered to my satisfaction. I agree to voluntarily participate in this research and give my consent freely. I understand that I can withdraw my participation from the project up to the point of publication, without penalty, and do not have to give any reason for withdrawing.

I understand that all information gathered will be stored securely, and my opinions will be accurately represented. Any data in which I can be clearly identified will be used in the public domain only with my consent.

Participant Signature

Researcher Signature……………………………………………

Date: 30th November

Complaints Procedure:

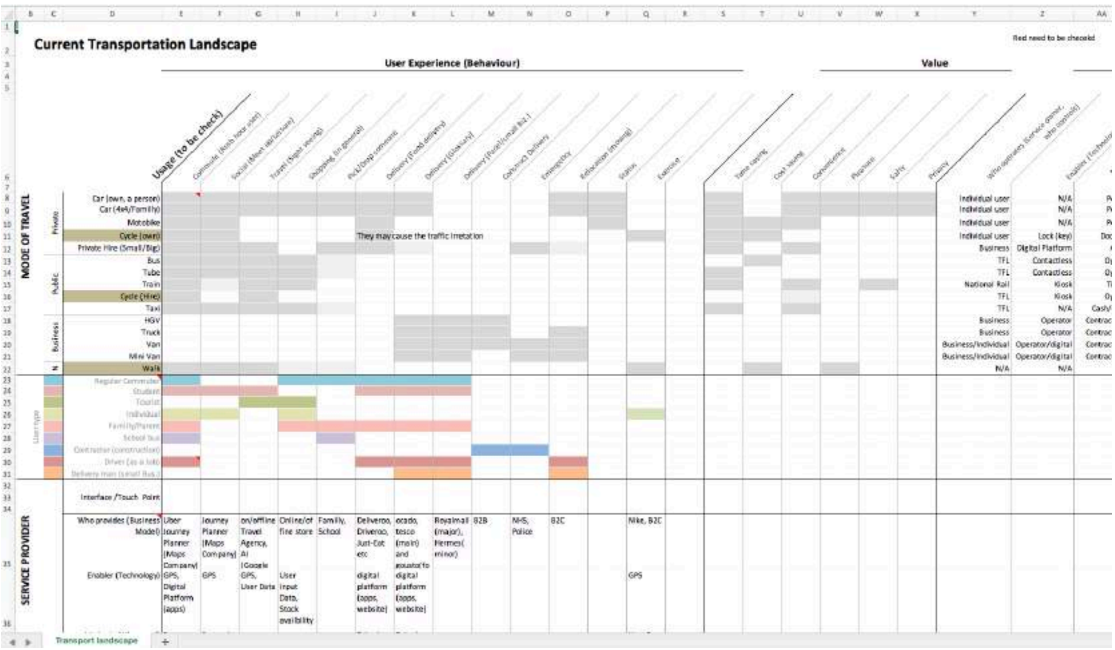
This project follows the guidelines laid out by the Royal College of Art Research Ethics Policy.

If you have any questions, please speak with the researcher. If you have any concerns or a complaint about the manner in which this research is conducted, please contact the RCA Research Ethics Committee by emailing ethics@rca.ac.uk or by sending a letter addressed to:

The Research Ethics Committee
Royal College of Art
Kensington Gore
London
SW7 2EU

