TOWARDS A TECHNOLOGICALLY ADVANCED AND MULTILINGUAL NORTHLAND SHOPPING CENTRE UTILIZING IoT, BIG DATA AND CLOUD COMPUTING

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ABSTRACT: *With the recent advancements in sensors and communication technologies, the Internet of Things (IoT) has developed rapidly. IoT implementation and applications have been highly successful in transforming various businesses and institutions together with contexts such as buildings, cities and roads into smart environments, where tasks handling is more efficient. Success in such digital transformations is not only due to proper IoT implementation but also to the effective employment of big data and cloud computing technologies. Despite the significant amount of IoT research in various contexts in recent years, attention given to linguistic landscapes (LLs) is still very rare. The aim of this paper is to improve the quality of life for people by proposing a smart Northland LL which takes into account the appropriate employment of IoT tools and relevant technologies. A thorough literature review of the field is conducted covering the IoT, big data, and cloud computing studies, followed by a review of the recent publications involving the successful integration of IoT technologies combined with big data and cloud computing in various contexts. Based on a detailed analysis of the literature, a framework comprising three different levels (i.e. the object, communications, and application levels) together with the components that are required for IoT-based smart LL solutions is proposed. Finally, the challenges facing the successful integration of IoT technologies are discussed with proposals for future research directions in the IoT field. The key rationale behind this study is to develop technologically advanced and quality shopping experiences for a wide range of consumers utilizing IoT tools and techniques.*

Keywords: IoT, big data, cloud computing, smart buildings, Northland, smart grid, energy efficiency

1. INTRODUCTION

The Internet of things (IoT) is a network of interconnected physical objects containing an embedded technology that allows these objects to measure the parameters of their state or the state of the environment, and to utilize and exchange this information. The peculiarity of this definition is that the things/objects themselves are often connected with the help of machine-to-machine protocols (M2M), rather than the Internet. It includes solutions on the basis of which communicating sensors, controllers, and other gadgets interact without human intervention [1]. Also, this term illustrates the potential for connecting radio frequency identification (RFID) tags used in corporate supply chains to count and track goods without the need for human intervention [2]. Nowadays, IoT is widely used to describe scenarios in which Internet connectivity and computational functions extend to certain objects, devices, sensors, and other physical objects used in our daily life.

1.1 Cloud Computing and Big Data

An essential stage in the development of the IoT is the emergence of two concepts, big data and cloud computing. Cloud computing offers the required infrastructure and involves the rental of services and resources for storing and processing data on the relevant network. Cloud systems have five main characteristics: self-service on demand, broadband network access, resource pool, the ability to quickly reconfigure expansion, and service quality measurement [3]. The concept is based on the general utilization of the relevant software and hardware infrastructure of the provider, allowing users to reduce costs and flexibly increase their information resources [4]. Cloud technologies are suitable for IoT projects because they are characterized by flexibility, scalability, and relatively low cost, which is critical in the context of adequate use of both tangible and intangible resources [5- 6]. The cloud provides adaptable scaling and allows a wide range of projects related to the IoT and big data to be implemented. Due to the technology of big data, it is now possible to analyze huge amounts of IoT-data at the same speed with which these data enter the cloud [6]. In addition, a comprehensive solution allows for timely action to be taken when events occur that require a specific response following predefined rules [7]. By collecting big data, there may be a problem in sorting and interpreting this data on dedicated servers due to limited computational capacity. Cloud computing and particular applications that make this data useful provide increased bandwidth and scalability and allow data to be adapted to user requirements [8-9]. These operations relate to both internal data on operational activities and external data.

