University of Fort Hare

Together in Excellence

Factors Influencing Continuous Data Collection for a Public Safety Crowdsourcing Smart City Project

By

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Abstract

More than 50% of the world's population are now living in cities. The trend towards urbanisation has placed an enormous strain on the limited resources and services available to citizens in these cities. As more people live in cities, public safety issues also increase. These issues include crime, natural disasters and accidents.

In order to effectively manage the limited resources as well as reduce the public safety issues in a city, the smart city approach can be implemented. A smart city makes use of technology to collect data from the citizens in order to make more efficient use of existing resources. This study focuses specifically on East London, South Africa, a developing country, and argues that currently there is no existing crowdsourcing system that can be used by the city to continuously collect public safety information from citizens for continuous data collection in order to improve public safety.

The aim of the study is to develop a model that can be used by a city in a developing country to collect public safety information continuously from citizens. With the use of the interpretivist paradigm and mixed methods to gather and analyse data collected via conversational analysis, observations and questionnaire, it can be concluded that in a developing country, people are motivated to participate by three factors: intrinsic, internalised extrinsic, and extrinsic. Therefore the study further recommends that in order for the crowdsourcing system to be effective, the city must use all three factors to motivate citizens to report public safety information.

Keywords

Smart city; public safety; participatory crowdsourcing; incentive theory

Declaration

I, Elizabeth Bosha, hereby declare that:

- The work in this thesis is my own work.
- This thesis has not previously been submitted in full or partial fulfilment of the requirements for a qualification at any other educational institution.
- I am fully aware of the University of Fort Hare's policy on plagiarism and I have taken every precaution to comply with the regulations.
- I am fully aware of the University of Fort Hare's policy on research ethics and I have taken every precaution to comply with the regulations. Ethical clearance certificate number: FLO041SPD01.
- This study was supported by funding from the National Research Foundation (NRF) and International Business Machines Corporation (IBM). Any opinions, findings, conclusions, or recommendations expressed in this research are those of the author(s) and do not necessarily reflect the views of the aforementioned institutions.

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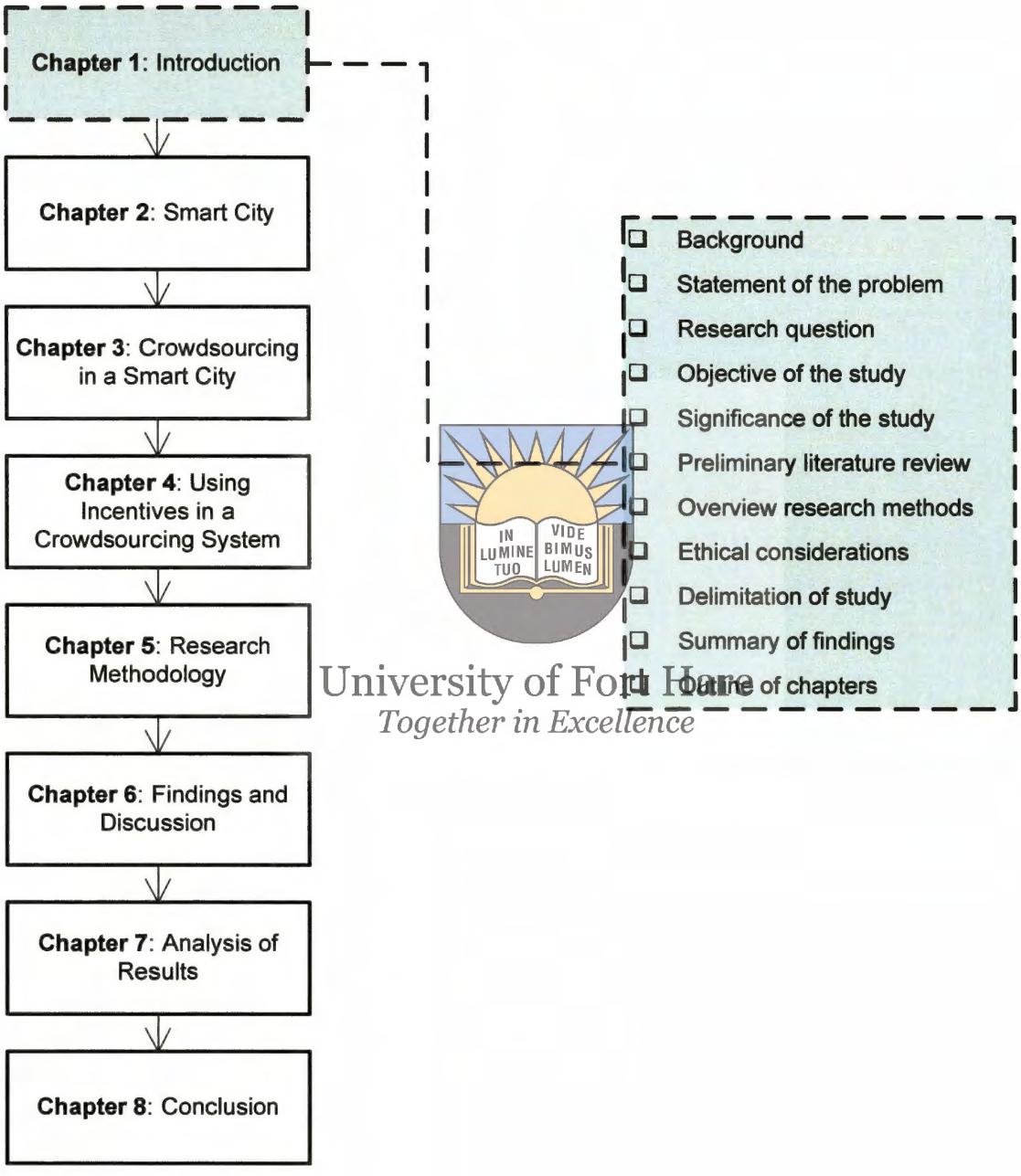
Table of Contents

