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SENSE IN THE CITY: MAKING THE GOLD COAST AN INTELLIGENT AND SUSTAINABLE CITY

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ABSTRACT

Many cities are facing challenges of urban sprawl, traffic congestion, diminishing quality of life and increasing pressure on their natural environment. Recent advancements in information and communication technologies (ICTs) such as wireless sensor networks and ubiquitous computing are potential tools for addressing these problems. How can the emerging technologies be used to create smarter, greener and more economically efficient cities? To what extent can ubiquitous technologies add value to place, community and environment? The paper examines current trends in ICTs such as wireless sensor networks, RFID, mobile devices and their potential roles in making cities sustainable. The paper develops a conceptual ICT implementation framework to make Gold Coast an intelligent and sustainable city. It examines the potential application of sensors for activities such as event and tourism management, enabling innovation, smart infrastructure, liveability and disaster resilience. Lastly, the paper discusses the practical and policy challenges of implementing these ideas in terms of issues such as privacy, affordability, security and stakeholders' engagement.

Keywords: intelligent, sustainable cities, ICT, sensors, Gold Coast

INTRODUCTION

Many cities around the world are now facing a number of on-going challenges, some of which include rising traffic volume and congestion, diminishing quality of life, urban sprawl and degradation of the natural environment. Information and communication technologies (ICTs), which are rapidly evolving, represent potential, instrumental tools for cities to function more intelligently and address these challenges. The major objective of this paper is to examine the potential role of ICTs in creating intelligent cities. It will also outline a vision of the potential ICT applications that could make the Gold Coast city and its business centre of Southport easier and less costly to administrate and more conducive to businesses dependent on knowledge workers. Lastly, the paper discusses practical and policy challenges of implementing ICTs to create intelligent cities. This is an

exploratory paper to develop a framework for building smart and sustainable cities based on critical analysis of literature and understanding of the local context of Gold Coast.

ROLE OF ICTS IN CREATING INTELLIGENT CITIES

Cities must now operate intelligently in order to tackle various long-term challenges and short-term challenges such as climate change and traffic congestion, respectively (The Climate Group *et al.*, 2011). The rapid emergence and evolution of ICTs, particularly social media, the Internet, smartphones and sensors, is drastically transforming the way we live, work and play (Arup, 2010). ICTs could be implemented to provide new, innovative city services, which are more accessible and convenient for citizens. Thus, these technologies can assist cities in their endeavours to function more intelligently and efficiently.

Giffinger *et al.* (2007) defined the 'intelligence' of a city by way of the extent to which it utilises ICTs to monitor and control its built environment so as to function in a manner that may be considered to be 'smart' and 'sustainable'. With ICTs, information as regards the functioning of the city and the state of its environment could be published to its community through real-time data exchanges (Arup, 2010). Furthermore, ICTs could be implemented in various aspects of urban development and planning processes in order to improve the quality of life within cities (Lee *et al.*, 2008).

Three emerging ICTs which are being implemented to create intelligent cities include sensor networks, smartphones and radio-frequency identification (RFID). Increasingly, the sensors involved are connected wirelessly and therefore collectively known as 'wireless sensor networks' (WSNs). These sensors are small data-collection tools which can collect environmental data continuously. Wireless sensors are more cost-effective to administrate than the traditional method of manual data collection (CSIRO, 2011). WSNs are being applied to monitor a wide variety of data types and their applications are being regarded as almost limitless (DEHP, 2011).

The use of smartphones is becoming widely prevalent in many countries. As an example, as of 2012, 76% of adult mobile phone users in Australia are operating phones defined as smartphones (Mackay, 2012). RFID technology involves the use of radio waves to automatically identify humans or objects. In Australia, over 2 million smartphones are currently integrated with the near field communication (NFC) equipment, which is based on RFID technology (Brinkley, 2013). These devices are capable of communicating with RFID devices to complete various functions such as retrieve information on billboards and attractions, perform financial payments and lock/unlock doors. Recent smartphones such as Samsung Galaxy S4 are incorporating

an extensive range of environmental sensors including tools for tracking changes in temperature and humidity.

