The Tracking and Tracing Technology Integration in Supporting Smart City Concept

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ABSTRACT
The world is undergoing the largest wave of urban growth in history. As reported by the Department of Economic and Social Affairs United Nation, 54% of the world's population lives in urban areas and this proportion is expected to increase to 66% by year 2050. To handle the large scale of this population's waved; the city or urban area should by now have completely has a sustainable infrastructure component and a strong technology support to serve the citizen. To counter this problem, smart city concept has been proposed. Smart city can be defined as a developed urban area that aims to increase citizen's quality of life by creating sustainable economic development, through technology utilization, integration and enhancement. Tracing and tracking is one of the components that support smart city concept. It combines the related technologies to perform the smart city application such as the mobile workforce.
The objective of this study was to understand the concept of tracing and tracking in supporting the smart city. An example of smart city application which is the mobile workforce has been taken out for testing purposes. During testing, related technologies are then being identified and listed its technical potential. Finally, the technology integration is reviewed and compared to ensure its performance contribute to a new way of living.

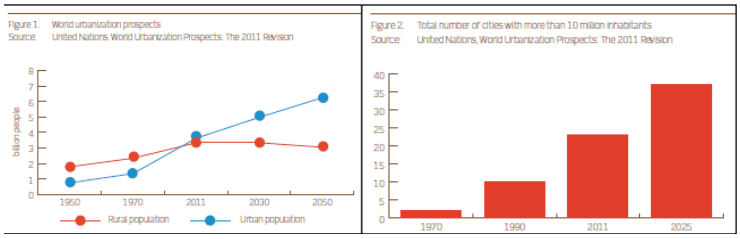
Key Words: Technology, Smart City, Mobile Workforce, Tracing, Tracking

INTRODUCTION

City is growing increasingly larger, more complex and more important. More than half of the Worldsare tend to lives in urban area. This shift from a primarily rural to a primarily urban population is projected to continue for the next couple of decades. According to the United Nations Population Fund [1], 2008 marked the year when more than 50 per cent of all people, 3.3 billion, lived in urban areas. By 2030 this number is expected to increase to 5 billion. With the rapid increase of the urban population worldwide, cities face a variety of risks, concerns and problems. In some situation it tend to engaged into a problem such, difficulty in waste management, scarcity of resources, air pollution, traffic congestions and inadequate, deteriorating and aging infrastructure and unemployment. The unprecedented rate of urban growth creates an emergency to finding smarter ways to manage the accompanying challenges.

Some cities are identified to successfully operate in a smarter way to solve concern. City is the focal point for many activities. A well-managed city are able to accommodate the heavy population by providing the civilian a good facilities and promising a sustainable living and liveable city [2]. For that, a city should be equip with the latest and modern infrastructure so that all activities or task able to deploy in a short while, without any limitations. Here, technology and efficient technology management plays important role for creating a city versatile and it is known as a smart city. Nevertheless a deep understanding of smart city concept and how technology and technology management implemented is essential to ensure liveable conditions within the context of worldwide urban population growth.

Graf 1and 2: showing increasing of number of population in urban (Source: United Nation Report, 2013)



To that extend, this studyaims to understand the purposes of tracing and tracking and also to highlight the potential technology that able to support the smart city concept in Malaysia. Throughout the research, these technologies will be list, integrate and analyse its performance through a process of managing workforce. At the end, an expected output is to have at least one (1) prototype system that consist of tracking and tracking element, where integrates all the technologies supporting the mobile workforce for smart city.

Mobile workforce is a smart city application that performs tracing and tracking. To continue the study, PLUS was chosen as a sample appropriate to the needs of the department requires the delivery and collection of data quickly, without requiring the employee to the office as well as to prepare reports accurately and

promptly. The paper after this introduction is divided into 4 sections where the first section will is defines the meaning of smart city and highlight some past research. Section 3 will focus more on the overall and proposed concept including the system architecture suits to PLUS requirement. And finally in the analysis section, where some of module interfaces will publish to show the effectiveness and the successful of technology integration.

DEFINING SMART CITY

The definitions of smart city are various. The concept of a smart city itself is still emerging, and thework of defining and conceptualizing it is in progress [3, 4].Holland's[5] recognize smart city as an "urbanlabeling" phenomenon, particularly in terms of what the label ideologically reveals as well as hides. The label smart city is a fuzzy concept and is used in ways that are not always consistent. Several working definitions (see Table 1) have been put forward and adopted in practical and academic use.