Big data can be defined as huge datasets that cannot not be observed, collected, managed and processed by traditional database software and/or hardware tools within a reasonable time [10]. Together, the technology of big data and the IoT will assist in solving three of the most important tasks of IoT: 1) extracting valuable knowledge about processes, products and quality; 2) predicting early failures in order to reduce downtime; and 3) reducing costs by optimizing equipment and using resources efficiently [10-11]. The development of the IoT is closely intertwined with the analysis of big data. The challenge is to identify important data elements to derive new knowledge and apply this to the development of particular applications and processes. The IoT and big data reinforce each other, providing more solutions [9]. Projects based on the IoT and big data solve the following critical tasks: data collection and responding in real time, analyzing sensor data in combination with existing corporate data in order to extract valuable knowledge, and using the obtained knowledge to improve processes and applications and to contribute to timely decision making [12]. The connectivity of the IoT and big data is fully realized if information is effectively collected and integrated into existing processes. In most cases, it is necessary to combine IoT data with other types of corporate data and integrate this into all critical applications and information systems of the organization, from enterprise resource planning systems to business intelligence, to have a positive and continuous effect on the shape of the data management landscape [13].

1.2 Smart Cities and Smart Communities

For consumers, innovative IoT products, such as smart home appliances with Internet connections, home automation components, and power management devices, provide an approach for the smart home concept, offering better energy consumption and higher levels of privacy and security while facilitating daily task handling. The benefits of this technology will provide a higher level of independence and quality of life, introducing innovation and transforming reality [14]. IoT systems such as vehicles connected to a single network, intelligent traffic management systems, and built-in sensors on roads and bridges, will reduce the number of traffic jams and energy consumption. IoT technology has the ability to transform agriculture, industry, production, and energy consumption by increasing the availability of information across the entire value chain in the workplace using network sensors [15]. Thus, this technology represents a developing aspect of the interaction of people and physical objects with the Internet in personal, social, and economic life.

The development of IoT and proper implementations can lead to a change in the way that traditional businesses' compete while most objects within their environments are effectively connected. The potential result will be a hyper-connected world, as a confirmation of the general purpose of the Internet, without limiting the scope of services to which this technology can be applied. The IoT significantly transforms personal and social aspects of life, as well as businesses and entire industries [16]. Also, such a technology has the potential to solve modern global problems because the devices connected to the Internet also provide more opportunities for rational resource management [17].

The concept of the smart city emerged as a result of the expansion of the potential of the IoT and can vary depending on the real requirements of a particular city and its financial capabilities. It involves digital and communication technologies, which are used to solve a variety of infrastructure and social problems, mainly traffic management, lighting, waste, education, health, and social issues. IoT technology is widely used in power engineering, such as smart meters, loss detection, or theft in the power grid [18]. In the oil and gas sector, for example, pipelines are monitored remotely [19]. Many solutions have been developed for safer car operation. For example, one benefit of connected car technology is that an ambulance can be called in an emergency situation using a built-in SIM card. Vehicle transport tracking systems, cargo transportation monitoring, shipping and warehousing control are widely used in transportation [20]. The fundamental property of such systems is their industrial orientation and the need for human participation in making managerial decisions. This aspect significantly limits the use of M2M technologies and led to the emergence of the concept of the IoT [21]. Currently, IoT is most actively used in smart home technologies: remote management of home devices, remote monitoring and control of heating, lighting, media devices, electronic security systems, warnings of intrusions, fire-fighting systems, etc. via the Internet. The IoT can help a smart household to save on utilities such as heating, lighting and water. It is important to note that the lives of individuals, as well as the entire social reality and the modern world, will change. One of the most affected industries, perhaps, will be telecommunications, as mobile operators will gradually change their business models from network providers to providers of smart services and applications.

1.3 Linguistic Landscapes

Over the past decades, scholars have produced a significant body of research relevant to language studies. The study of the linguistic landscape (LL) focuses on public signage and covers all of the linguistic objects that mark certain places such as airports, businesses, schools shopping centres, universities, parks, etc. It comes under the linguistic discipline as a branch of general language research. LL was initially defined by Landry and Bourhis [22], who stated "the language of public road signs, advertising billboards, street names, place names, commercial shop signs, and public signs on government buildings combines to form the linguistic landscape of a given territory, region, or urban agglomeration". LL as a field of study has been proven to be a significant area for investigating the dynamics of the main aspects of social life due to the fact that it both shapes and is shaped by cultural and social associations [23]. Signs which form the LL are typically categorized as either official, such as guidance and warning official signage created by governmental authorities like Councils, or non-official as in commercial settings such as products and services advertising, which aim to draw consumers or public attention [24]. Both types of signage tend to distribute certain messages in symbolic and/or informational forms to the targeted audiences.