Appendix 7. Service design project- transport landscape review

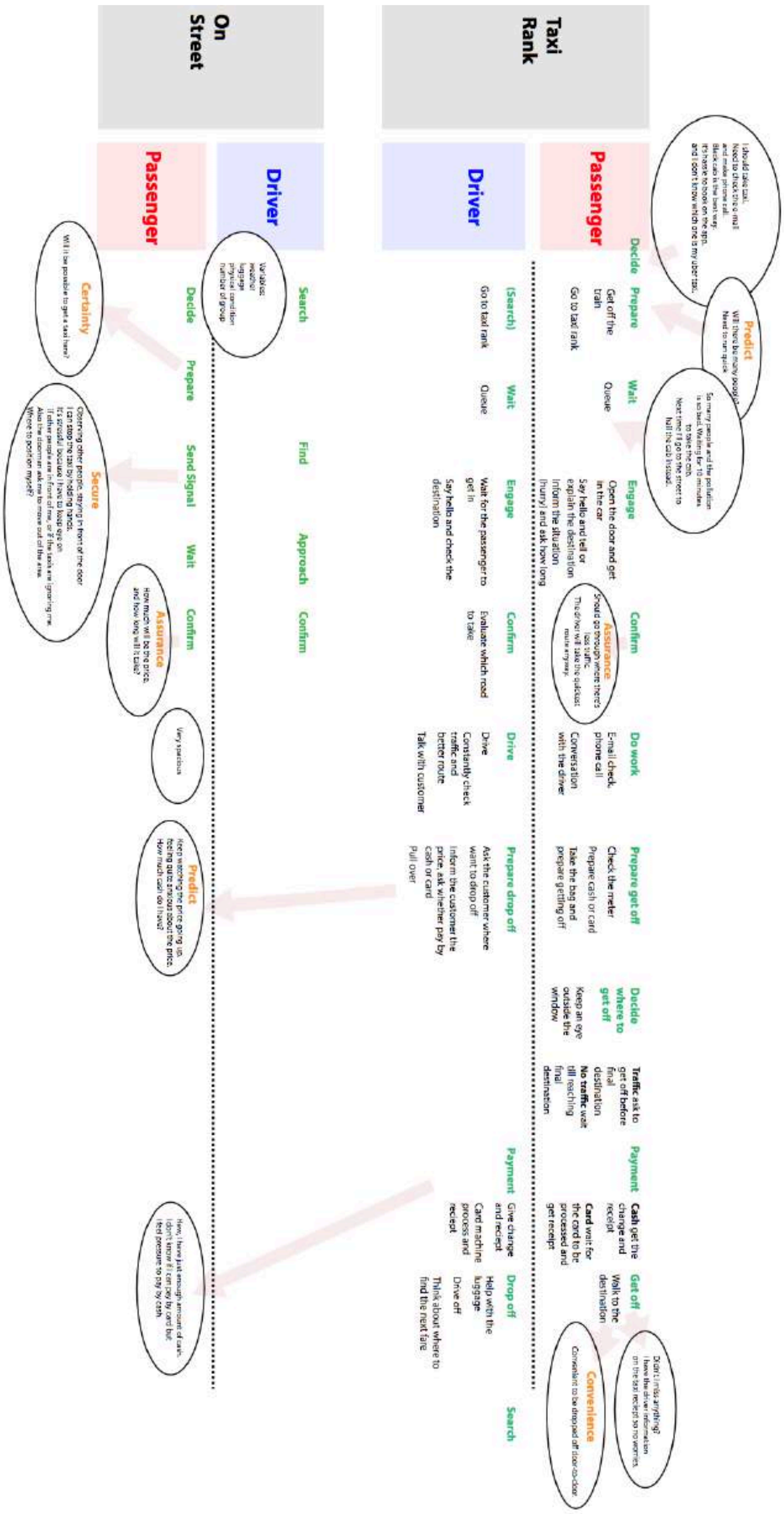
Discovery, Define stage: transport landscape