To illustrate examples of different ICT applications in the natural and urban environments, two case studies are briefly discussed here. A Sensing City project is currently underway as part of the post-earthquake rebuild of Christchurch, New Zealand, facilitating its transformation into an intelligent city. The project is incorporating an integrated network of sensors throughout the physical infrastructure in the city's CBD. The data collected from the system, which will be available to the public in real time, are expected to be transformed into a range of innovative information products and services for its local population (Sensing City, 2013). Meanwhile, Springbrook National Park, a 6725-hectare World Heritage-listed rainforest in Gold Coast, has been incorporated with approximately 400 wireless sensors. The sensors have been monitoring a range of environmental variables at the park in order to track the area's biodiversity restoration progress (DEHP, 2011).

Evidently, ICTs have advanced rapidly and will continue to evolve. As such, there are opportunities for improving cities' services, infrastructures and quality of life through strategic integration of ICTs. However, although many cities have undertaken initiatives to become intelligent, the full potential value from ICTs and data is yet to be realised (The Climate Group *et al.*, 2011).

DEVELOPING GOLD COAST AS AN INTELLIGENT AND SUSTAINABLE CITY

The city of Gold Coast, located in the South East Queensland region of Australia, is home to a population of approximately 540,000 people. It is a relatively young city that has grown from a historical focus on tourism. Its most densely populated area is largely focussed on tourist apartment accommodation and includes one of the tallest residential buildings in the world. With this history, the city has not had as yet had an obvious CBD. The Gold Coast City Council (GCCC) has recently designated the Southport suburb as the city's Central Business District (CBD). As a result, Southport is expected to undergo rapid development as it rises to perform this new function. An opportunity therefore exists to incorporate a strategic integration of ICTs into the new plans for Southport so that its new function will enjoy the benefits of the status of an intelligent, sustainable hub. This initial project may function as a pilot for the deployment of many more sensors within this CBD as well as a more-widespread deployment of ICTs throughout the city as a whole.

The paper now outlines a proposal of sensor and ICT applications for the city of Gold Coast, with a particular focus on Southport. The proposal is

underpinned by five major themes or desired outcomes, which are based on priorities identified from discussions with the GCCC. The themes are summarised as a framework in Figure 1, which also outlines potential ICT applications (shown in boxes in diagram) to achieve each of the five key expected outcomes (shown in circles in the diagram) for the Gold Coast.