2. STUDY CONTEXT: NORTHLAND SHOPPING CENTRE

Northland Shopping Centre is one of the major marketplaces located on Murray Road, Preston, approximately 11 km north of the Melbourne central business district in Victoria, Australia. The Centre comprises more than 330 businesses and services in a single location. Northland Shopping Centre houses a variety of cafes, restaurants, fashion and clothing shops, fresh food stores, and gifts shops with other professional businesses including insurance companies, public services, clinics and banks. Managed by Vicinity Centres, one of Australia's leading retail property groups, the Centre is the largest predominantly single-level shopping mall in Melbourne [25]. Preston, the suburb in which Northland Shopping Centre is located, is approximately eleven kilometers north of Melbourne's central business district. Preston is part of the City of Darebin, a local government council. The council has a wide range of responsibilities involving but not limited to: ensuring the safety and cleanliness of the community, providing business support including business start-up advice, along with the delivery of customer care programs, preventing pollution, noise and disease [26], among other services that also involve engaging in the creation and viewing public/private signage.

According to the Australian census 2016, Preston has a population of over 32,851 people [27]. According to the City of Darebin Council, 55% of the population speak a language other than English at home [28]. The most common languages are Italian, spoken by 12.7% of the population, Irish spoken by 10.2% of the population, Greek spoken by 9.2% of the population, Chinese spoken by 7.1% of the population, Scottish spoken by 6.9% of the population, Indian spoken by 3.6% of the population, Vietnamese spoken by 3.0% of the population, Macedonian spoken by 2.9 of the population, German spoken by 2.7% of the population, Lebanese spoken by 2.0% of the population, Dutch spoken by 1.0% of the population and Filipino spoken by 0.8% of the population [28]. These diverse groups reflect to a great extent on the linguistic landscape of Northland Shopping Centre. Languages that are presented on signage at Northland Shopping Centre include: English, Italian, Urdu, Arabic, Greek, Spanish, Cantonese, Maltese, Mandarin, Punjabi, Macedonian, Vietnamese and Turkish.

For the purpose of this paper, the combined blocks of the Northland Shopping Centre locale selected is shown in Figure (1). In previous LL research, the selection of a specific locale was crucial, particularly where the residents living in the surrounding areas are from diverse backgrounds, such as immigrants from diverse countries with different linguistic and cultural backgrounds [29-30]. To ensure the comprehensiveness and rigor of the analysis, a particular section of the shopping centre was chosen for this study, which can assist in focusing efforts on a specific area of a manageable scale, taking into account the limited time and resources provided.

Figure (1) The study area is highlighted by the blue line, indicating that Northland Shopping Centre is under investigation (source: Google Maps)

Figure (2) shows some examples of Northland Shopping Center LLs, where the majority of signage uses English as the main language together with a mixture of symbols and/or pictures, using different colors and designs put together into a spatially definable frame.

Figure (2) Commercial sign using English and Mandarin at Northland Shopping Centre

Nowadays, signage is becoming more innovative due to the utilization of multimedia and technologies. For example, more dynamic signs have now evolved where the use of small screens have replaced traditional signs. Such screens have dynamic functionalities due to the fact that they are connected to computers, which enables content to be updated when needed. It is evident that the utilization of such small screens in commercial areas has increased exponentially and is contributing to the current shape of LLs [31]. Due to its flexibility, LL signage owners are able to update the content of their signs in an effective manner to meet their desired goals. In addition, digital signage is interactive, enabling consumers to locate information or directions with the touch of the screen. Digital screens are supported by a special antenna that assists in connecting with the relevant server/s for remote content update purposes. Figure (3) demonstrates an example of this type of recently developed signage.

Figure (3) Digital signage supported by the antenna for remote content update purposes (Photographed at Melbourne Tullamarine airport, 2018)

In recent developments, LLs have been used to support people suffering from visual impairments. Researchers have recently designed a smart system that enables a connection between objects and the building's signage.

