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How Smart Cities Transform Operations Models:

A New Research Agenda for Operations Management in the Digital Economy

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Abstract

The notion of smart cities is growing in prominence in the digital economy. The integration of urban infrastructures with information and communication technologies (ICT) enables the development of new operations models. Digitised infrastructures offer opportunities for public and private organisations to design and deliver more customer-centric products or services, particularly for those that require geographical proximity with consumers in the O2O (online to offline) context. A framework is developed and used to analyse three case examples. These cases illustrate the emergence of new operations models and, demonstrate how smart cities are re-defining the characteristics of operations models around their scalability, analytical output and, connectivity. We also explore the feasibility, vulnerability and acceptability of each new operation. This paper contributes to our understanding of how smart cities can potentially transform operational models, and sets out a research agenda for operations management in smart cities in the digital economy.

Keywords: Smart city, big data, operations model, online to offline (O2O), digital economy, transformation

1. Introduction

Over the last four decades, information and communications technologies (ICTs) are increasingly integrated into urban infrastructures, leading to the rapid development of smart cities (Manville et al., 2014). This integration has three main effects: i) it improves the efficiency and effectiveness of public services that rely on urban infrastructures (e.g. utilities and healthcare); ii) it enables the creation of new innovative services that disrupt city-based sectors (e.g. Uber in the urban taxi service); and iii) it encourages the update of existing operations models by unlocking the economic value of city-based resources (e.g. Airbnb in the hospitality). In each of these cases, smart cities are facilitating the transformation of operations models, by innovatively addressing traditional operational problems and resource constraints in urban settings, and developing new ways of value creation and delivery to different stakeholders.

However, most existing studies of smart cities have been focused on town planning, particularly as an 'urban labelling phenomenon' (Hollands, 2008), rather than the development of more efficient and effective operations across different industries using new operations models (Allwinkle and Cruickshank, 2011; Paroutis et al., 2014). This is rather surprising given the near ubiquitous broadband and mobile networks in cities, the rapidly growing range of smart devices carried by the urban population, the explosive development of big data associated with the Internet of Things (IoT), and the potential effect of connected vehicles and smart homes on consumer behaviour and on city services management. Such developments pose serious challenges and opportunities for operations managers to transform their operations models, and they call for new theoretical and empirical research in operations management (George, 2014; Anttiroiko et al., 2014.).

Furthermore, the rapid development of ICTs and the transition to the information economy have enabled organisations from different sectors to re-evaluate their strategies and operations, and to adopt radically different new business models and new organisational forms (Li, 2006, 2014). This has already resulted in the transformation of operations models in a wide range of industries, from travel, music and retailing, to search and advertising. However, online retailing (retail e-commerce) only represents less than 10% of total retailing in most countries (for example, less than 7% in the USA in 2014 according to data published by the US Census Bureau, Figure 1), as many products need to be physical delivered; and many services require close geographical proximity between service providers and consumers. Smart cities offer the ideal combination of advanced ICT infrastructure and services with a high concentration of people within urban areas, which creates the environment to unlock the enormous potential for the remaining 90% of products and services that have yet to fully benefit from e-Commerce.

The redesign of traditional operations models to take advantage of the smart city environment and target the 90% of activities not yet adequately addressed by e-Commerce represents a significant new area that deserves strategic consideration across industries. This set of activities is often termed O2O (online-to-offline or offline-to-online), which significantly extends the scope of current e-Commerce activities and opens up new possibilities for transforming operations models across different sectors. A range of examples are emerging in areas including personal, domestic and community services (Bizzby, GlamSquad), taxi services (Uber), catering (Opentable), and urban tourism (Airbnb). Such services are only feasible in smart cities where people are concentrated, and as such, demand and supply are geographically close and are easily connected by a ubiquitous digital infrastructure. This is an area that has not been adequately addressed by previous studies.

Insert Figure 1 about here

Therefore, the central question guiding this paper is: how will smart cities transform operations models? To answer this question, we commence by discussing the origin of the smart city concept and reviewing alternative notions of the phenomenon (Haque, 2012; Nam and Pardo, 2011; Manville et al., 2014). We then propose a conceptual framework, which highlights the role that operations management will play if a firm is to achieve (operational) transformation in the smart city context. In this framework, we propose that smart cities enable the development of new operations models by re-defining three central characteristics: scalability, analytical output and, connectivity. We then offer an evaluative approach of these new models of operation, where we assess their feasibility, vulnerability and acceptability (Slack and Lewis, 2011).

This framework can help operations managers to address conceptual and practical questions when developing, evaluating and comparing new operations models smart cities. We have developed three theory-guided case studies to serve as examples of new operations models in the digital economy. As will be discussed later in the paper, the main purpose of these case studies is not to validate particular new operations models, but to illustrate the potential of smart cities in enabling new operations models across different sectors. These cases will help us understand the tactical and strategic decision-making facing operations managers and the impact of active customer participation in the new operations models.

The paper is structured as follows: Section 2 reviews the relevant literature, illustrates the evolution of smart cities, and provides a working definition of the concept. Section 3 presents a conceptual framework for understanding the role of scalability, analytical output and connectivity in developing new operations models, and for evaluating such new operations models in terms of their feasibility, vulnerability and acceptability. Section 4 illustrates how smart cities are enabling the emergence of new operations models in three different areas, using the framework outlined in Section 3 and the case studies we have developed. Section 5 summarises the main insights emerging from the case studies. Finally, Section 6 concludes the paper and outlines a new agenda for future research investigating operations management in the digital economy.

2. The Emergence of Smart Cities

The urban population accounts for 54% of the total global population and it is expected to reach 66% by 2050. Africa and Asia are projected to urbanize faster than other continents and they will host the largest cities on the planet. However while their urbanization rates will reach 56% and 64% respectively, it is predicted that it will be European cities that will have a higher proportion of their populace (with over 80% of their citizens) living in city areas by 2050 (United Nations, 2014).

Overcrowded cities pose a major challenge for national and local governments in scaling up their public infrastructures and services (i.e. education, transportation, water and energy supply) and meeting strict environmental standards to provide wealthy and healthy living conditions, including efficient and effective healthcare, security and protection systems, accessible social, artistic and cultural networks, and a wide range of products and services. Densely populated cities also pose new challenges for organisations in the design and management of their operations. There is an urgent need to develop more efficient and effective operations models, both for the management of urban infrastructures and, the production and delivery of products or services that rely on these urban infrastructures.

One response from cities around the world is to leverage the power of ICTs by integrating urban and technological infrastructures (e.g. streets, utilities and telecom networks) and digitalising traditional services (such as online Land Registry, energy smart metering, and healthcare electronic records). This enables urban authorities to integrate online and offline services and reach citizens at lower costs and higher quality (Layne and

Lee, 2001; Ho, 2002; Moon, 2002; West, 2004; Carter and Belanger, 2005; Nam and Pardo, 2014). The development of smart cities opens up new possibilities for organisations to re-consider their operations models. Today, sensors are increasingly embedded in consumable products and other everyday objects, creating a new world where all objects are connected through IOTs (Petrolo, Loscri and Mitton, 2014).[1] At the same time, we are witnessing pervasive adoption of smart, portable electronic devices and related applications by the urban population, where both fixed and mobile broadband networks have become near ubiquitous. Most of all, applications running on mobile devices (e.g. tracking medical parameters, real-time geo-location of people and objects), as well as sensors embedded in consumer products (smart homes) and other objects (including other urban infrastructures) are generating a huge amount of real-time and archived data, which can be monitored, analysed and acted upon by citizens, governments and businesses, through increasingly more powerful analytics and automated tools. It is the effective use of such data that will make cities 'smart' and further enrich the notion of smart cities in the years to come.