List of Figures

List of Tables

1 Introduction



1.1 Background

More than 50% of the world's population live in cities, thus resulting in fewer resources and services for all citizens living in these cities (Nanni, 2013). Washburn and Sindhu (2010) are of the view that the scarcity of resources and services are a result of more people living in cities, thereby straining the limited resources currently available. This scarcity of resources threatens the safety of citizens giving rise to public safety issues such as crime and suspicious activities in a city.

Public safety can be defined as protecting the public as well as preventing any events that could place people's lives in danger (Smith, 2001). Examples of these include issues such as crime, accidents and natural disasters. In order to be able to ensure safer living conditions for citizens, a city has to find better ways to manage its existing resources. This can be achieved by: identifying and addressing public safety issues in the city; being able to recover faster from natural disasters, and being able to collect public safety information provided by [illegible] thereby improving the quality of life for all citizens (Nam & Pardo, 2011). Therefore, existing resources can be utilised better and the city becomes smarter.

A smart city uses technology in order to gather information about citizens (Papa, Gargiulo, & Galderisi, 2013). Rayon (2012) extended this definition by stating that a smart city is a concept that deals with using information and technology in order to improve the quality of life of citizens in cities. In order to be able to make a city smart as well as improving the quality of life, citizens therefore need to be willing to provide public safety information continuously. The public safety information that is collected from citizens has to be analysed in order to understand the public safety issues in the future.

Analysing public safety information provided by citizens can lead to a decrease in public safety issues if the city acts on them. The data collected in a smart city project, once analysed, improves the ability to forecast and manage activities that could increase public safety issues in a city (Chourabi, Gil-Garcia, Pardo, Nam, Mellouli, Scholl, Walker, & Nahon, 2012). This data can be gathered through crowdsourcing which enables citizens to provide public safety information willingly.

In this study, public safety information from citizens in East London, South Africa is gathered making use of crowdsourcing. Crowdsourcing is providing a task to the crowd in order to obtain solutions for the problem at hand. Lebraty and Lebraty-Lobre (2013) define crowdsourcing as "the externalisation of an activity by an organisation to a large number of individuals whose identities are most often anonymous" (p.17). Crowdsourcing in this study requires citizens who participate in the problem-solving process by making a call and providing information about a public safety issue (Brabham, 2010). This crowdsourcing example is known as participatory crowdsourcing.