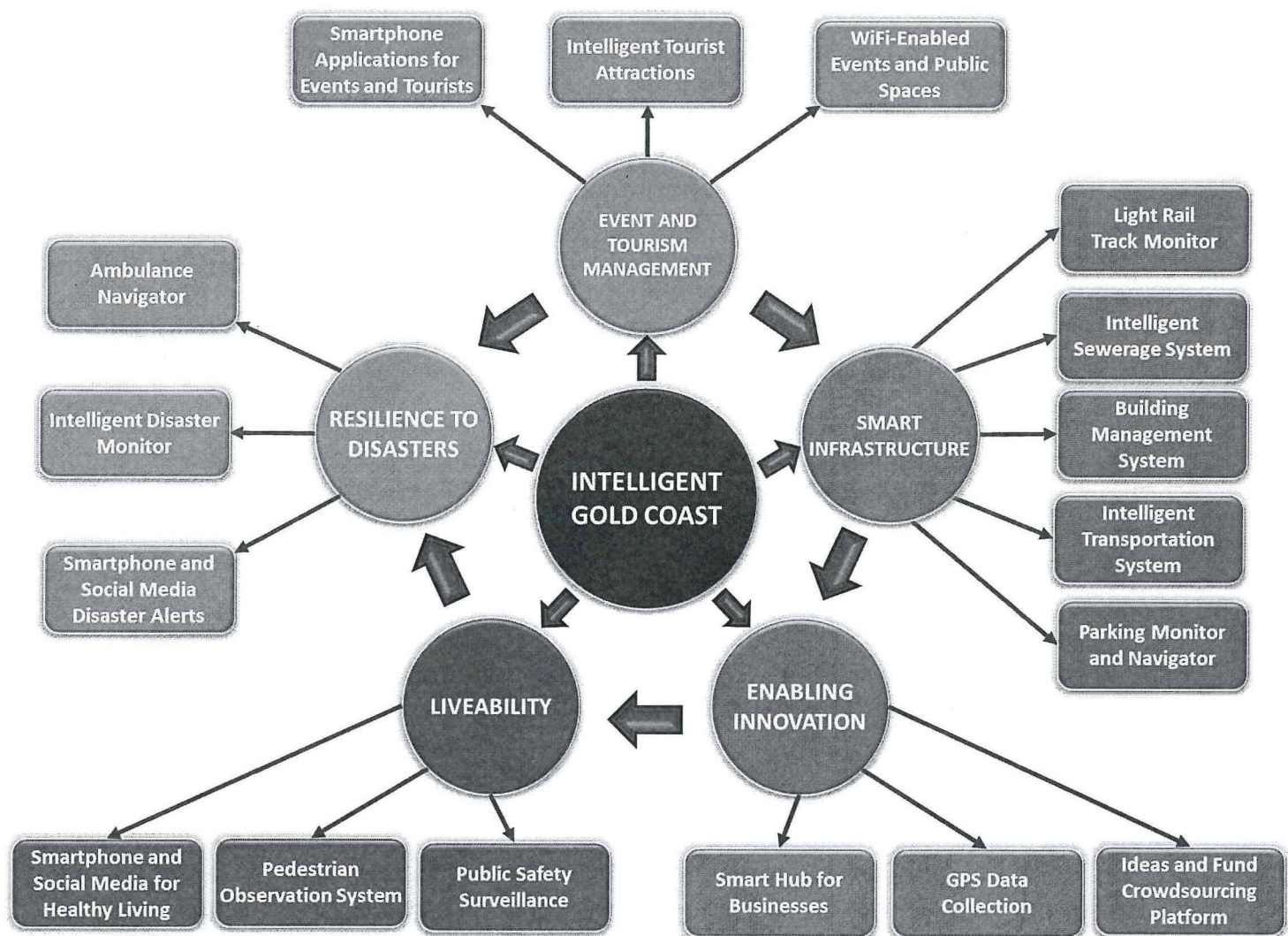


Figure 1 Proposed ICT Implementation Framework for Gold Coast

Figure 1 suggests that the five themes are strongly interrelated. By achieving a positive result in one theme, better outcomes will also be attained in other themes. For instance, promoting the city's resilience to disasters will also increase public safety, leading to higher liveability. The ICT applications shown in Figure 1 are discussed below.

Theme 1: Event and Tourism Management

The Gold Coast will be hosting the Commonwealth Games in 2018 and is a city that regularly hosts smaller events which attract a large number of tourists annually. The first theme is centred on strengthening the city's

tourism industry. To achieve such an outcome, and to give a mobile and transient tourism population access to the city's static and remotely sensed real-time data, smartphone applications are suggested as being ideally suited. These could be created in order to provide a range of information and functions for city visitors such as event schedules, event ticket booking, public transport tables, weather reports, local news and disaster warnings.

RFID tags and Quick Response (QR) codes could be integrated throughout the city's landmarks and parks to create intelligent tourist attractions. These technologies can enable tourists to instantly retrieve information on these attractions with their smartphones. Furthermore, a free, public WiFi network could be enabled throughout public spaces and major event venues in order to allow visitors to access the Internet with their smartphones. The WiFi-enabled events and public spaces may serve as a catalyst for attracting not only tourists but also knowledge workers, thus supporting the proposal's theme of enabling innovation. From an urban planning perspective, there is value to be derived from the monitoring of the usage of such services, not only to identify the popularity of locations and events but also to identify patterns of behaviour, which along with the (permitted) Global Positioning System (GPS) tracking of these users, can provide accurate insight into behaviour and profiles of tourists.

Theme 2: Enabling Innovation

The second theme aims to support the GCCC's Economic Development Strategy, which proposes to increase the city's economic productivity through promoting skilled workforce. To this end, the theme seeks to position the city as a smart hub for businesses, which could be achieved by transforming Southport into an ICT-enabled environment. Some of the ICTs which may be implemented for this purpose include smarter green buildings, sustainable public transport system, and high-speed Internet infrastructure. Such an environment could attract knowledge workers and businesses, stimulating Southport's innovation and growth as a CBD.