From an operations management perspective, digitalisation and IoT signal the beginning of a fundamental shift in how citizens engage with services, and how products and services can be designed and delivered in a more customer-centric way. Encouraging society to become more connected and data driven is described as the 'cornerstone' in smart cities where citizens are 'informed, engaged and empowered' (Kamel Boulos, 2014: 3). However, the progressive digitalisation of cities also raises major questions pertaining to their role and function, and the impact that increasing digitalisation has on human

[1] The IoT is enabled through instrumentation, defined as the 'integration of live real-world data through the use of sensors, kiosks, meters, personal devices, appliances, cameras, smart phones, implanted medical devices, the web and other similar data acquisition systems, including social networks as networks of human sensors' (Chourabi et al. 2012). The speed in which citizens are engaging with Internet enabled technologies is transforming the professional services landscape, with a greater appreciation of the value in being able to participate in the design and delivery of services (Vredenburg and Bell 2014).

interaction and the engagement of citizens in urban activities and, product and service consumption. Cities have been 'for a long time of critical importance for economy and society, as they bring together (in geographic proximity) many different types of resources and people' enabling social and economic activities to take place efficiently (Loukis et al., 2011: 145). ICT applications and digital mobility increasingly challenged the notion of cities as centres of aggregation where people need to converge to efficiently work together (Graham and Marvin, 1999; Loukis et al., 2011). However, as Graham and Marvin (1999: 90) have argued, 'it is now clear that most IT applications are largely metropolitan phenomena. They are developing out of the older urban regions and are associated with new degrees of complexity within cities and urban systems, as urban areas across the world become relationally combined into globally-interconnected, planetary metropolitan systems'.

Despite the challenges, it is clear that in smart cities where the ICT infrastructure is dynamic and constantly evolving, the manner in which organisations and their associated operations strategy connects to the smart city infrastructure can be a key determinant of competitive advantage. Smart technologies allow operations and customers to connect in more innovative and direct ways and therefore whilst the technology is used as a mechanism to deliver products and services to the market, it is the customers themselves who become more involved in the service production and delivery process. This enables organisations to radically redesign their operations models in smart cities.

Previous studies have identified eight critical dimensions for smart cities, around management and organisation, technology, governance, policy context, people and communities, economy, built infrastructure, and natural environment (Chourabi et al, 2012). This research will build on some of the relevant dimensions (i.e. management and organisation, technology, people and communities) to examine the development of new models of operations management in a smart city context. Specifically, we explore how new technologies enable smart people and communities to connect with operations in updating or innovating traditional service delivery approaches. Although many traditional operations models will remain viable, there is immense potential for these operations to evaluate how the smart city can help transform the way they deliver value to customers.

2.1 The evolution towards smart cities

The notion of smart city has evolved significantly over the last four decades. From the late 1960s, there has been a progressive integration of ICTs with other urban infrastructure and services. This has allowed local governments, businesses and institutions to explore new approaches to service design and delivery. The cities have been described as *wired, virtual, digital, information, intelligent, and smart* (Nam and Pardo, 2011; Lee et al., 2013; Kitchin, 2014). Some of these terms are often used interchangeably, although each emphasises specific aspects or characteristics of the city. What they share in common is a focus on the increasing adoption of ICTs in urban settings.

Dutton et al. (1987: 3) defined wired cities 'as a community in which all kinds of electronic communications services are available to households and businesses', with particular focus on 'experiments and projects involving the use of advanced information and communications technologies for the provision of services to households and businesses'. As suggested by Targowski (1990), such definitions were built on a futuristic idea of cities, following the introduction of cable technologies and the digitalisation of the telecommunications switching systems in the UK and US during the 1960s (see also Smith, 1970; Martin, 1974; Cornford and Gillespie, 1992). Broadly speaking, wired cities have been based on the idea of WAN (Wide Area Networks) for connecting city-based activity and the urban population. These networks would see the city using various digital media from computer-aided design to virtual reality games and words (Batty, 2012).

The concept of virtual cities is associated with the rapid development of the Internet (Graham and Aurigi, 1997; Firmino, 2003). It illustrates Internet-based urban initiatives to 'widen local participation in telematics and to engineer the emergence of new "electronic public spaces" [that] will complement or replace the undermined physical public spaces of cities' (Graham and Aurigi, 1997: 19). The investigation of a 'virtual urbanity' is aimed at the development of digitised social relationships, and the democratisation of knowledge and information has been the first attempt made by scholars to look at the impact of digitalisation on human activities in an urban setting.

The transition to intelligent city (Komninos, 2008; 2009) has significantly modified the interpretation of the integration of urban and ICT infrastructures and their potential applications. Defining intelligent cities as 'territorial innovation systems combining knowledge-intensive activities, institutions for cooperation and learning, and web-based applications of collective intelligence', Schaffers et al. (2011: 434) added cooperation activities and knowledge capital as a core resource enabled by technology to foster a process of knowledge, learning and innovation. Santinha and de Castro (2010) and Zavadskas et al. (2010) have used the notion of intelligent cities to unravel its impact on regional development and territorial governance. The idea of intelligent cities implies an active role of local governments to create governance that helps cities and societies exploit the potential of ICTs to create innovation (Batty, 1990). As in Santinha and de Castro (2010: 77), it is the mix of 'organisational capacity, institutional leadership, creativity and technology [that act] as drivers for change in a globalised and knowledge-driven economy'.

The concept of the intelligent city is based on the way hard infrastructures are used (Batty et al. 2012) and they are acknowledged to have 'the ability to support learning, technological development and innovation procedures' (Nam and Pardo, 2011: 285). These core characteristics helped Nam and Pardo (2011: 285) to make a clear distinction with what they call the digital city. By arguing that 'every digital city is not necessary intelligent, but every intelligent city has digital components', they characterized a digital city by the engagement of digitalisation in various city functions such as work, environment, recreation and housing, thus not limiting it to knowledge-based and innovation activities. In fact they affirm that a digital city 'refers to a connected community that combines broadband communications infrastructures, a flexible, service-oriented computing infrastructure based on open industry standards [and] innovative services to meet the needs of governments and their employees, citizens and businesses' (Craglia, 2004; Nam and Pardo, 2011; Yovanof and Hazapis, 2009). Various examples of digital cities exist (e.g. Digital City Amsterdam) that have fostered the interaction among citizens and with digital information made available by early city-initiatives. These developments together have laid the foundation for smart cities.

2.2 Defining smart cities

In moving towards a definition of smart cities, it is acknowledged that the difference between intelligent and smart cities can be difficult to ascertain. Allwinkle and Cruickshank (2011: 9) clarify that 'for smart cities the capacities that intelligent cities have sought to develop over the past twenty years or so become the technical platform for their application across a host of service-related domains'. This infers that the distinction is a shift from *innovation* (i.e. computational power, databases, knowledge-transfer capabilities of cities, etc.) to *application*.