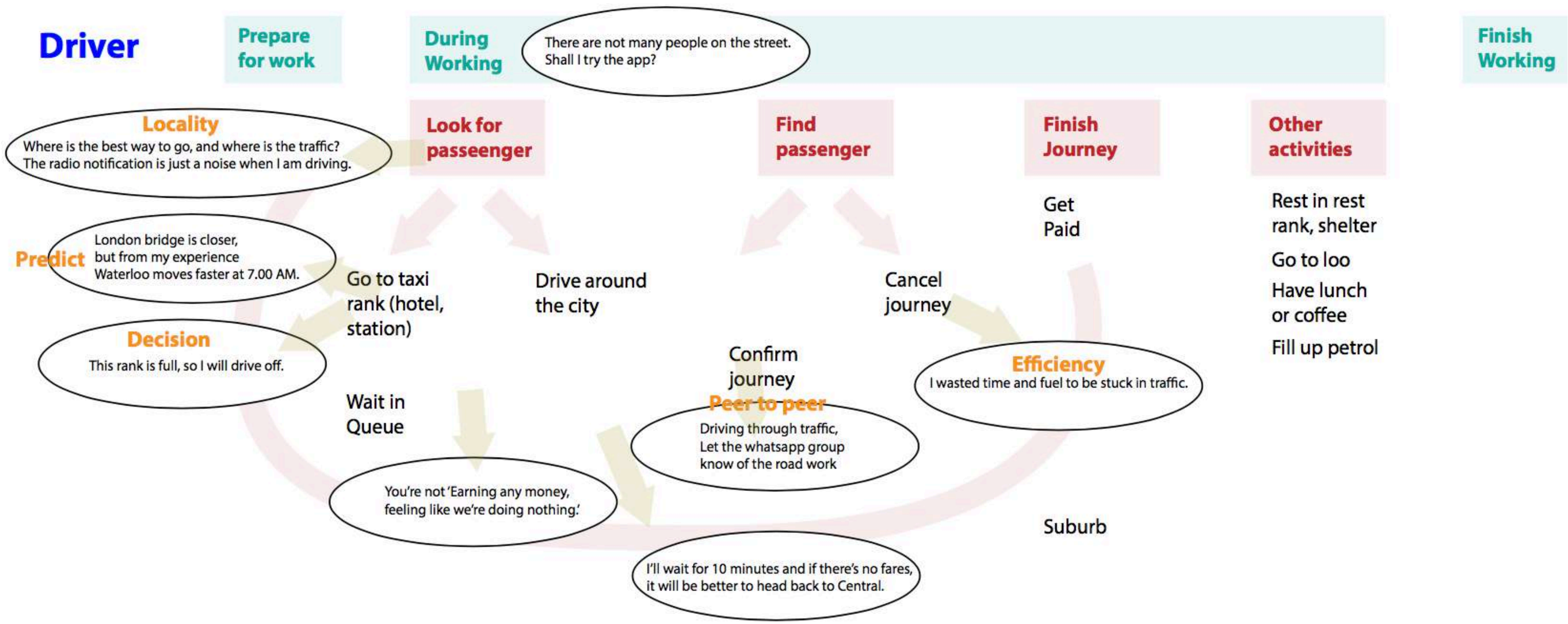


Transportation landscape (UK)

Appendix 8. User journey mapping

Black cab drivers' journey mapping




Driver
Prepare for work
During Working
There are not many people on the street. Shall I try the app?
Finish Working
Locality
Where is the best way to go, and where is the traffic? The radio notification is just a noise when I am driving.
Look for passeenger
Find passenger
Finish Journey
Other activities
Predict
London bridge is closer, but from my experience Waterloo moves faster at 7.00 AM.
Go to taxi rank (hotel, station)
Drive around the city
Cancel journey
Get Paid
Rest in rest rank, shelter
Go to loo
Have lunch or coffee
Fill up petrol
Decision
This rank is full, so I will drive off.
Confirm journey
Peer to peer
Driving through traffic, Let the whatsapp group know of the road work
Efficiency
I wasted time and fuel to be stuck in traffic.
Wait in Queue
You're not 'Earning any money, feeling like we're doing nothing.'
Suburb
I'll wait for 10 minutes and if there's no fares, it will be better to head back to Central.

Appendix 9. Persona development

1. Target Group

Target group: Black cab driver

Area live outskirt of London (zone 4, 5)

Age over 50s

Routine Starts from 6am or 11am and finishes by 7pm to avoid traffic coming into London.

Earning recently it drops around £150-170 before earned £200/day

Pride in the job *"You do the knowledge and train for over three years. It gives you pride in the job. It's different from jumping into the car in 2 weeks."*
- Driver interview

Different sources of information *"You use Waze, Google maps, twitter and mix that with your own knowledge to make a decision for the passenger."*
- Driver interview

Target group: Tourist

Aim looking for cultural experience

Needs family tour, luggages, shopping

Area shopping and main tourist areas airport to hotel

"Tourists come to London; they might ask what's good to do. You might recommend a certain restaurant and to get there just before the sun goes down."
- Driver interview

"It's so atmospheric. You connect London to a Black Taxi. One time the driver was playing Classical music. The driver's are so friendly and nice. We have a small talk with the driver, you feel welcome".
- Tourist interview