The theme also intends to facilitate innovation in research, products and services. Through crowdsourcing GPS data from smartphones, information on activities and location of people can be accumulated. The GPS data could facilitate innovative urban studies by research institutions and universities. It may also allow the GCCC to strategically identify town planning controls, suitable locations of future businesses as well as underutilised public spaces and facilities which could be improved in the future.

Additionally, the council can create a platform for the crowdsourcing of ideas and funds with social media and smartphone applications. The platform might allow local businesses and residents to publish their ideas and accumulate financial support from the public. With the crowdsourcing platform, ground-breaking ideas could transpire and create new products or services, transforming the Gold Coast into an innovative hub.

Theme 3: Smart Infrastructure

The third theme aims to create a smart city infrastructure system which is cost and resource efficient. Operation of the city's sewerage system is incurring significant costs. Thus, sensors could be integrated throughout the city's sewerage infrastructure to monitor and regulate sewage flows on a mathematically optimised basis. They might also monitor and detect leakages, which can then be fixed early to avoid costly structural damage.

Existing and future civic buildings in Southport could be incorporated with a building management system (BMS), which controls their heating, ventilation and air conditioning (HVAC) for optimal thermal comfort and energy savings. Additionally, sensors can be installed to monitor and control water usage in these buildings. These systems will reduce Southport's carbon footprint and promote Southport as a resource-efficient CBD. They may also attract knowledge workers and businesses to Southport over the long term. Masdar City is a prime example of an intelligent, sustainable city which seeks to attract entrepreneurs and businesses and facilitate knowledge creation and innovation.

An intelligent transportation system could be established in Southport by integrating wireless sensors into its road infrastructure. The sensors might monitor traffic and adaptively control traffic signals in real time. The system can lead to reduction in Southport's traffic congestion and carbon emissions, thus enhancing public health. Furthermore, the data collected from the sensors could be invaluable for future transportation planning projects in Southport. This system might be designed to facilitate priority routes for emergency vehicles, detected in real-time, which is particularly relevant to this locale considering the presence centrally of Queensland's largest hospital being built in the hub of this new CBD area.

Public parking spaces in Southport could be monitored with wireless sensors. Motorists might then be guided to the closest available parking bays with a GPS and the use of smartphone apps, which receive the sensors' data and also allow motorists to purchase parking tickets. The sensors may then track the vehicles' length of stay and charge parking fines if the vehicles exceed their parking limits. Alternatively, any such system opens up prospect for a variety of new models for charging for parking, such as a system of having no fines that instead uses escalating charges (performed electronically) the longer any one vehicle remains in the same bay. In addition to assisting the council in collecting parking revenues accurately and consistently, the parking system could reduce vehicular traffic in Southport as motorists will be able to locate available parking spaces promptly.

Theme 4: Liveability

The fourth theme is centred on enhancing liveability for the Gold Coast's permanent residents as well as its visitors. A smart surveillance system,

which is capable of automatically detecting abnormal behaviour and dangerous objects, could be implemented throughout Southport. Once a situation is detected, the system may alert the police promptly. In Germany, small (automated unmanned) drones are even now being deployed to provide mobile surveillance and the detection of graffiti. Currently, the GCCC is spending \$1.6 million annually for the removal of graffiti alone.

As cities become increasingly populated, city authorities need to have a better understanding of pedestrian movement and activities in order to plan and manage their urban environment effectively (Seer *et al.*, 2012). However, observing and understanding pedestrian movement is traditionally a time- and resource-consuming process given that extensive personnel input is required. A smart pedestrian observation technology, such as a system utilising Microsoft Kinect proposed by Seer *et al.* (2012), could be implemented in Southport to automatically monitor and analyse pedestrian movement in the area. The data collected from the system may assist the council in making Southport's public spaces more culturally active and responsive to walking. Additionally, similarly to the collected GPS data, the data from the pedestrian observation system could facilitate innovative urban research projects in the future.

The GCCC is managing an Active & Healthy Program, which delivers over 170 physical and healthy living activities to local residents on a weekly basis. However, there is currently low awareness of the Active & Healthy Program among local residents (Queensland Health and GCPAA, 2012). As such, a smartphone app and social media could be utilised to promote the program more effectively in addition to monitoring the popularity and effectiveness of this spend of taxpayer's money. Any such applications could allow residents to search for activities, parks and exercise facilities according to their preference. With social media, residents might be kept informed of new or popular active and healthy activities.