There are many living examples (e.g. Eindhoven in the Netherlands, Birmingham and Glasgow in the UK) and working definitions of smart cities (e.g. Caragliu et al., 2011; Batty et al., 2012; Komninos, 2013; Paroutis et al., 2014; Anttiroiko et al., 2014; Goodspeed, 2014; Manville et al., 2014; Neirotti et al., 2014; Piro et al., 2014). Manville et al. (2014: 9) regarded smart cities as 'a place where the traditional networks and services are made more efficient with the use of digital and telecommunication technologies, for the benefit of its inhabitants and businesses';[1] and as 'cities seeking to address public issues via ICT-based solutions on the basis of a multi-stakeholder, municipally based partnership'. In fact, 'smart cities' describe the set of technologies, systems and methodologies that could enable the spread of more efficient and effective city-enabled operational applications (Manville et. al., 2014). This is aligned with the perspective of Batty et al. (2012: 2) that 'cities can only be smart if there are intelligent functions that are able to integrate and synthesise data to some purpose, ways of improving the efficiency, equity, sustainability and of life in cities'. The smartness of an urban environment stems particularly from the ability and actual implementation of big data management with effect on the provision of a broad set of city-wide services (e.g. urban transports, healthcare, tourism) and related activities (e.g. booking taxi services, delivery of healthcare services, assistance in city-trips planning).

An important characteristic of smart cities is smart people, which are described as one of six smart city characteristics whereby people and communities are enabled to 'input, use, manipulate and personalise data, for example through appropriate data analytic tools and dashboards, to make decisions and create products and services' (Manville et al, 2014: 28). The existence of smart people enables a collaborative approach among citizens, institutions and business organizations that 'establishes the smart city as a platform that fosters the collective (local) intelligence of all affected stakeholders' (Walravens et al., 2014). As operations seek to explore the online-offline interfaces, smart people and their connectivity have become an important resource in new operations models.

2.3 Smart cities, big data and operations management

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[1] See the Digital Agenda for Europe. A Europe 2020 Initiative: http://ec.europa.eu/digital-agenda/en/smart-cities

Local governments, citizens, businesses and other organisations create data in their daily activities by exploiting the potential of ICT infrastructures and services. A smart city environment enables the production and use of such data in the provision of services in these cities.[1] This fast-growing data generated in an online community-like setting is shared across the network amongst manufacturers and services operators. This on the one hand enables local governments, businesses and other organisations to act smartly by processing the data to provide customised services that respond to emerging needs within cities; and on the other hand, allows citizens to take an active role in data sharing with service providers and providing real-time feedback on services. The development of smart cities presents unprecedented challenges and opportunities for operations managers: they need to develop new tools and techniques for production planning and control, and be aware that the increased transparency and convenience of smart city infrastructures and services calls for the development of new operations models.

For example, an operations manager can capture individual or team level data relating to the movement of employees around a workspace, or time attributed to a particular task. Such data can be used to craft more accurate forecasts. In conjunction with the appropriate predictive analytics (from statistics, to modelling to data mining), operations managers can analyse current and historical data to make forecasts for the future (Fawcett and Waller 2014). Taking a broader supply chain perspective, if operations collaborate with other actors in their supply chain, using big data they can optimise customer value across the entire supply chain, cooperate to improve processes, and

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1 Big data is not a term uncommon to the current day business parlance. Generated through a plethora of sources (from Internet movements and purchase transactions, mobile applications, social media, sensors or sales enquiries), George et al (2014: 321) state that big data can 'meaningfully complement official statistics, surveys, and archival data sources that remain largely static, adding depth and insight from collective experiences –and doing so in real time, thereby narrowing both information and time gaps'.

leverage the productive and technical capabilities of their suppliers to offer greater levels of customisation to customers at competitive prices. In this sense, big data is enabling a new source of customer intimacy and closeness (Fawcett and Waller 2014). Today, RFID tags are used in their billions to sense the position of inventory on shelves and in-transit, increasing the level of stock transparency external to the operation in their supply chain. This level of information visibility helps to realize improvements in inventory management and asset utilization (Delen, Hardgrave et al. 2007). However, the real value in RFID lies in the big data generated and the intelligence that can be offered around business processes, the value chain and their redesign (Moradpour and Bhuptani, 2005). Internally generated data are increasingly combined with data from external sources.

Big data and the associated analytics are being extensively applied in efforts to predict and mitigate the effect of supply chain risks and disruptions, which can severely disrupt operations and their associated supply chains. The increasing importance of big data to operations managers has heightened their attention to ensuring that high quality analytical output is selected and interpreted. Tactical and strategic decisions based on poor quality, inaccurate data could be costly. The quality of the data on which they base these decisions should be as important to them as the interaction they have with their service customers or the products they deliver (Hazen, Boone et al. 2014).

3. Smart Cities and New Operations Models

Building on the previous section which described the evolution of smart cities and their defining characteristics, this paper will now examine how smart cities can enable the transformation of operations models. We define an operations model as the content, structure and interaction of an operation’s resources, processes, people and capabilities, configured in order to create customer value. In presenting our definition of an operations model, we refer to the lack of definitional clarity surrounding 'business models' more generally and their various contexts (Zott et al, 2011).

A business model is a complex, multi-dimensional concept, which has been defined differently by previous studies (Zott et al, 2011). Generally speaking, it defines the rationale and logic that a firm identifies, creates, delivers and captures value; and illustrates the architecture of the product, service and information flows, the sources of revenue and benefits for suppliers and customers, and the method by which a firm builds and uses its resources to offer its customers better value than its competitors and make money in doing so (Massa & Tucci, 2012; Baden-fuller & Morgan, 2010: Li, 2014). An operations model is a key part of a business model, as it defines the way a business model works and how the firm implements its strategy, and in particular, how the firm configures its people, processes and technology to create and deliver value to its different stakeholders.

We assert that a focus on the operations of an organisation is necessary to explain the impact of smart cities on product and service provision. Many traditional operations models will co-exist with new operations models, but there is immense potential for these operations to evaluate how the smart city can help update and evolve the way they deliver value and compete in an increasingly digitised environment. Figure 2 presents the conceptual framework which guides the remainder of this paper. It focuses on the integration of smart cities and operations models. Specifically, we delineate the characteristics which enable the development and assessment of new operations models in a smart city context.

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Insert Figure 2 about here

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3.1 Key characteristics of new operations models

Smart cities are enabling the formation of new operations models by redefining three characteristics of the technologies that underpin operations: scalability, analytical output and connectivity. These characteristics are traditionally strongly linked to process volume and variety (Slack and Lewis, 2011). However in a smart city context, the digitised infrastructure and the smart city mind-set of citizens enable operations to use geographical proximity, coupled with the online connectivity of citizens to services, to redefine off-line service consumption and challenge traditional notions of volume and variety.

Scalability: The impact of smart cities in operations can be described in relation to the scalability of processes and the capacity growth they can enable. Scalability is defined as the 'ability to shift to a different level of useful capacity, quickly, cost-effectively and flexibly' (Slack and Lewis, 2011). Some technologies will be more readily scalable than others and the implications for the operation can be significant if the technology cannot match the level of customer demand or engagement. Scalability also depends on particular ICT systems working together, inferring that the design and system architecture of a technology is important in determining how it connects to other services in a smart city. Citizens place a wide variety of demands on technology-based services in smart cities, and this should serve as the basis for organising services, devices and technology types. The scalability of the technology - and the operations based on the technology - is thus an important consideration for new operations models.

Analytical Output: According to Slack and Lewis (2011) there are two drivers influencing analytical output, namely the amount of data processing required and the level of customer or citizen interaction. In the context of smart cities, a great deal of information is created that can enable the development of new operations models by generating data for the operation (e.g. demand preferences and trends) and often its customers or users (e.g. customer feedback reports). However, the amount of processing required and the degree of interaction (i.e. the analytical content) has an important impact on the event to which this information can be effectively leveraged to improve current operations models.