Participatory crowdsourcing in this project enables the citizens of East London to assist in addressing public safety issues such as natural disasters, terror attacks and crime by voluntarily reporting any issues they observe (O'Connell, 2013). There are various examples where developing countries designed and used participatory crowdsourcing systems in order to ensure that citizens are able to report any issues. These include the system for tracking and reporting national disasters in Haiti, reporting war incidents in Libya, and reporting any cases involving human rights violations, violence and abuses in Kenya (Bott & Young, 2012). In addition, a commercial example of participatory crowdsourcing is that of Amazon Mechanical Turk where users are paid as a form of incentive to perform tasks (Ipeirotis, Provost, & Wang, 2012).

Literature suggests that in order for citizens to participate in crowdsourcing there are two dependent factors: intrinsic and extrinsic (Brabham, 2010). Intrinsic factors are the internal desires to perform a particular task; doing something because it is enjoyable (Brabham, 2010). In this study, intrinsic factors include the feeling of accomplishment and fewer public safety issues in the city. Extrinsic factors are when people perform tasks in order for them to obtain a reward (Adair, 1990). The extrinsic factor in this study is the airtime incentive which is to be given out to the citizens who participate in reporting public safety issues. Brabham (2010) is of the view that in order to sustain a more productive platform, an organisation should have a clear understanding of what encourages citizens to participate (extrinsic or intrinsic factors), while being cognisant that people can be motivated for different reasons.

This study focuses on ensuring data collection from citizens who participate by reporting public safety issues they observe, thus making use of an effective crowdsourcing system. To maximise citizen participation, there has to be a link between crowdsourcing and incentives. This means that incentives can be used to motivate citizens that are willing to participate in the reporting of any public safety issues they observe. Therefore, the amount of information is increased by making use of an effective crowdsourcing system. The next section explains the problem statement and the research question.

1.2 Statement of the problem

Nanni (2013) stated that more citizens are moving to and living in cities. As a result of increased urbanisation, many challenges are experienced by people living in cities (Donnelly, 2013). These challenges include public safety threats such as accidents, crime and natural disasters, which jeopardize the safety of citizens and in turn increase demand on limited city resources (Nanni, 2013; Washburn & Sindhu, 2010). Citizens therefore need to participate in the surrounding system by providing information they observe that might affect public safety. The city can then deploy and use its resources more effectively to prevent problems in the future. The information provided by the citizens therefore has to be collected through an effective crowdsourcing system. This highlights the problem in that **there is no effective crowdsourcing system in place to optimise the continuous data collection of public safety data from citizens in a developing country.**

1.3 Research question

What factors must be in place to ensure continuous data collection through an effective crowdsourcing system for a smart city public safety project in a developing country?

1.3.1 Sub-questions

1. **What type of crowdsourcing system should be in place to provide meaningful and useful data for a smart city public safety project in a developing country?**

This question focuses on the most effective type of crowdsourcing system that should be available for citizens to provide useful data. This research project also explains the process of data collection using the crowdsourcing system which enables communication between citizens and the city of East London.

2. **How can participatory crowdsourcing be used to increase the collection of meaningful data required for public safety in a smart city?**

This second sub-question focuses on the benefits of the data collected for a smart city through participatory crowdsourcing, whereby citizens provide public safety information willingly by calling a public safety project toll free number or submitting reports via a mobi site.

3. **What kinds of incentives are effective in encouraging citizens in a developing country to participate in providing information about public safety?**

This question identifies and discusses the types of incentives that are available, including different ways of incentivising participants in a crowdsourcing system.

This section provided the main question for this study and has been broken into sub-questions in order to provide a solution to the main research question. The next section discusses the main objective of this study.

1.4 Objective of the study

The main purpose of this study is to find an effective crowdsourcing system that can improve public safety in a smart city through the data provided by the citizens. The proposed crowdsourcing system will help improve public safety in a smart city by making use of data provided by citizens. This can be achieved by linking the airtime incentive that will motivate the citizens to participate in the crowdsourcing system. The

crowdsourced data is then used to give the citizens of East London a better understanding of what is happening in the city and how these events impact the community.