Theme 5: Resilience to Disasters

The final theme is focussed on increasing the Gold Coast's resilience to disasters and emergency events. The Gold Coast Health and Knowledge Precinct, which comprises Griffith University and Gold Coast University Hospital, is being established in Southport. The \$1.9 billion precinct aims to extend the range of health services in the Gold Coast. Based on the data collected from the intelligent transportation system, a navigation system for Gold Coast University Hospital's ambulances could be implemented. The system might inform ambulance operators of routes with the least amount of traffic. It may also allow the operators to automatically control and proceed through traffic signals with minimal disruption. The system can assist in ensuring an efficient co-existence of normal traffic along with emergency priorities.

An intelligent disaster monitor system utilising wireless sensors could be integrated throughout the city's beaches and waterways in order to detect potential natural disasters. Once a disaster is predicted, the sensors can promptly transmit the information to the council. The sensors' data may also be transferred to smartphone applications to inform residents and visitors of current beach and ocean conditions in real time. This information can allow the population to better plan their beach visits.

Once the GCCC receives a disaster warning from the wireless sensors, it could then disseminate disaster alerts to the public to ensure early preparations or evacuations are undertaken. Potential platforms for the alerts include smartphone applications, social media and Short Message Service (SMS). The smartphone applications may also allow citizens to visually track current status of the disaster through real-time maps.

CHALLENGES OF ICT INTEGRATIONS IN CITIES

The first and most important challenge is privacy, which can affect one or more of the following four dimensions of an individual: 1) personal identity; 2) physical wellbeing; 3) personal behaviour and; 4) personal communications. Most ICT implementations, underpinned by current data protection regulations in many countries, have attempted to address the privacy of users' identity (Bartoli *et al.*, 2012).

Affordability is a prospective challenge for many cities, particularly those with limited resources, for developing them into intelligent cities. Given cities' existing, heavy reliance on various ICTs and other infrastructures, the costs of updating the current technology systems and incorporating new ICTs will be very expensive (Hancke *et al.*, 2013). Furthermore, security is another potential concern for incorporating ICTs, particularly data collection devices, in cities. These technologies are susceptible to cyber-vandalism and cyber-terrorism which could result in inappropriate ownership and usage of sensitive or personal data (Hancke *et al.*, 2013). Lastly, creating an intelligent city requires implementation of diverse ICTs to achieve multidimensional benefits. As such, the process represents a "very multidisciplinary challenge" which requires collaborative efforts of local councils, national policy makers, academics, innovative suppliers and the community (European Commission, 2010).

CONCLUSION

This research is speculative and outlines the potential role of ICTs in creating intelligent cities. Many cities are now facing on-going challenges driven by rapid urbanisation and growth. The advancements in ICTs have created opportunities for these technologies to be utilised for improving cities' services and infrastructures. Smart infrastructures and services can

assist cities in becoming greener and economically efficient as well as tackling their challenges more effectively. WSNs, RFID, smartphones, the Internet and social media are some of the technologies which could be strategically implemented to make cities more intelligent and sustainable.

An integrated approach to make the Gold Coast city more intelligent and sustainable has been outlined in this paper. A number of potential ICT implementations have been proposed for the city to achieve five holistic outcomes, namely: event and tourism management, smart infrastructure, enabling innovation, liveability, and resilience to disasters.

The data generated by the proposed ICTs could be utilised to further drive innovation for the Gold Coast. Strict protocols and procedures should be put in place to filter the raw data and ensure citizen privacy. Once the data has been safely aggregated, it could then be made available to the public in real time. The GCCC could share any important information (such as disaster warnings) with the public. Businesses and community organisations could utilise the data collected by the council to develop new products and services for Gold Coast (such as smartphone applications). These outcomes can add significant value to the Gold Coast and promote the city as an efficient city and an attractive place to live, work and play.

There are, however, practical and policy challenges associated with ICT integrations for creating intelligent cities. Some of the challenges which should be considered include personal privacy, affordability of various advanced technologies, securities of implemented ICTs and engagement with a wide range of stakeholders.

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