Table 1.Working Definitions of a Smart City

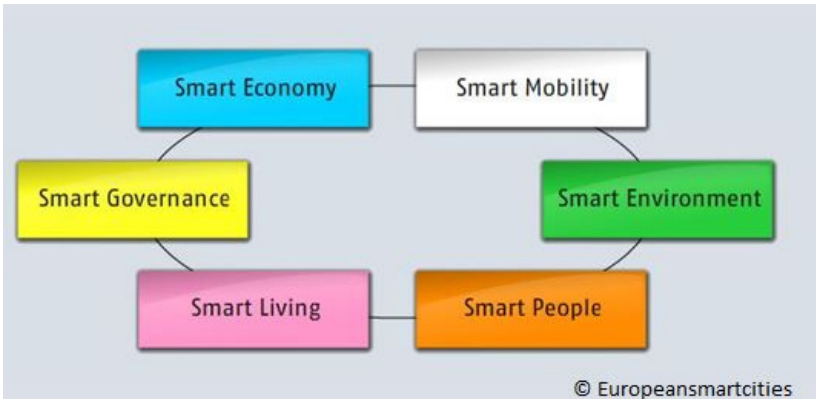
• A city well performing in a forward-looking way in economy, people, governance, mobility, environment and living, built on the smart combination of endowments and activities of self-decisive, independent and aware citizen.[6]
• A city that monitors and integrates conditions of its entire critical infrastructure, including roads, bridges, tunnels, rails, subways, airports, seaports, communication, water, power, even major buildings can better optimize its resources; plan its preventive maintenance activities and security aspect while maximizing service to its citizen. [7]
• A city "connecting the physical infrastructure, the IT infrastructure, the social infrastructure, and the business infrastructure to leverage the collective intelligence of the city" [8].
• A city striving to make itself "smarter" (more efficient, sustainable, equitable and liveable) [9].
• "the use of Smart Computing technologies to make the critical infrastructure components and services of a city-which include city administration, education, healthcare, public safety, real estate, transportation and utilities-more intelligent, interconnected and efficient" [10]

Giffinger et al's[6] definition considers smart as performing in a forward-looking way. In Harrison et al's study [8],a smart city denotes an instrumented, interconnected, and intelligent city. Instrumentation enables the capture and integration of live real-world data through the use of sensors, personal device, appliances, cameras, smart phone and other similar data-acquisition systems. Interconnection means the integration of those data into computing platform and the communication of such information among the various city services. Natural Resources Defence council [11] define smarter in the urban context as more efficient, sustainable, equitable and liveability.Washburn et al. [10] view a smart city as a collection of smart computing technologies applied to critical infrastructure components and services. Smart computing refers to a new generation of integrated hardware, software and network technologies that provide IT systems and real-time.

2.1 Characteristic Smart City

The city is smart when investments in human or social capital and IT infrastructure fuel sustainablegrowth and enhance a quality of life. Below are the main characteristics of smart city.

Table2: Is the component of Smart City (Source: Europeansmartcities)



2.2 Technology as the enabler for smart city

Technology is the key in contributing smart city. Most research on smart city address issues oftechnological infrastructure and enabling technology. The focus on infrastructure and technology stress accessibility and availability of systems. [12, 13]. Smart computing refers to a new generation of integrated hardware, software and network technologies that provide IT systems with real-time awareness. Integration of ICT with development projects can change the urban landscape of a city and offer a number of potential opportunities; they can enhance the management and functioning of a city.

RESEARCH METHODOLOGY

To performresearch on the Tracing and Tracking Technology Integration in Supporting Smart City Concept, there are some aspect have to consider and look into, especially on the understanding on tracing and tracking concept. A good reviewon which appropriate technology used will help to reduce time in making decision and yet, will contribute the system functional. The study begins with concept understanding, technology selection and finally is integration process.
At the first stage, study and analysis of tracking with tracing technologies and their service platforms have to be done.

- Study and analyze the technologies, service platforms and service provision schemes of satellite-based of tracking and tracing system.
- Analyze trends, technological platforms, services for different tracking and tracing application domains and sectors.
- Classify and prioritize the analyzed applications upon commercial and public interest requirements.
- Establishing inter-operability protocols and standards for tracking devices
- Development of tagging module (data capturing, wireless form, tracing)

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3.1 Tracking and Tracing System

Tracking and tracing, is a process of determining the current and past locations and other information of a unique item or property. In response to a growing number of recall incidents such as food, pharmaceutical, toys and laboratory, a lot of software, hardware, consulting and systems vendors have emerged over the last few years to offer a range of traceability solutions and tools for industry. Radio-frequency identification (RFID) and barcodes are two common technology methods used to deliver traceability.