1.5 Significance of the study

The importance of this study was to ensure that East London citizens have a better quality of life as the city will be safer. This is as a result of a well-functioning participatory crowdsourcing system, which allows citizens to provide public safety information using the system. The public safety information provided by citizens creates awareness to the city, so that they can use their limited resources more wisely and deploy them in such a way as to reduce the public safety concerns. This will enable East London to be a smart city. Further, this participatory crowdsourcing system can be applied to other areas of a smart city such as transport, healthcare, education, energy and water management (Azkuna, 2012).

1.6 Preliminary literature review

In this section a theoretical foundation is provided and relevant theories will be discussed in order to provide a solution to this study by providing answers to the sub-questions. The first section discusses the first sub-question which compares and contrasts the crowdsourcing systems. This is followed by the benefits of collecting data using participatory crowdsourcing and types of incentives discussed in section 1.6.3. The incentive theory will be discussed in the last section. The next section discusses the crowdsourcing components.

1.6.1 Crowdsourcing components

Data can be collected in a smart city through various methods such as crowdsourcing and crowdsensing as shown in Figure 1-1 (Jerry, Jack, & Silverman, 2011). Crowdsourcing consists of two methods which are known as participatory crowdsourcing and involuntary crowdsensing. Involuntary crowdsensing makes use of sensors where data is collected automatically. The crowd is seen as targets of sensing, making use of sensing technologies such as handheld devices. These devices collect

information from an individual, measuring how they use information and interact with others (Batty, Axhausen, Giannotti, Pozdnoukhov, Bazzani, Wachowicz, Ouzounis, & Portugali, 2012).

Participatory crowdsourcing provides an opportunity to collect information which citizens control and volunteer. As illustrated in Figure 1-1, crowdsourcing represents the crowd as involuntary sensor operators, or they could be represented as participatory natural data collectors. This study views the crowd as sensors; the citizens can volunteer public safety information willingly. Therefore, the information provided by citizens has to be collected through an effective crowdsourcing system in order to ensure continuous data collection.