Other city-based stakeholders (e.g. local governments and public institutions) can access and manage large volumes of data in order to more efficiently plan the delivery and organise the consumption of value added services. For an operation developing or integrating smart technology there is great potential that resides in this data (as described in Section 2.3) as the analysis and meaning that emerges from it can help to differentiate smart city from current operations models. Accurate processing and analysis of data can help an operation better understand customer demand patterns and thus forecast more accurately, whilst also providing transparency of supply chains. However, the mere generation of big data does not generate value improvements for an organisation and some smart technologies, by design, will create more easily codified and interpretable data.

Connectivity: Connectivity relates to the degree to which operations are connected to other infrastructures, service providers and information sources. Traditionally, connectivity was understood as the physical hard wiring of different IT processes. However as cities become increasingly wired and digitised, connectivity in the smart city context relates to the integration of information, systems, people and services across the urban environment (Caragliu et al, 2011). In addition, smart cities require the connectivity of technological components with political and institutional components. Political components represent various political elements (city council, boroughs and government) and external pressures such as policy agendas and politics that may affect the outcomes of some operations. Smart technologies will display differing levels of connectivity with other infrastructures and importantly, their users. Depending on the nature of the industry in which an operation resides, and the organisation of the service provision (public versus private), some smart technologies will 'connect' with a greater number of smart city components and thus may require a degree of 'readiness' at the institutional level (e.g. removing legal and regulatory barriers) (Miorandi, 2012).

Connectivity allows the real time transfer of data, offering both demand side and supply side transparency for an operation. In this regard, it allows operations to connect more intimately with different customers, tailoring services accordingly.

3.2 Assessment mechanisms for new operational models

Previous works have examined general and overarching frameworks and decision models around the development of smart cities (Lee, 2013). However, little attention has been placed on the implications for the operations model of an organisation. For every operation it is imperative that they evaluate smart technologies and their implications, both for their operation and customers or users. This evaluation involves determining its value or worth, and also should it include some consideration around the adoption of alternatives or the consequences of not adopting at all (Slack and Lewis, 2011). We align with Slack and Lewis' (2011) broad classes of evaluation criteria (feasibility, vulnerability and acceptability) and apply them to a smart city context.

Feasibility assessment: Feasibility relates to the degree of difficulty in implementing and adopting new operations models and the supporting technology required, as well as the resources required to effectively implement them.

Financial Feasibility: The financial feasibility pertains to the amount of financial investment that smart technologies and the new operations models will require. Depending on the existing ICT infrastructure of the operation, this could range from a one-off purchase to a more considerable investment in hardware or software development. Using big data and predictive analytics, there is potential to simulate projections around net cash flows likely to be earned if a proposed new operations model was introduced. However, feasibility assessments need to extend beyond that of financial projections and should include an assessment of how the resources required to effectively implement new technologies align with the resources and capabilities that are accessible to the operation.

Market Feasibility: Determining the changes required in current resource and capability base is an important consideration for operations. To borrow Fawcett and Waller's analogy (2012: 161): 'New competitive rules demand a new type of team'. Having smart technologies and data storage facilities in place is one thing, but having the capabilities and human capital, capable of managing this technology and interpreting this valuable data resource is quite another. The operation will require data management and analytical skills to be present or accessible across functions, so that the connection of customers or users to the operation can be sustained. In the case of new operations models like Uber and AirBnB, where the ideas are particularly innovative, the skills required had to be defined at the outset. However, in health services that are adopting new technologies and new operations models, the first step is to identify the required skills and match them against the skills already available.

Regardless of the nature of analytical output produced by an operation, in order to effectively leverage its potential, analytical expertise (in the form of data scientists) is required to tackle both the technical and the managerial issues that can emerge around interpretation and application of big data. The data scientist is described as one of the most lucrative jobs of the 21st century but shortage of supply is becoming a serious constraint in some sectors (Davenport and Patil, 2012).

To assess the feasibility of new operations models and the underpinning technologies, a series of questions need to be asked: What are the likely technological trajectories of the supporting technology? How sustainable are they? Has strategic level commitment been given to the new operations model? What knowledge/capability gaps exist in terms of know-how and expertise, both at the user and organisation level?

Acceptability assessment: Acceptability is a multifaceted term which includes financial and resourcing acceptability alongside factors associated with the market and customer preferences.

Financial Acceptability: Perceptions or ideals around what is deemed 'financially acceptable' will differ across industry and depend on the nature of the operation. It should be defined with particular attention to the value proposition of the operation. In healthcare, a smart initiative or technology might be evaluated on the basis of how it impacts on operational workload. For instance, the improvement the initiative makes to lowering variance in the % of full beds or improvements in theatre occupancy rate and other efficiency gains.

Citizen/Customer Acceptability: As has been acknowledged, some operations require the customer to take on a 'prosumer' role and participate more concertedly in the service provision or production process (Roth and Menor, 2003). Given that the smart city context works on the premise that 'smart people' will be more connected and by implication, more participative in some services, the evaluation of the suitability (or acceptance) of their involvement is important, as there are some instances in which customer participation is not always optimal (i.e. services with higher levels of expert input or professional care required).

Traditionally, increasing the level of ICTs within a service offering was associated with a loss of personal attention and 'distance' in delivery. However, in a smart city, the digitalisation of many services actually offers a more personable and customised service experience. Using healthcare as an example, smart cards contain personal information about patients: identification, emergency data (allergies, blood type, etc.), vaccination, drugs used, and the general medical record, effectively acting as an electronic medical record for the patient (Aubert and Hamel, 2001). The smart card reduces delays in the admissions process for patients and allows the physicians or caregivers to get a complete picture of that patient quickly, tailoring the treatment accordingly. From an operations perspective, customisation is normally associated with increased variability and variety in the process, which is not ideal. Variability has long been acknowledged as something to be reduced or eliminated, in order to increase consistency and reduce complexity in the operation (Vredenburg and Bell, 2014). For the customer, the associated customisation engenders perceptions of service quality and control over the service process (Xie et al, 2008). However, the smart city context can offer increased customisation for citizens, without increasing the variability for the operation, as the ICT infrastructure of the operation can offer customised interface, based on data collected and auto analysed.

As well as quality, the smart city context can allow operations to position their products and services to improve speed, dependability, cost or flexibility from a customer's perspective. The greater the extent to which a new operations model or initiative is perceived to deliver, or exceed, customer expectations in such areas, the greater the likelihood that it will be viewed as 'acceptable' from a market perspective,

However, the degree to which ICT interventions or technologies are acceptable for the customer is also likely to be connected to the nature of the service. Where the value in a service is based around implicit (or psychological) services, personal interaction is important and therefore citizens may show some reluctance to engage (Roth and Menor, 2003). In considering how a smart city can support the development of an operations models and its service offering, it is imperative to consider the service concept and how smart technologies fit with the values, culture and practices of different citizens and customers. The compatibility of the technology to the norms and practices of these groups lowers the probability of rejection by the social group. This is linked to the concept of social approbation (Tornatzky and Klein 1982). Acceptance of the technology may also increase if it improves the image of the customer or citizen (Moore and Benbasat, 1991).

In practice, the acceptability of a new operation model and its underpinning technologies need to be addressed through some of the following related questions: What value does the new operations model provide for the customer? How does the technology impact delivery or response times for customers or users? How flexible is the technology in terms of customer use? How is performance defined in this operation? What improvements in performance would we expect to leverage through the adoption of new technology? What is the current level of customer participation in this operation? What are the opportunities for customers to adopt a 'prosumer' role? What are the associated benefits and challenges?

Vulnerability assessment: The third criteria pertaining to the risks that an operation may be susceptible to following the implementation of the technology.