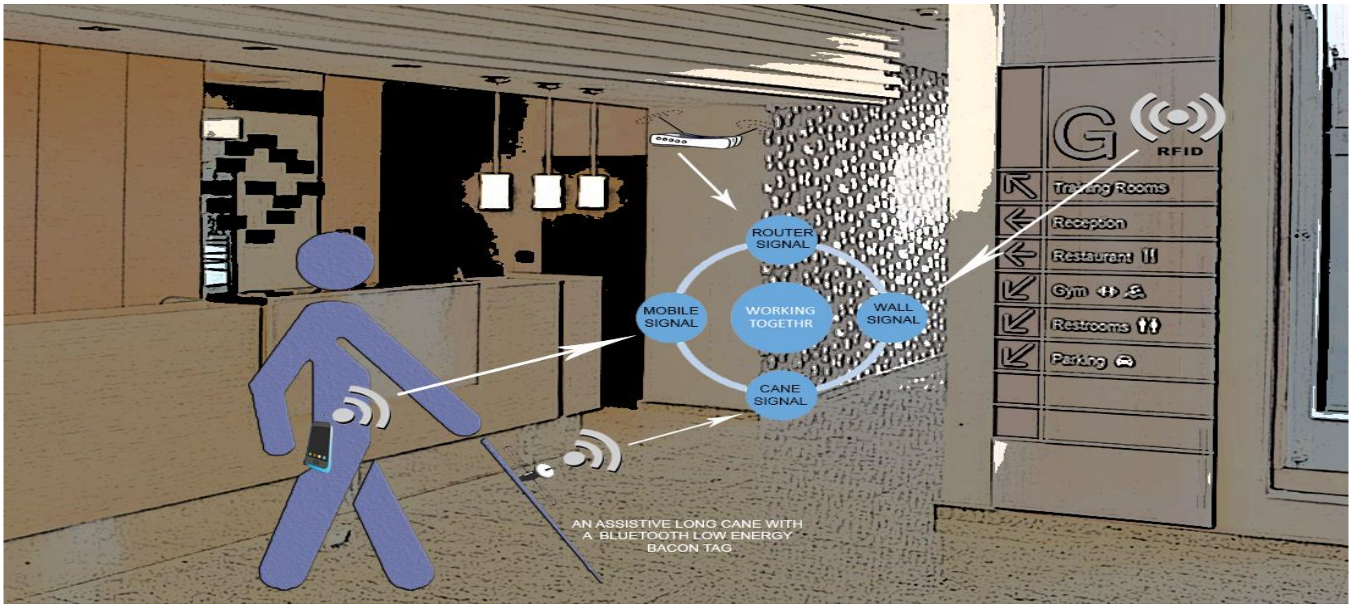

Figure (4) A smart signage system to assist people with visual impairments (adapted from [32]) and reproduced by the author

The system involves three components, namely an assistive long cane with a Bluetooth low energy receiver built in, a sign with the special sensor and wireless connection, and a smart device, as shown in Figure 4 (32). When the visually impaired person approaches the sign, signals are communicated between the system components and the required instructions and/or information are provided assist the visually impaired person to navigate to the relevant section of the building. The results show that the system enabled visually impaired people to have better accessibility to the site and a more comfortable navigation experience. The information for this study is classified into two categories. The first category is informative where users can obtain certain information or details, and the second category is directive information, where users can be given directions to their desired location. Therefore, the successful integration of recent technologies has the potential to effectively shape the LLs of various contexts in ways that significantly help users with visual impairments or those with other special needs.

3. IoT AND SMART LLS

In this section, a three-level framework, the object level, the communication level and the application level, is proposed to incorporate the IoT into a LL, based on a detailed review of the literature in similar contexts, namely smart buildings [33], smart homes [34], environments [35], and smart cities [14]. It is evident that such successful integration results in more effective and efficient task handling. The following three sub-sections further explain each level of the proposed smart LL framework.

3.1 The Object Level

At this level, every shop sign must be outfitted with sensors connected to the shop wireless network. In some scenarios, actuators may also need to be attached to the shop sign if certain functionalities are required. These sensors and/or actuators can then sense, actuate, process data and interconnect over the wireless networks similar to those installed for smart homes' IoT solutions [36].