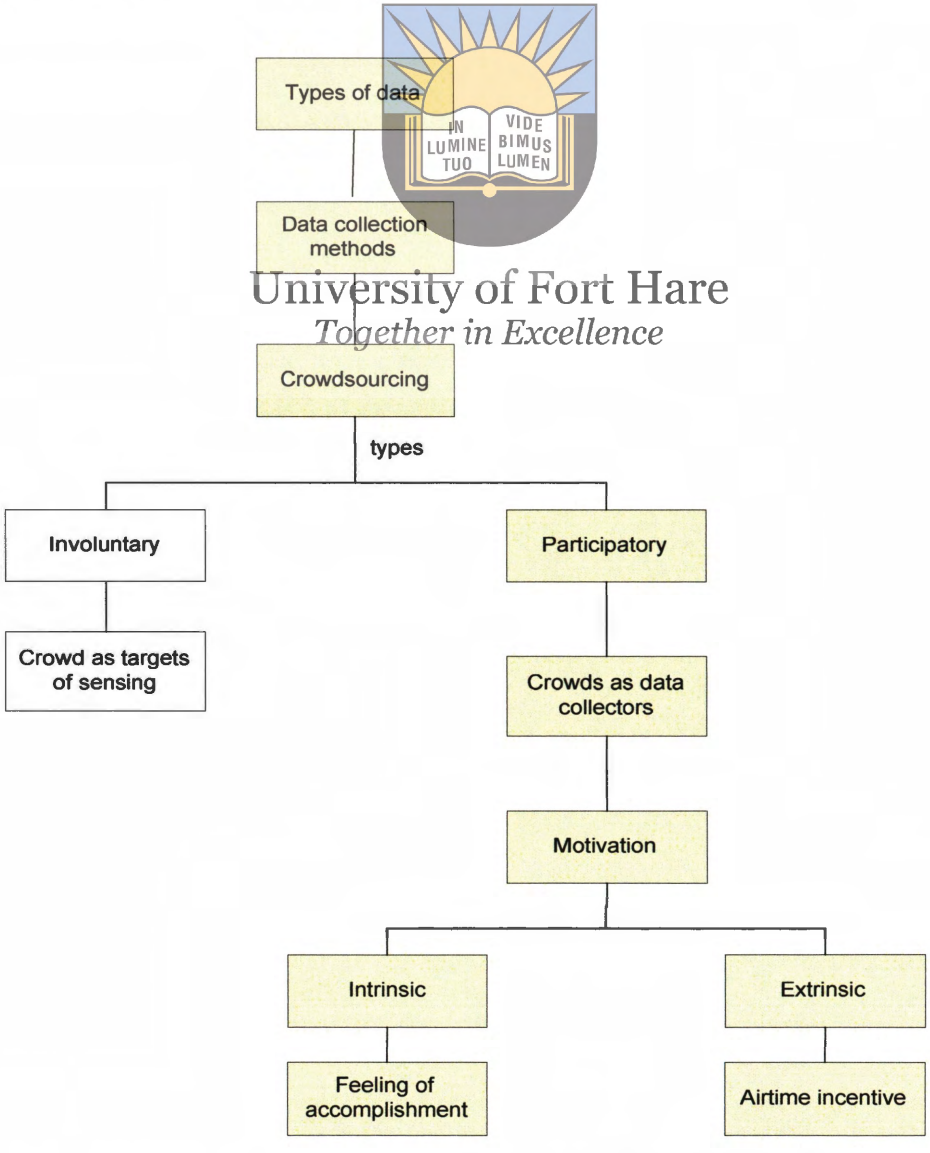


Figure 1-1: Components of Crowdsourcing (Adapted from Bhana, Flowerday, & Satt, 2013)

Participatory crowdsourcing provides a number of benefits which are discussed in the next section.

1.6.2 Benefits of data collection using participatory crowdsourcing

Brabham (2010) stated that in order to increase information in a problem-solving situation, a number of individuals (the crowd) should participate. In this study, the crowd consists of citizens who participated by reporting public safety issues, thereby enabling data collection for a smarter city. Citizen participation provides a number of benefits to data collection. One of the benefits being that participatory crowdsourcing helps in strengthening the relationship between citizens and the city. This is achieved by the involvement of citizens when reporting public safety information, thereby reducing public safety issues (Azkuna, 2012).

Therefore, the public safety information provided by citizens assists by providing information of what is happening in the city, as well as identifying living standards of citizens, thus helping the city of East London to take into account these issues brought forward when planning for the city (Rijmenam, 2013). The data collected might also help the city of East London introduce policies or programmes that will increase the quality of life of all citizens (Clay, 2014). However, in order to encourage citizens to participate, incentives may be used. The next section discusses the incentives that can be used to encourage citizens to participate.

1.6.3 Types of incentives to encourage citizen participation in a developing country

In order to maximise citizen participation, there has to be a link between the crowdsourcing system and the incentives citizens receive when reporting information. Turnbull (2010) defines incentives as "a thing that encourages or motivates an individual to perform or do something" (p.758). This study makes use of incentives in order to encourage citizens to provide any public safety information they witness through a crowdsourcing system. These incentives can be either intrinsic or extrinsic. Table 1-1 shows different crowdsourcing systems used by different organisations and the types of incentives that are offered to encourage their participants.

Table 1-1: Examples of Crowdsourcing Systems and Incentives Offered

Name	Desired outcome	Type of incentive	Selection Process	Participants
Innocentive	Scientific solutions	• Money	Best solution that meets the technical requirements	Registered Innocentive members
Amazon Mechanical Turk	Solutions	• Money	Contest	Registered Amazon members
Threadless	T-shirt designs	• Money • Threadless gift certificates	Best T-shirt design	Registered Threadless members
Public safety project	Public safety reports	• Airtime • Feeling of accomplishment	All registered citizens in East London	Citizens of East London who registered on the website

There are different types of incentives that can be offered to the citizens, namely: monetary and non-monetary incentives (Pardupa, 2012). An example of monetary (extrinsic) incentives is payment for services rendered, whereas non-monetary (intrinsic) incentives include recognition, pride for accomplishing a task, and praise. The next section discusses the underlying theory: the incentive theory.