Privacy and Security: Issues of privacy and security influence the vulnerability of the technology and the operations it supports. The smart city often requires that customer information and data sharing be more fluid. However, embedded security and privacy-preserving mechanisms need to be considered at a systematic level by the operation and embedded into the design of the operation in order to ensure adoption (Miorandi et al, 2012). Without guarantees in terms of system-level confidentiality, authenticity and privacy the relevant stakeholders are unlikely to adopt solutions around smart technologies on a large scale (Miorandi et al, 2012). Big data sharing agreements today are described by Koutroumpis and Leiponen (2013) as informal, poorly structured and manually enforced. Instead, agreements need to be designed with robust mechanisms for data protection and privacy, incorporating access and usage control that can be trusted by all key stakeholders (George, 2014). Failures in security and privacy often generate strong negative publicity.

Information Incompleteness: With the growth of the digital economy and the increasing prevalence of IoTs, there is the significant risk that operations assume completeness of ‘the picture’ when in reality the data only represents what can be digitally captured. However, digital economy has a fundamental flaw in that many things cannot be digitised (Li, 2006). Fawcett and Waller (2012: 158) question the balance between ‘seeking analytics-based first mover advantage and striving for causation-driven understanding’. Seeing a relationship between two variables hidden in big data does not infer anything about causality – human judgment at some stage is often required.

There are some types of knowledge and information that are inherently difficult to codify and capture, and as efforts to be ‘information rich’ intensify, these sources can be overlooked. Insights, experience, and the tacit knowledge of individuals and groups cannot be easily digitised, but do warrant attention and analysis. With the movement towards information liquidity in smart cities, this information can however be overlooked in decision making, whereby decisions are based on what is known, rather than unknown. Redman (1998) reports that the costs of poor data quality range from 8% to 12% of revenues for a typical organisation and, up to 40% to 60% of a service organisation's expense. Cities are complex systems, comprised of technical, social and physical parts, and an overreliance on ‘the technical’ can have negative consequences. Human interpretation, cognition and emotion should not be eliminated in the interpretation of big data, and big data analytics should not be viewed as the panacea of human decision maker error. Social and technical components need to be jointly considered by operations to ensure that they continue to deliver customer value and remain competitive in an increasingly digitised environment.

To assess the vulnerability of a new operation model and its underpinning technologies, a series of important questions need to be asked. How does the new operations model impact traditional modes of operation? Are there interdependencies created with other operations through the adoption of new technologies? How critical are these interdependencies and what proactive contractual action is needed? Is there scope to develop in-house expertise to manage new technologies? What legal protection is required with the changing operations model? Assuming an increased level of customer participation, where are the most likely 'failure' points for the customer in the process and what are the implications for failure at each stage?

4. Theory Guided Case Studies: How smart Cities Transform Operations Models

Three cases were purposively selected in order to advance the conceptual framework presented, and demonstrate the emergence of new operations models in different sectors in smart cities. Following Levy's (2008) theory-guided case studies, we framed our case analysis to enable the production of 'causal explanations based on a logically coherent theoretical argument that generates testable implications'. Our research was also informed by Patton's (1990) theoretical sampling approach in choosing cases which are likely to extend or replicate the emergent theory of operations models in smart cities.

Theory guided case studies allow us to explain a single case avoiding generalisation beyond the data due to the structure offered through a conceptual framework, which is focused on theoretically specified aspects of reality. The structure of our cases studies is then determined by the proposed framework and allows us to examine the selected underpinning theoretical concepts. This theoretical framing of the data enabled the researchers to consistently explore similarities and differences between key operational model characteristics. In particular, the case examples illustrate: (1) how smart city can enable the development of new service operations models (Uber) that are industry altering; (2) how smart city can enable the creation of a new market niche via new operations models by unlocking the economic value of city-based resources (AirBnB); and, (3) how smart city can help address some of the operational challenges of traditional service industries (i.e. healthcare), through the development of smart technologies and new operations models that integrate the users in the service process (telehealth).

Information was primarily gathered from secondary sources, including published media interviews, industrial journals and trade magzines, newspapers and web data. Some confirmatory field data, consisting of observation notes, expert interviews with providers and users of the services for each case – was also collected to cross validate our key findings. The construct validity of our cases were achieved by developing constructs through a literature review, use of multiple sources of evidence, establishing a chain of evidence, and having key external informants review our draft case study reports (Miles and Huberman, 1984; Yin 1993). In accordance with Eisnedhardt (1989), the internal validity is established by linking of the analysis to prior theory identified in literature review, expert peer review, and the development of diagrams, illustration and data matrices to demonstrate the internal consistency of the information collected.

4.1 Case example 1: smart transport - Uber

Firstly launched in San Francisco in 2009 – and available in more than 200 cities with an estimated value of US$17billion+ in June 2014 – Uber offers an industry rule-changing service (i.e. ride sourcing) that links passengers requesting a ride with a community of non-commercially licensed drivers through a mobile application that shares passenger's GPS location (see also Rayle et al., 2014). This example illustrates one of the many O2O operations in smart cities. In line with the growth of smart cities, this service helps to satisfy an increasing demand for urban mobility at reasonable cost, and offers considerable flexibility for independent drivers.

Uber does not own the cars and does not employ the drivers, but instead drivers are independent agents who decide when and if they will access their Uber application and accept requests for rides from Uber customers. Uber aligns with the smart mobility concept and connects online customers, in real-time, with a traditional offline process (e.g. a taxi ride) which generates value for both passengers and drivers. The operations model for Uber is fundamentally different from traditional taxi firms – for example, either the London Black Cabs whose operations model is primarily to drive around the street or wait at stations, airports or other taxi stands for customers to come (Skok and Tissut, 2003). This is also very different from the private hire taxi firms in the UK, whose customers have to telephone the Taxi office in advance to order a taxi through an operator, so the firm can send a taxi to pick up the customer from a specified location and time.

In terms of *connectivity,* Uber operates around a very straightforward application which integrates GPS positioning with 3G and 4G mobile technologies. Customers and drivers are connected with ease. This ease in connectivity increases the propensity of passengers and drivers to engage with the technology underpinning the unique service offering as little 'education' is needed and one download of the application onto a smart phone or tablet is all that is required. The level of connectivity is thus not complex as single stand-alone devices just need to be connected to the web and they don't need to be connected to one another. The technology does not need to be installed in any physical location, increasing the mobility of components.

This unique *connectivity* allows the real time transfer of data *(analytical output)*, offering demand side and supply side transparency for an operation. The value for both parties relies on the possibility to share passengers' position (i.e. GPS data) and drivers' directions. Passengers can easily locate the closest available cars near their locations. They can use the embedded real-time location tool to map the community of drivers moving across the city and choose the one that has not only the most convenient location but also has been recommended by previous passengers. This operation thus works on the basis of real-time data being analysed online, by both the driver and the passenger, to determine if they want to engage in a service transaction off-line. From the perspective of the drivers, they can pick up the requests of passengers, whose location aligns with their planned trip through the city, reducing the time wasted and increasing the occupancy rate of their vehicles. From the customers' perspective, they can use available information to determine which driver is most geographically suitable and also understand the service experience of previous customers, and make their decisions accordingly.

The simplicity of connectivity in this operation and the transparency offered for both drivers and customers already suggests a level of innovation and 'smartness' in design. However, the scalability of the operation in a smart city context also distinguishes it from traditional operations in this industry. With its ability to shift to optimum levels of useful capacity, quickly, cost-effectively and flexibly (Slack and Lewis, 2011), Uber's model can be described as highly *scalable.* By design, Uber incurs very little cost and through dynamic pricing (at certain times) can easily influence the levels of capacity offered, and the amount of demand satisfied. Changes in dynamic pricing (introduced in 2012) are driven algorithmically when wait times are increasing dramatically, and 'unfulfilled requests' start to rise. Drivers can thus choose to 'add capacity' at the busiest times as this is when the fares will be highest. This chase capacity strategy reduces idle time for drivers and increases the probability for Uber that their customer demand can be fulfilled.