According to Viani *et al.* [37], sensors at the object level need to process raw data before forwarding this to an upper level (i.e. the communication level) component, such as data storage in the cloud and relevant hubs. When consumers who have a smartphone, tablet or device with a specific application installed walk around a certain shop, sensors and/or actuators can detect and communicate personalized messages and/or specific information about services, products, and offers as appropriate. Hence, shop owners will have better opportunities to provide and disseminate updated information about their goods and facilities to the cloud in a timely manner, hence gaining an advantage from IoT technologies. This also can help them to analyze the consumers' demand over a certain amount of time to ensure better decision making for the future of their business. The object level and its components are shown in Figure (5).

3.2 The Communication Level

At this level, two main components are taken into account, the hub, and the cloud. The hub is a device for collecting raw and/or processed data from objects (i.e. the object level) and forwards them to the cloud or vice versa for analysis and storage purposes. According to Viani *et al.* [37] and Zhu, Wang, Chen, Liu & Qin [38], hubs are required to perform some local data processing after the data has been collected from the smart objects to reduce the amount of data being sent to the cloud and to avoid redundancies. Similar to a smart home setting, the hub sends commands to smart objects to act as a local regulator or planner [36]. For the purpose of this paper, which aims at developing smart Linguistic Landscapes, the hub is called the LL hub, as shown in Fig 5.

Hubs also are necessary to understand the communication protocols utilized by these objects and to regulate the data flow between them or to the cloud due to the fact that communication between smart devices/objects is difficult and challenging [4, 39].

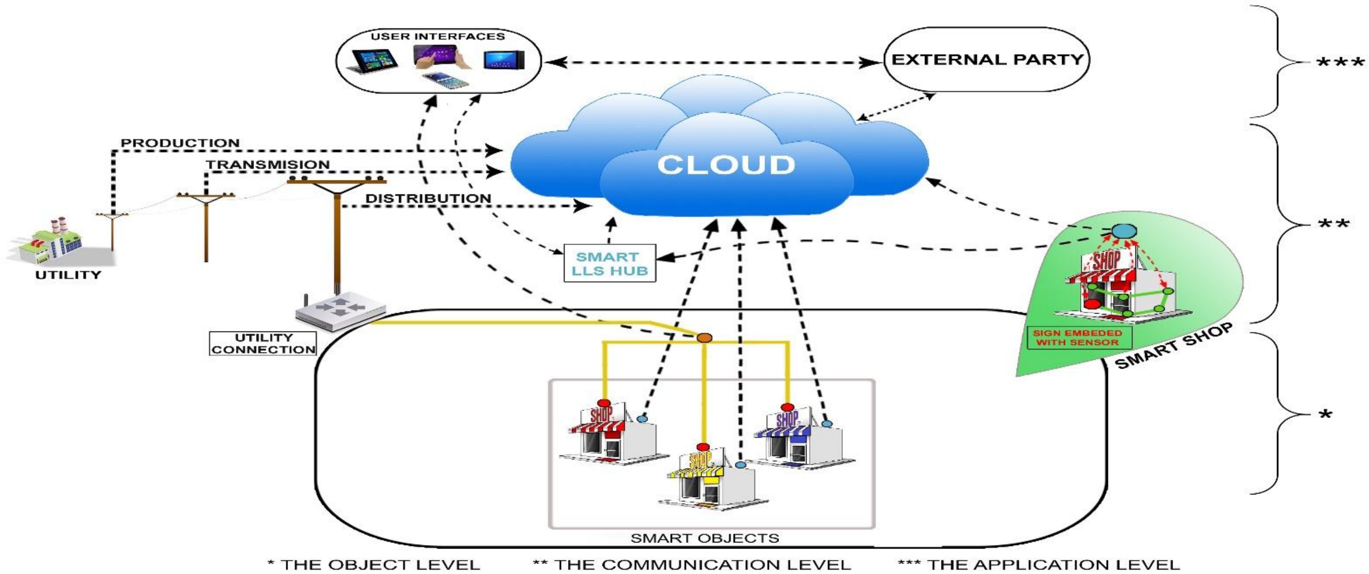

Figure (5) IoT framework involving the required components for smart Northland Shopping Centre LLs