3.2 Satellite Technology

Global Navigation Satellite Systems (GNSS) technology has become vital to many applications and isexpanding from the established Global Positioning System (GPS), the Russian Global Navigation Satellite System (Glonass) and the coming Galileo, Beido and QZSS. Few studies havebeen presented in the literature regarding the various applications of satellite systems in tracking and tracing. Politecnico di Milano (2007) presented interesting examples of projects andapplications which include GPS integrated with other technologies (e.g. RFID, weighing system, sensor systems, General Packet Radio Service (GPRS)). Ursa et al. (2006) has worked on the monitoring and tracking through GPRS/Universal Mobile Telecommunications System (UMTS). GNSS systems can bridge the gap and enable global monitoring of products/systems. By using the function related, for instance to GNSS, RFID device and other communication systems such as Universal Mobile Telecommunications System (GSM), some added value services can be assured.

3.3 QR Code

QR codes were originally designed to track assets during manufacturing process. A QR code is ultimately a two dimensional barcode that stores data both horizontally and vertically. When compared with barcodes, QR codes can hold much more information. In fact, a complex QR code can store over a page of plain text. Since QR codes are much smaller than barcodes, they are also easier to scan using smartphones (Eicher, 2012). Additionally, unlike barcodes they can be scanned at any angle making mobile data collection much faster than before.

There are several ways in generating QR Code. The code can be generated from QR Code Creator website, the second method is using QR Code Creator in Android application in the smartphone and another one is a generator from kaywa website. The QR Code reader is freely downloaded from Google Play Store application. Below are the samples of QR code available in the market.

Figure 1: QR Code used in Shopping Complex (Sourec: Nurulain, 2013)

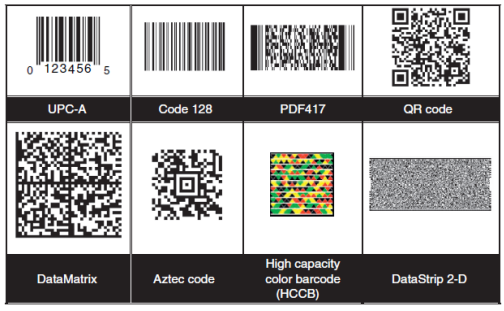
3.4 RFID

Radio-frequency identification (RFID) is synonymous with track-and-trace solutions, and has a critic role to play in supply chains (Sarac et al., 2009). RFID is a code-carrying technology, and can be used in place of a barcode to enable non-line of sight-reading. Deployment of RFID was earlier inhibited by cost limitations but the usage is now increasing. Schultmann, et al. (2008) in his paper Life Cycle Information of Buildings Supported by RFID Technologies addressed the benefits of using RFID. The benefits include less contact, non-line-of-sight identification of objects over long distances, bulk or mass identification, insensitivity of the transponders against moisture, dirt and abrasion; possibility to store information directly at the item, and the possibility to write new data onto the chip of the transponder.

3.5 Barcode

Bar coding is a common and cost effective method used to implement traceability at both the item andcase-level. Variable data in a barcode or a numeric or alphanumeric code format can be applied to the packaging or label. The secure data can be used as a pointer to traceability information and can also correlate with production data such as time to market and product quality. There are several barcode symbols available which are linear and 2D. The following figure shows example of various barcode symbolizes available

Figure 2: Barcode Sample (Source: Grover, et al., 2010)



3.6 Smart phones

Mobile phones can be classified by smartphones and non-smartphones. The smartphone can becategorized into several classifications which are Touchscreen Smartphones and Non Touchscreen Smartphones. As described in Nielson website, the following table summarizes the 4-way mobile devices classification.

Table 3: Way Device Classification (Nielson, 2012)

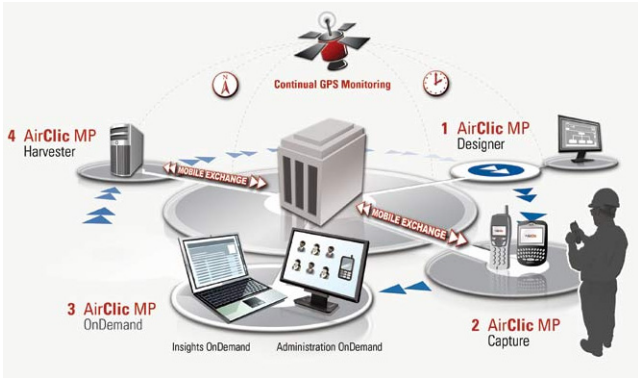
Mobile Phone Class	Smartphones		Non-Smartphones	
	Touchscreen Smartphones	Non-Touchscreen Smartphones	Multimedia Phones	Features Phones
Definition	Open OS* allow installation of applications. Features touchscreen *Open OS include :iOS, Android, Blackberry, Symbian, Maemo, Windows, Linux (Web OS), Bada	Open OS* allows installation of applications. No touchscreen. (Only device with QWERTY or alpha-numeric keypads are include)	Touchscreen and/or QWERTY, but not an open OS. Must be able to acces internet by WIFI or 2.5G upwards, and has HTML browser.	All other phones. (No touchscreen, no QWERTY keypad, no open OS)