It is relevant to note also that Uber is unlikely to develop in a non-city context as its operations model is embedded in the creation of value from processing data shared by two interdependent communities (i.e. passengers and drivers) that interact online in an offline urban street network. The key factor to the efficient functioning of the urban operations model is scale, both in the number of cars available across the city, and demand from customers over time and across the urban space. Uber enables an innovative online and smart use of data (i.e. passengers' needs and driver and vehicle's characteristics) that affect the match of demand and supply in a scalable and flexible operations model.

4.2 Case example 2: smart tourism – Airbnb

Like Uber, Airbnb was founded in 2009 in San Francisco where its three founders rented out an inflatable mattress (as an AirBed & Breakfast) at their apartment via a website, on the occasion of a major conference event in town. Identifying a way to directly access the increasing demand in the tourism industry for affordable short-term accommodation, the founders developed a new operations model that has so far redefined the rules of the hospitality industry, through the utilisation of idle capacity (in terms of beds) in residential dwellings. The 5-year-old Airbnb model is based on a centuries-old practice, namely renting out spare beds to travellers (Guttentag, 2013:4), and as of February 2015, Airbnb has 1,000,000+ listings, with an estimated market value of $13bn.

Airbnb has shifted a fully offline service (accommodation has to be physically 'consumed') to an operation that is managed online by a new category of entrepreneurial homeowners. In terms of *connectivity*, the difficulties encountered by owners in connecting with potential guests has been addressed through the creation of an online community of hosts and guests with easy access to a database of properties, communication tools, payment methods and booking options. A new reservation procedure enhances the accountability of owners and renters, through connection with an external identity verification system. Both owners and renters require only access to the web and then they need to create an online profile which communicates relevant information about them, allowing both actors in the potential exchange to connect 'socially' to some extent to determine if they are happy to proceed (Edelman and Luca, 2011).

Smart tourism is about leveraging technology and their social components to support the enrichment of tourist experiences, and the Airbnb model thus represents a movement in this direction through the instant and simple connectivity it offers. The transparency afforded through this connectivity has addressed some of the safety concerns associated with other models (such as Home Away).

In terms of *analytical output*, the website and smartphone application provides real-time accommodation availability for a particular city or area, on requested dates, based on the guest preferences inputted. Also multiple sources of evidence (in the form of previous guest reviews) are synthesised on the website to allow potential guests some insight into the service experience of previous guests. This information flow is dyadic as hosts also can access the profile, characteristics and feedback on guests. As such, this model and the technology that underpins it provide the opportunity to connect real-world actions to a virtual reputation – another example of the rapidly growing domain of O2O services.

For the tourist industry, Airbnb represents one of the most *scalable* innovations as it effectively enables any connected citizen to advertise spare capacity in their homes or residences online. The effective capacity of cities, in terms of tourist accommodation, across continents has grown considerably as a result of this model. This peer-to-peer operations model broadens the access to accommodation for those who desire it and who may have, in the past, been unable to access it due to the expense often associated with some hotels or guest houses. For Airbnb, by offering a safe, digital environment in which to connect, the company can create a leaner business model that does not require a large workforce to deliver the service (as in traditional hospitality models). What makes this operation revolutionary is not the (offline) service itself, but the ability to leverage it by using the power of internet connected systems and the willingness of 'smart people' who are open to exploring the potential of new mode of service delivery. Similar to Uber, the city context is key for the volume of supply and demand. In doing so, a new operations model is successfully created in the smart city context.

4.3 Case example 3: smart healthcare – Telehealth

In 2007, the government of Taiwan initiated a series of pilot telehealth programmes for homes, communities, and institutions. The 'Smart Care' service, announced by the Ming-

Sheng General Hospital, is a common telehealth home care model in Taiwan. Telehealth programmes enable the aged with chronic illnesses to live independently in their own homes and get acute care more efficiently without increasing the manpower needed from the hospital (Hsu, 2010). The services in this model included: (A) telemonitoring of physiological parameters (blood pressure and/or blood sugar); (B) providing the relevant health information and medication instructions: and, (C) offering consultations with healthcare professionals via videoconferences. In recent years, a wide range of telehealth services have been launched in the UK, Europe and North America and across many other parts of the world. In the UK, companies such as Docobo, Tunstall and iSpy Digital have implemented various telehealth - and telecare - services for old people using similar operations models (Oderanti and Li, 2013).

This healthcare operations model encourages *connectivity* between hospitals, medical devices manufacturers, IT vendors, and health care providers to develop telehealth solutions for the elderly and to improve traditional operations models that are increasingly unsustainable with a rapidly growing aging population. Using broadband technology, TV set top boxes connect the patients to the telehealth services. Patients are provided with medical sensors to monitor parameters such as body temperature, blood pressure, and breathing activity. Other sensors, either wearable or fixed are deployed to gather data to monitor patient activities in their living environments. Patients themselves measure their vital signs, according to the instructions provided by their doctors. They can either upload this information or report it through voice response systems, or video calling if concerns are raised. The team in the call centre (consisting of nurses and doctors) can engage with patients periodically to monitor their health status and address their concerns. In terms of connectivity this patient data can be integrated into the hospital's computerised physician order entry (CPOE) system or into the hospital information system (HIS) directly. The collection and analysis of this data supports the movement by physicians towards evidence based medicine through systematic review of clinical data and make treatment decisions based on the best available information (Jee and Kim, 2013).

This model works on the basis of active patient participation, a willingness to engage with the technology and an involvement in the remote sharing of personal health data. Effective customer participation has been shown to increase the likelihood that the needs of a product or service are met and this is particularly apparent for service such as healthcare where the outcome is dependent on patient participation (Bitner, 1997). Indeed, such technologies have signalled a greater level of participation from patients in the service delivery process. Patients have moved from being passive recipients of treatment, to playing a key role in the determination of quality, satisfaction and service value.

In terms of *scalability*, this model relies on the integration of technology and data with other healthcare service operations, which adds complexity to the logistics of scaling up the service. There is also a heavy reliance on the capabilities of the patient and their carers to play a reliable and attentive role to the reporting of data and use of the technology, which can render some patients groups as 'unsuitable customers'. Also, the operational, human and societal implications for the operations could be significant if the technology cannot match the level of customer engagement of the current provisions and be aligned with the intervention of personal care when needed. The technology needs to demonstrate a high level of reliability which can impact the degree to which capacity can be added quickly and efficiently (i.e. scalability). There are significant cost implications associated with scaling up these operations and they are also likely to be met with some resistance from those citizens who may view such evolution in the operations model as 'depersonalisation' as opposed to 'customer-focus'.

The individual patient monitoring capabilities offered through telehealth allows the continual monitoring of patients in their own homes, which enables the tracking of changes in their health conditions and can be tailored to the specifics of their ailment or diagnosis.

In terms of the level of *analytical output*, the data extracted from each patient and their online participation with the operation has obviously direct implications for the immediacy, and nature of their treatment, offline. However, the hospitals and other city-based stakeholders can access this data at an aggregate level in order to plan the delivery and organise the consumption of their service offerings more efficiently. The data gathered has the potential to transform the operations models and revolutionise healthcare service provision in smart cities.