Target group: Professional

Aim quickly move between short distance

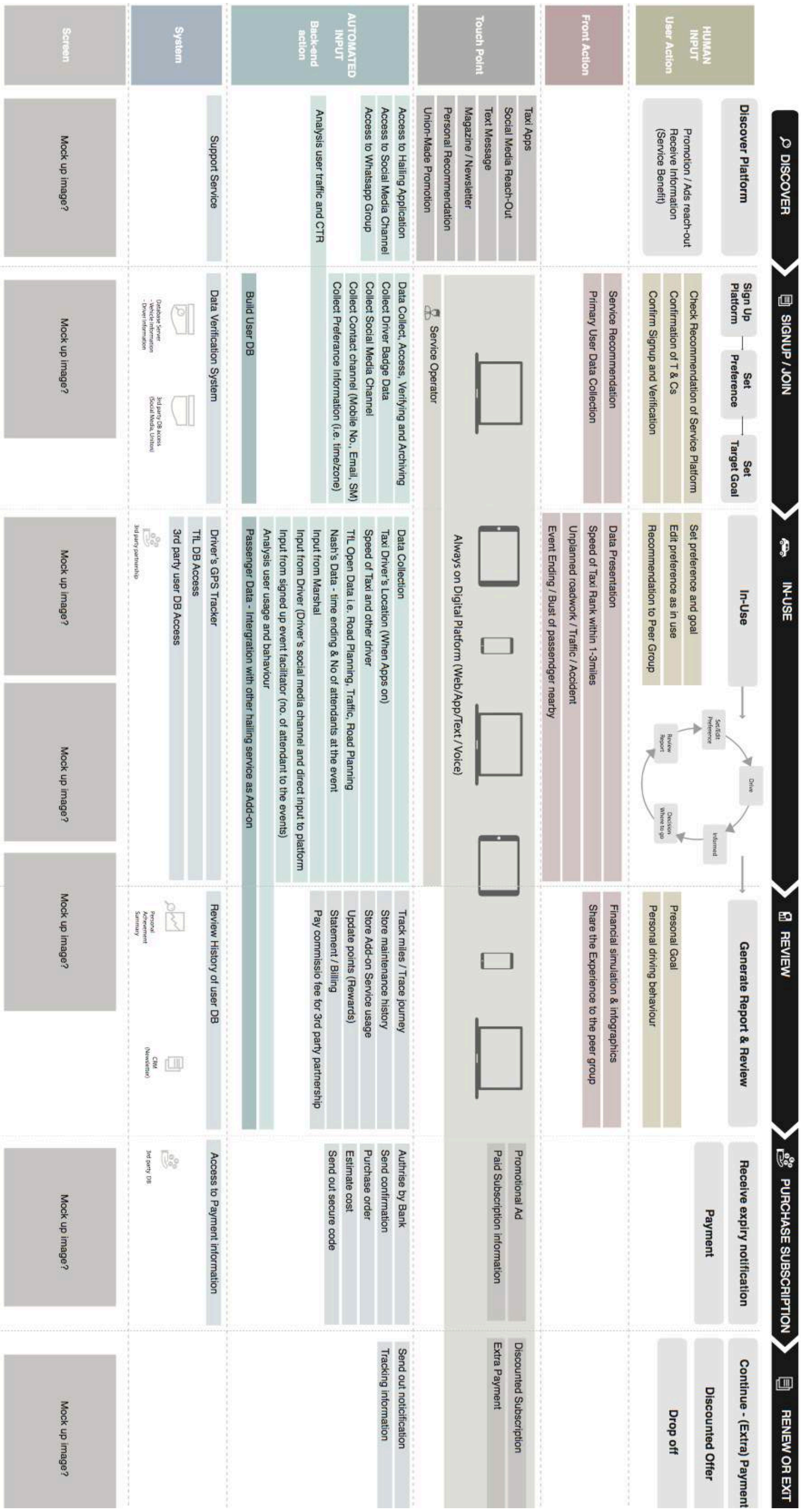
Needs avoid traffic, comfort, privacy

Area Soho area

"The privacy is important. I need to check email, make phone calls. Black Cab is convenience of it."
- Professional interview

"There's not much price difference in the morning time with uber, and it's hassle to book on the app, and I don't know which one is my uber taxi. Black cab is quickest one"
- Professional interview

Appendix 10. Service blueprint



Appendix 11. Design project solution: Predictable urban flow

Phase 1

Target user	Licensed black taxi drivers in London
Target	Supply side & Infrastructure (~2020)
Problem	They spend time drifting **30-50% of time looking for fares.** They don't have information source tailored to their habit and location. (preference) Their passengers are **unpredictable**. They don't have much **trust** in current systems.
Goal	Help them **make decision to go to the nearest place where they can quickly get customer** without getting caught in traffic.
Solution	Our service delivers real-time, location-based taxi rank, traffic and event information through digital channels such as ipads or iphones in driver's cab, or digital signage in taxi ranks. By analysing the driver's driving habit we tailor the information to fit their local and **habitual needs**, and they can edit to see their preferred ranks or places.
How it works	**Collect speed of rank** from individual driver's app Once driver pulls into the rank and leaves the rank, we collect data on how quickly the rank is moving and average the speed to send out information Analysing the driver's **habit** can help us tailor what to show to individual drivers Back up by the **peer-to-peer confirmation** (unpredicted road closure, burst of customers) *trust
Benefit	Increased business for black cabs Reduced congestion and pollution
Implementation Plan	Pilot with one local borough taxi ranks (or certain group of taxi drivers) Information can be manually pulled out by Marshals and turned automatic

Phase 2

Target user	Commuters
Target	Demand side & Infrastructure (2020~2025)
Problem	The outer London is growing quickly, bringing in more **commuters from**