MOBILE WORKFORCE AS SMART CITY APPLICATION

Since smart city concept is required support by technologies and IT component, the workforce model has been transform into a mobile workforce where technology plays a big role to make it happen. Mobile workforce system provide ways to understand and manage the location and history of mobileworkforce and assets, [12](Dri1scol and Sheldrick, 2006). However, the problems of mobile workforce management are rarely studied. Researches in mobile computing mainly focus on the enabling technologies at communication layers instead of the deployment of applications such as mobile workforce management. [13]Guido et al. (1998) pointed out some mobile workforce management issues and evaluation criteria, but the details are no longer up-to-date because of the fast evolving technologies. With the advancement in mobile and wireless technologies, mobile workforce management has become more and more decentralized, with involved components becoming increasingly autonomous, while location or situation awareness are being incorporated into system design [14](Lee et al., 2003).

Picture below is the sampleon how technologies is being managed and integrate. As a result, it helps and improves the quality of life especially in managing systems, nevertheless it also promising sustainable living.

Figure 3: Shows on how the technologies is being integrate



SYSTEM ANALYSIS AND TECHNOLOGY INTEGRATION

Many researchers had explored the capabilities of tracking and tracing, related device and technologyas well as the satellite related tracking capabilities utilizing GNSS. Some did evaluate the accuracy of the GNSS and recently about integrating both capabilities dependent and independent of device.

Thompson (2003) integrates PDA, GPS and Geographic Information System (GIS) Technologies for Mobile Traffic Data Acquisition and Traffic Data Analysis, presents a new method of dynamically collecting traffic data that is based on the integration of GPS and GIS technologies in a handheld device. The development as a tool for dynamic collection of traffic data and subsequent analysis of the same in order to ultimately obtain congestion related data.

5.1 Identified Users and Applications

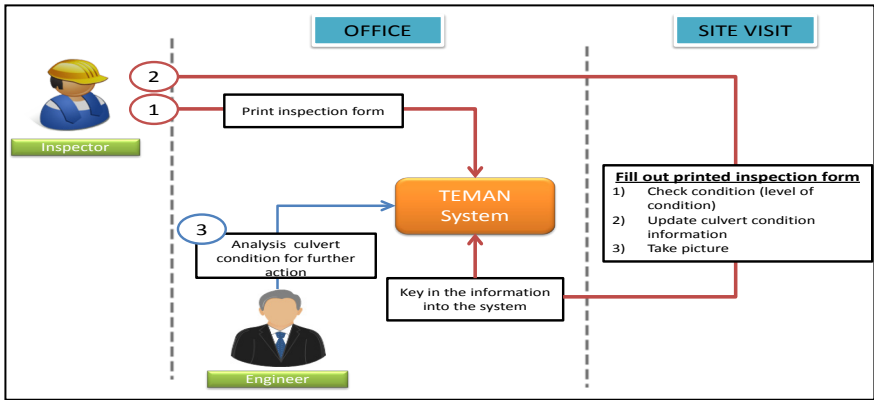
The section starts by reviewing the current flow practice in the selected industry, followed by the workflow of the mobile workforce utilizing the developed prototype, the conceptual design of the tagging and tracing module and tracing and tracking module, the overall system architecture of prototype developed, hardware and software requirement as well as the development tool used for this project. At the final sub section, a general database design is explained briefly to give a surface understanding of the prototype system.

PLUS Malaysia Berhad (PLUS)	Site inspection for monitoring condition of culvert and slopes.