Traditionally, healthcare operations were encouraged to examine how process mapping and standardisation can be implemented to improve patient flow, throughput and ultimately hospital performance (Boyer and Pronovost, 2010). However, new solutions based on technologies used in this Taiwanese example highlight the potential of patient involvement to improve the operations process and facilitates the development of smart healthcare as a core component of smart cities. Telehealth is growing in prominence across both developing (Mohan et al, 2004) and developed contexts (Mohan et al, 2004; Oderanti and Li, 2013). Fichman et al (2011) argues that ICT can expedite the transformation of the healthcare sector by redefining the relationships among key healthcare stakeholders through innovative operations models.

5. Case Synopsis: Emerging Insights from the Case Studies

Table 1 provides a summary to illustrate the interface between the characteristics of operations models and their assessment criteria (in the three cases). We provide an overview of the development of new operations models in relation to three central characteristics – scalability, analytical output, and connectivity. Table 1 also offers an evaluative approach of these new operations models around their feasibility, vulnerability and acceptability.

Insert Table 1 about here

These cases demonstrate that there are significant opportunities for transforming operations models in smart cities - both in the management of urban infrastructures themselves [such as smart meters for urban utilities, and the development of intelligent transport systems (Giannoutakis and Li, 2012)], and in production and service operations across different sectors that rely on digitised urban infrastructures. Table 1 helps to explicate the behavioural, technological and operational factors, which contribute to the scalability, development of analytical output and connectivity across operations models. The involvement of smart people in each of the cases emerges as well as the role of information creation and usage (big data).

This paper examined how the rapid emergence of smart cities enables the development of new operations models around the central characteristics of scalability, analytical output and connectivity, by reshaping the feasibility, vulnerability and acceptability of the operation in urban context. The framework we developed was effective as a cognitive tool in understanding the transformation of operations models in smart cities. Going forward, more empirical and theoretical research is needed to further develop and validate the framework, not only as a conceptual instrument, but also as a practical tool to guide user practice. More research is also needed to understand the opportunities and challenges involved in transforming operations models across different sectors

6. Conclusions and Future Research

Our paper explored how smart cities could enable the development of new operations models and how these models can be evaluated. Further it aimed at setting out a new research agenda that fuses and crosses the boundaries of operations management and the digital economy. As the prominence of smart cities continues to develop and stakeholder groups become increasingly knowledgeable and engaged, there is considerable incentive for operations managers across industry sectors to consider the opportunities and challenges facing their processes and people, as well as the tools and frameworks they deploy for strategic and operational decision making. The opportunities are not only in improving efficiency and effectiveness of their existing operations, but also in transforming their operations models, and in some cases, developing radically different new ones.

While technology companies (such as IBM, Siemens, Cisco) are assumed to have a first mover strategic advantage (as they provide the digitised infrastructures to tackle the data-driven operational challenges of smart cities) in urban projects and initiatives, they are also essentially the enablers of a smart city. For organisations developing new operations models, the challenge is to build on and leverage these digitised infrastructures to connect physical goods, services, and people (offline), with real-time data driven processes (online), in seamless O2O operations. This requires a re-design of long run operational competencies and capabilities in order to respond to the rapidly changing smart city environment.

The characteristics of smart cities, and the associated transparency and predictability they potentially offer, enable the development of new operations models across different sectors. The digitised infrastructures on which smart cities are based present new ways for organisations to design and deliver products or services in more customer-centric manners, particularly for those that require geographical proximity with consumers in the O2O context. In this paper we have developed a conceptual framework which integrates smart cities and operations models together. Case studies were then presented to explore the emergence of new models of operation in travel, tourism and healthcare.

Despite the importance of operations management to smart city implementation for both practitioners and researchers, we have yet to see a systematic framework for analysing and cataloguing emerging operations models. As such, our conceptual framework makes an initial contribution to operations management theory in the digital economy. This research only used three ‘theory-guided’ cases studies to illustrate the transformation of operations models in the smart city context. Therefore much more in-depth analysis and more detailed models are clearly needed to assist in the implementation of smart city initiatives and facilitate new innovations in operation management. Some of the changes that operations and their connected supply chains face are revolutionary, and this requires careful consideration from both a practical and theoretical point of view. Going forward, three types of research are urgently needed.

First, intensive case studies of the transformation of traditional operations models and the development of new operations models in different sectors and domains in the smart city context need to be identified and documented. The description of the new operations models and the rich context in which these new models are embedded will provide deep insight to researchers and operations managers in exploring similar opportunities and challenges in their own domains. Such case studies will also provide the basis for the development of a comprehensive taxonomy of emerging operations models in smart cities, and the conditions required for their successful development. It will also enable us to identify and conceptualise emerging trends that are not yet quantitatively significant but with the potential to affect a broad range of sectors or domains.

Second, given the growing importance of big data associated with smart cities, new analytic frameworks, tools and techniques need to be developed to systematically capture relevant data and generate reliable insights to inform the operational and strategic decision making of operations managers. Some existing frameworks and tools can be adapted for big data, but new ones need to be developed to address emerging opportunities.

Third, and perhaps the most important, is new theoretical and empirical research about the transformation of traditional operations models and the emergence of new ones in the O2O space. The digital revolution has already made a profound impact on a range of industries through e-Commerce and e-Business. Smart cities provides the ideal environment for a range of new innovations at the interface between online and offline activities. O2O will significantly extend the scope for the digital transformation of operations models across different sectors, from personal, domestic and community services, urban tourism and hospitality, to mobility services and urban transport, and a wide range of other products and services that demand close geographic proximity between providers and consumers. It is at the interface between online and offline activities that old industries will be transformed and new industries will emerge in the years to come.

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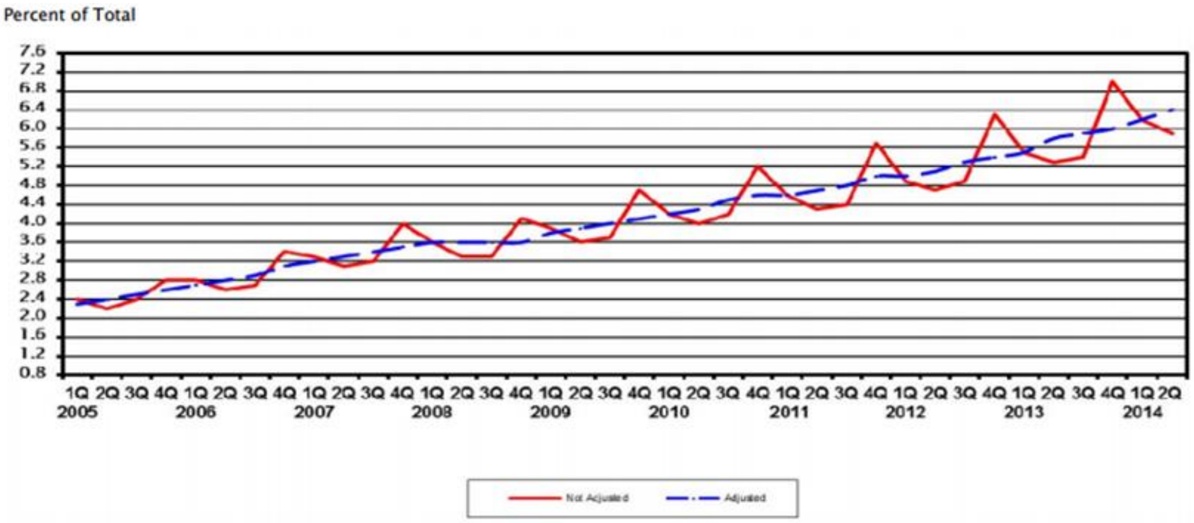
FIGURE 1 ESTIMATED QUARTERLY US RETAIL E-COMMERCE AS PERCENT OF TOTAL QUARTERLY RETAIL SALES 2005-2014



The Quarterly Retail E-Commerce sales estimate for the third quarter of 2014 is scheduled for release on November 18, 2014 at 10:00 A.M. EST.