The other component in the communication level is the cloud. As the amount of data generated by smart objects is huge, the cloud embedded with big data is the component responsible for storing and processing such data [40]. In the proposed smart LL setting, consumers who have a specific application installed on their smart devices are able to receive information on products and services in their preferred language from neighboring businesses and this communication comes from information stored in the cloud. Sensors for nearby businesses/shops sense and communicate certain information to the cloud through the LL hub. For example, a consumer who only speaks Mandarin may be interested in purchasing a jacket from the Northland Shopping Center. In this case, the consumer is required to open the smart application on arrival and enter the product name (jacket) in Mandarin, and the search term will then be internally translated and the smart IoT-based LL system will provide a list of available products within the shopping center. The list will be translated into Mandarin for the consumer and smart applications and guidance will also be provided as appropriate. Figure (5) illustrates the communication level for the smart IoT-based Northland Shopping Center LLs, including both components.

3.3 The Application Level

At this level, an external party is needed to design and develop a multilingual application for the consumer interface. The application should be designed in a way that provides consumers with guidance on how to use such advanced technologies in an effective manner. In order to realize the anticipated advantages of this technology, such as time-saving and informed decision making, the consumer must have a sufficient understanding of how to effectively utilize a smart application. For instance, there are five insurance businesses in the Northland Shopping Centre, so when a consumer wants to purchase a home contents insurance policy, they can obtain a list of prices from all five insurance providers within the shopping area using the smart developed application and choose the most appropriate option rather than walking into each insurance company branch for seeking information on their desired product/service. Similarly, in a smart home setting, the applications developed to take into account the tailored recommendations based on the consumers' needs in order to provide more effective and efficient experiences with the appropriate utilization of IoT equipment [41]. The application level is depicted in Figure (5), taking into account the external components of the network that exchange other information with the cloud through the utility connection that helps in communicating utility (i.e. electricity and water) usage and status information [42] and the required energy production, transmission and distribution for IoT-based smart LLs at Northland Shopping Centre. This can help the center management to efficiently control the energy consumption and broadcast important information.

4. CONCLUSION AND RECOMMENDATIONS

The Internet of Things is a term, which describes a computer network of physical objects equipped with built-in technologies which interact with each other or with the external environment. IoT technologies have the potential to improve people’s lives through both automation and augmentation. It is based on cloud computing which has the capability to analyze big data. This paper addresses the vision where traditional LLs can shift towards IoT-based LLs by successfully integrating IoT technologies. With the development of IoT technologies, the user's experience has spread to numerous smart devices connected to the network. Thus, the concepts of smart cities and smart communities embody the concepts of the IoT, big data and cloud computing. As in similar contexts (e.g. smart homes and buildings), shopping centers' LLs can be equipped with IoT components in order to cope with the huge technological advancements experienced across many settings. Challenges such as the provision of big data [43], privacy, security, and reliability [44], and the provision of tailored technologies for people with special needs [45] remain barriers to attaining the anticipated developments. The main contribution of this paper is the smart LLs IoT-centric framework, which combines three levels with different components, derived from the IoT literature. This IoT framework covers the object, the communication and the application level which are specific to smart LLs. It serves as a solid base for potential designers of IoT-based smart LLs solutions.

It is recommended that business vendors, shop managers, and application developers work in a cooperative manner to recognize the entire system's needs, involving the components discussed in this paper to assist the Northland Shopping Centre LLs to move towards the notion of smart. Future research directions could shed light on edge and fog computing to assist in tackling energy consumption issues for IoT technologies. In addition, addressing the challenges of big data, reliability, privacy, and security is crucial for such innovative systems. Another future research direction could investigate multilingualism, particularly in settings where people residing in the surrounding areas of the shopping center are diverse and come from different linguistic and cultural backgrounds. Different languages must be considered when developing smart LL applications in order to serve a wider range of society. Finally, regulations should also be devised to offer more effective and efficient experiences for consumers.

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