4.1 System Architecture

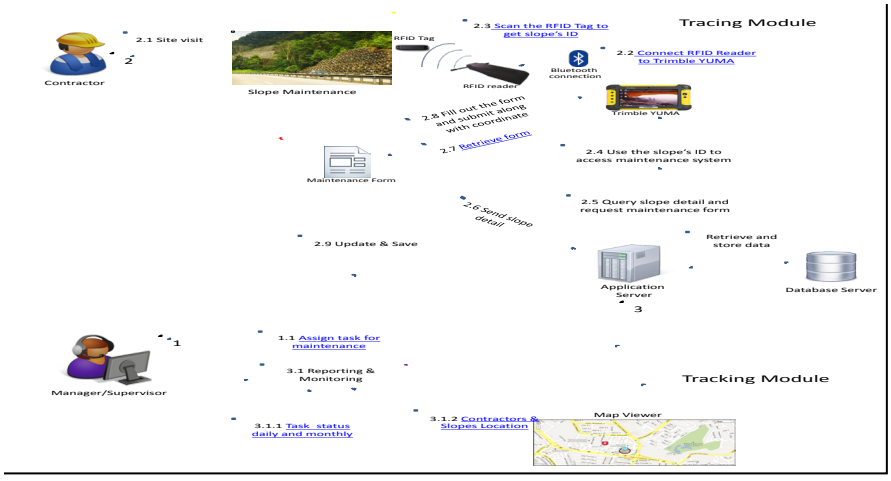
The following figure shows the current process workflow for PLUS. Picture below shows the existing and normal working flow of PLUS workforces when they had an assignment have to be done.

Figure 4: Showing the current and daily process of workflow (PLUS)



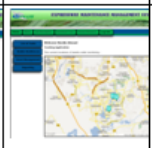
The proposed workflow comprisesaprototype system that integrates with the latest technology propose to PLUS compatible with their working environment. In this scenario, the worker only has to bring Trimble Yuma, log in to the applications for daily assignment and e-form. The activities involved are depicted in the following figure

Figure 5: Proposed workflow for maintenance activity – PLUS



The system comprises the following components: applicants, mobile workforce, GPS service, operation, GSM/GPRS, SQL database, application server, and, Google map server.

Table 4: Showing Test Result for Evaluation Process - Administrator, PLUS

Step	1	2	3	4	5	6
Normal Flow	Login.	Application homepage.	Assignment table (completed task).	Attachment.	Verification.	Assignment table (pending task).
Prototype						
Action	Login to web application hosted in application server.	View tracking application for current location of assets under monitoring.	View assignment table (completed task).	View uploaded image.	Verify location of mobile workforce.	View assignment table (pending task).
Remarks on Result	Able to login to web application hosted in application server.	Able to view tracking application for current location of assets under monitoring.	Able to view assignment table (completed task).	Able to view uploaded image.	Able to verify location of mobile workforce.	Able to view assignment table (pending task).

Step	7	8	9	10
Normal Flow	Assignment	View tasks.	Asset management.	Reports.
Prototype				
Action	Assign new task.	View tasks assigned to mobile workforce.	View tasks assigned as per asset.	Generate reports.
Remarks on Result	Able to assign new task.	Able to view tasks assigned to mobile workforce.	Able to view tasks assigned as per asset.	Able to generate reports.

The development process adapts Rapid Application Development (RAD) as the development methodology. The development of mobile application prototype starts with tagging information using QR Code and RFID tag. Eclipse for Android SDK is used for creating mobile application for tracing capabilities on Android platforms, utilized built-in GPS in the smartphone or dedicated GNSS instrument for tracking capabilities. The prototype develops web panel for online mobile workforce monitoring functionalities and used the PHP as a language where data was stored in the MySQL database. All prototype functions were successfully tested where finally tracking and tracing data can be retrieved, saved and appended thus fulfill the objectives of the project.

FINDING AND CONCLUSION

Below are some of the findings and conclusion along research and development been carried out:

- Tracing and Tracking concept
- Technology advancement
- Accuracy and cost efficiency
- Managing workforce into mobile systems

The two objectives of the project are: (i) understanding the concept of tracing and tracking in supporting the smart city and also technology integration process .

- The most prominent and important achievements of the project are the integration of the tracking with tracing capability and the output of the whole system is being presented in a comprehensible spatial representation of the map viewing via the web-based application for all three major components of the mobile workforce management systems which are not being emphasized by other developers as observed in this study.
- Prototypes are essentially the products of the prototyping process and there are different kinds of prototypes dependent on how they are used or constructed. Essentially prototypes are used for three main purposes which are exploration, experimentation and evolution in software development. The idea of developing the prototype for this mobile workforce application is mainly to improve manual process in monitoring mobile workforce activity by utilizing satellite related technology and exploring various technologies of the mobile platform, experimenting from pilot case study of asset maintenance and adding some features that can be enhanced in future.
- GNSS has been chosen as a technique for locating the mobile workforce during fieldwork. QR Code and RFID tag have been identified as mechanisms to store assets' ID. By knowing the location of an asset, the mobile workforce must be within the visibility range or buffer or radius of inspection to scan the QR Code and tag dedicated for maintenance purpose thus verifying the existence of the mobile workforce during inspection. The prototypes are expected to provide a total wireless solution that allow mobile worker to capture and transfer data efficiently and economically.

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