For information, including estimates from 4th quarter 1999 forward, visit the Census Bureau's Web site at <http://www.census.gov/retail>. For additional information about Census Bureau e-business measurement programs and plans visit <http://www.census.gov/estats>.

FIGURE 2: SMART CITES AND NEW OPERATIONS MODELS: A CONCEPTUAL FRAMEWORK

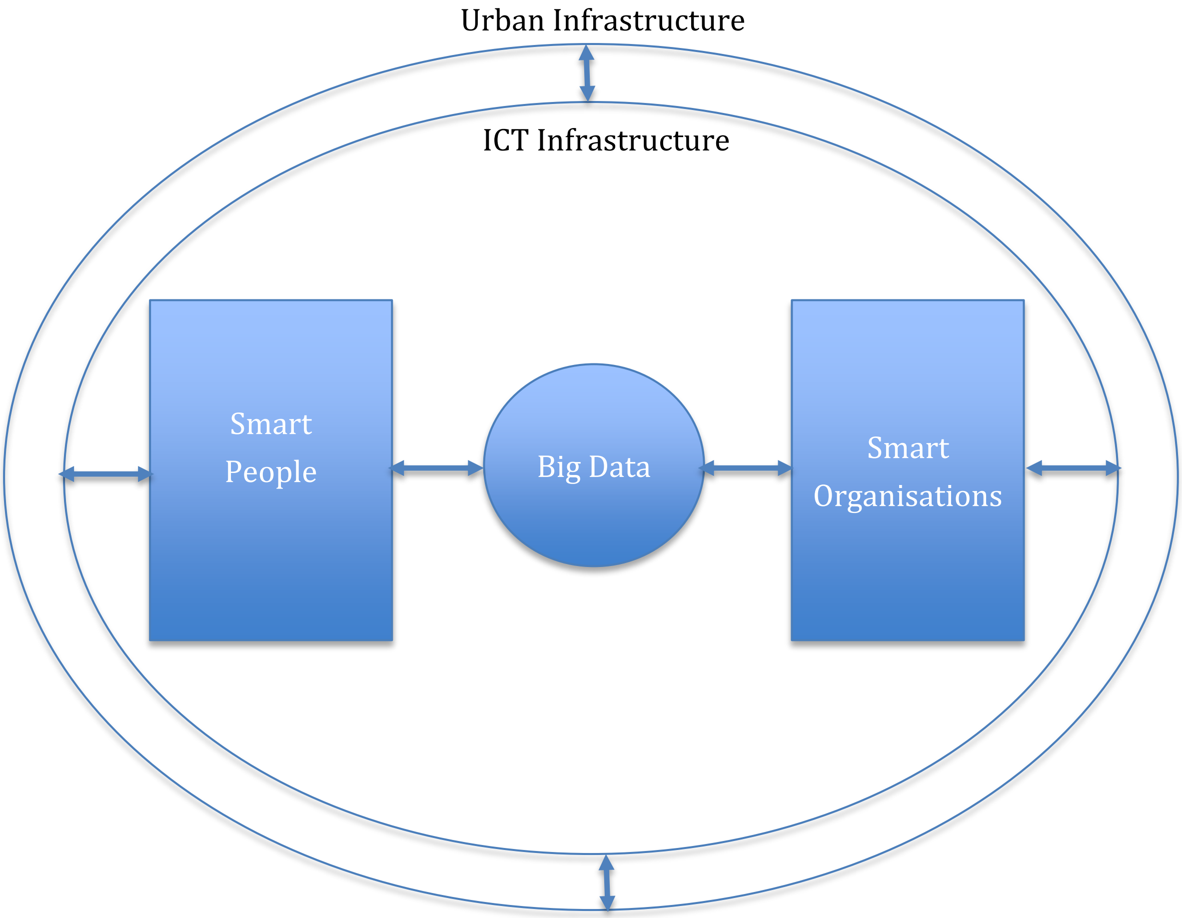


TABLE 1 AN OVERVIEW OF NEW OPERATIONS MODELS FROM THREE CASE STUDIES

			Assessment Mechanisms		
			Feasibility	**Acceptability**	**Vulnerability**
Uber	**Operation Model Characteristics**	**Scalability**	Minimal financial investment for both customer and operation Integrates stand-alone devices – therefore reducing resource investment (e.g.IT, people)	Little customer education is required – intuitive in design and minimal decision points in service process. High level of process simplicity easing adoption	Critical community size helps to foster perceptions of trust and service reliability. Community size also validates the existence & need for the service offered.
Uber		**Analytical Output**	Easily codifiable output for customer & drivers. Reliable output as based on GPS positioning.	Tracking capabilities generate value for user community & operation. User in control of information which is shared	The model has to be prepared to incorporate the driver & customer data. The model relies on the accurate & continuous production of this data.
Uber		**Connectivity**	Price and access are not restrictive. No multi-level integration with other systems.	Connectivity offers an expedited, and customised, service delivery, increasing customer satisfaction.	Trust development aided as minimal customer intrusion occurs (due to the nature and amount of the information that is shared)
Airbnb		**Scalability**	Uses excess/idle capacity to address customer demand. Fully flexible. Any homeowner can enter, or withdraw, market (affect capacity) with minimal cost. Minimal resource changes required to enter market as homeowner	Fully functional through online operational model and willing engagement of customers. The variety afforded through the scalability of the process, and relative cost, means users are willing to challenge conventional view of 'hospitality'.	Critical community size, and urban setting, are key enablers of this operational model.
Airbnb		**Analytical Output**	The application filters results according to customer input and host availability. No other system integration (or associated resource investment) required.	Data generated assists host and customer to determine the suitability of renting options.	Customer and host data can be analysed to determine relational/personal characteristics & decision altered accordingly. Secure payment systems
Airbnb		**Connectivity**	Easy to access database of comparable properties. No joining fee at outset to deter. Communication tools are online so can operate through web. Payment tools are fully integrated with booking system.	Technological and social components are integrated to support & enhance the tourist experience.	Social connectivity and communication tools offered can help to alleviate security/privacy concerns (identity verification system). Transparency for both demand and supply side.
Tele-Health		**Scalability**	Variation and variability of patients (assuming homogeneity) are both at a high level impacting the flexibility in offering telehealth services & altering capacity.	Reliant on patient/carer cooperation & capability with system technology. Growth in remote care could be perceived as depersonalisation of core service due to participation required.	Risk of failure present at individual, operational and societal level if balance between technology and human intervention not met. High level of technology reliability required to ensure capacity needs met.

		Analytical Output	Additional human resource & physician training required to engage with the technology, interpret data accurately & respond appropriately. Dynamic environment means speed of information transfer important in determining feasibility.	Patient data has to be integrated with other relevant hospital based systems (or existing patient records). Real-time monitoring can expedite care delivery or diagnosis. Customised care can be offered through individual, remote patient monitoring.	Requires subjective assessment (human interpretation) at some stage which will ultimately determine service 'performance'. High level of analytical capability required plan resource management at urban/community level
		Connectivity	Multiple stakeholder integration required at a minimum to deliver service to patients.	Patients' suitability assessment required as patient plays prosumer role.	High reliance placed on system connectivity and reliability. High risk of service failure if connectivity fails. Reliant on connectivity at multiple human, technological , physical levels