<table>
<tr><td></td><td>outer to Central London.
Crossrail in 2018 will make this journey more convenient, especially who traveling to Centre (Bond St., Tottenham Court Rd.) and east side of London (Farringdon, Liverpool and Whitechapel) but many are still commuting by private vehicles because the experience from train station to the office is unpredictable and troublesome.
How long you wait in the que at taxi rank can be unpredictable.
- Transit to different mode of travel is not always even. (Train - Tube - Walk, not prefered to use bus and cycle)
- Payment to Taxi is troublesome, you have to wait to get recept after ending the journey.
- There are empty areas that are not connected with public transport within central london that black taxis can tackle on disjointed journey.</td></tr>
<tr><td>Goal</td><td>Help commuters quickly and pleasantly reach their destination with connected public transport.
From 2018 onwards, black taxi will be started to switch to hybrid black taxi.</td></tr>
<tr><td>Solution</td><td>Our service enables commuters to travel in smoothest possible journey by linking different mode of travel using black cab (link train to destination, Black taxi joint new node)</td></tr>
<tr><td>How it works</td><td>Collect taxi rank information and apply which apps customer uses i.e. journey planner, citymapper
Showing reward
Queue / Unpredictable taxi issue
- Show taxi rank information (waiting time, available taxi) on Google maps or Citymapper
- Add option to use black taxi as connected journey
- Information comes from driver’s app, real-time taxi rank information
Payment soon: all the nationwide train to be paid by Oyster payment/contactless
- Policy pitch: taxi fare also applied daily cap like other public transport, in reward TfL gets the taxi and PHV data for future urban planning</td></tr>
<tr><td>Benfit</td><td>Instead of using private vehicle, use multi-modal public transport -> less congestion and pollution.
Discounted fare on Black Cab and special offer and discount
(Current Train ticket: pay for destination train ending or any London station if customer pay little extra)
Ideally use Oystercard payment as contactless</td></tr>
<tr><td>Implementation Plan</td><td>TfL ID - integrated payment
Oyster in black taxi</td></tr>
</table>

Phase 3

Target user	Policy maker (Decision maker, urban planner)
Target	Data & Infrastructure (2025 onwards)
Problem	Decision makers don't know where to put the rapid electric charging station. Also, the process of fixing the broken charging station is too slow because of different stakeholders like local boroughs. - The road is too narrow because of super cycle highways. - They are not sure what information to consider because they have to predict the future. - Different stakeholders are involved like local businesses or manufacturers. Current service: responsive, reactive (i.e. passenger to call or book or hailing a taxi → seamless transit? Transportation comes to you when you needed without booking or hailing?)
Goal	Help them make right decisions on right place to put the electric charging stations, and help them to create efficient service system around electric charging points.
Solution	Collect data from various source into one platform If payment can capture the journey demand, we can see which road is likely to be congestion, which road (Future electric taxis) are frequent journeys to be taken.
Benefit	Connection phase 1-2 If black taxi drivers work better (know where to go), they can help created connected experience from outer to central destination. Wide urban stakeholder be able to understand the urban flow Different mode of travel
Implementation Plan	2025 ~

Appendix 12. Feedback from Service Design Network 2017 for service design solution

Jury comments about this submission have been collated and summarised by Service Design Award 2017 by Project Manager and employee of SDN, these comments are not an exact transcript of the jury discussion.

SERVICE
DESIGN
AWARD
2017

Winner

Student Winner for Business Innovation in the Private Sector

This Service Design Award 2017 winner certificate is presented to **Shera Hyunyim Park, Jaehyun Park and Culainn Boland-Shanahan** in recognition of the world class standard of service design exemplified by their project:

"Smart Black Taxi Service: Flo"

Category: Student
Client: Hannah Kops - Transport For London Project Coordinator, Nick de Leon - RCA Service Design Head of Program and Nicolás Rebolledo - RCA Project Coordinator
Degree: MA Service Design Programme
University: Royal College of Art, UK

Internationally Recognised Standard of Excellence

The Service Design Award, curated by the Service Design Network, is the premier international award for service design. The award recognises work of an exceptional standard in the field of service design. A jury of experts commends projects which have been applied with an innovative, rigorous and impact driven design process.

Winning projects are promoted and documented in the service design case study library by the Service Design Network. The winners set a benchmark for best practice, as well as communicate the value and relevance of contemporary service design around the world.

Presented on 2 November, 2017, this certificate is recognised by the Service Design Network:

Kerry Bodine
Head of the Jury
USA

Birgit Mager
President of SDN
Germany

SDN
SERVICE DESIGN NETWORK

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