1.6.4 Underlying theory

This section discusses the theory that will be used in this study to assist in providing a solution to the main research question. The incentive theory suggests that people are encouraged to perform tasks because of incentives (intrinsic or extrinsic) (Cherry, 2013). This means that in order for East London citizens to participate, there have to be incentives to encourage them to participate. This study makes use of both extrinsic and intrinsic factors mentioned in the incentive theory. Extrinsic factors include airtime

incentives that are to be given out to the citizens that are willing to participate in the reporting of any public safety issues they observe. Intrinsic factors include the feeling of accomplishment and better quality of life in the city.

From the above literature review it can be seen how the incentive theory will help in encouraging the citizens to participate in the crowdsourcing project because of incentives they will receive after reporting public safety issues. The next section discusses the research design.

1.7 Overview research methodology

This section discusses the research methodology for this study and it has been divided into various sub-sections. These sub-sections will explain the research paradigm, research method, data collection methods, and data analysis methods used in this study. The next section briefly discusses the research paradigm.

1.7.1 Research paradigm

A research paradigm provides guidelines that can be followed by researchers when conducting a scientific research (Collis & Hussey, 2009). Saunders, Lewis, and Thornhill (2007) define a paradigm as "a way of examining social phenomena from which particular understanding of these phenomena can be gained and explanation attempted" (p.118). Various paradigms can be used when conducting research to assist researchers in understanding the approach to take with their work, as well as providing clarity on the view of nature. Some of the examples of these paradigms include: interpretivist, positivist, critical research, and design science. This project made use of the interpretivist paradigm.

The interpretivist paradigm is concerned with the understanding of the behaviour of participants from their world (Neville, 2007). Interpretivist paradigm can be defined as a study that is focused on providing an understanding of the social context of an information system research (Oates, 2006). This paradigm assumes that it is necessary for the researcher to undertake research among people in order to understand the differences between people in their communities (Saunders, Lewis, & Thornhill,

Research Methods for Business Students, 2007). The interpretivist paradigm states that researchers are not neutral; they use their beliefs, people's perceptions or values to shape the research process (Oates, 2006). This makes the research subjective (Collis & Hussey, 2009).

1.7.2 Sample and population

A research sample is a group of participants from the entire population that has been selected to participate in the research project (Gay, 1976). A population is a group of people from which a sample was taken from (Saunders, Lewis, & Thornhill, 2007). In this study, the study population is the citizens of East London who have registered on the project's website. A convenience sample was chosen from the East London citizens who have registered and participated in the participatory crowdsourcing project.

1.7.3 Research method

This study used the mixed method approach. This approach consists of qualitative and quantitative data gathering methods that are combined together to complement each method (Oates, 2006). Qualitative methods collect data as descriptive data and, unlike quantitative data which makes use of statistical and numeric data, usually cannot be measured precisely (Goldkuhl, 2012). The qualitative approach used in this study includes conversational analysis and observation of the pilot project.

Quantitative data consist of numeric data which can be measured. This is data based on numbers and is mainly generated by questionnaires, experiments and surveys (Oates, 2006). Quantitative data collection methods focus on testing a theory and hypothesis, making it a more objective method than qualitative data gathering methods (Goldkuhl, 2012). This research uses a questionnaire for quantitative data.

This study uses both qualitative and quantitative data types. By connecting these two methods, it allows for quantitative data to build upon qualitative data in order to obtain the result (Gay, 1976). The specific methods of collecting data for this research are discussed in the next section.

1.7.4 Data collection methods

There are two types of data that are used when conducting research: primary and secondary data. Primary data, also known as raw data, is the data that is collected for the purpose of a specific study (Driscoll, 2011). Primary data collection methods to be used include both qualitative and quantitative methods. Secondary data is data that has been collected by someone else for a different purpose. Oates (2006) is of the view that using different types of data collection allows the data gathered to be compared and analysed. Therefore, this study will make use of both types of data collection: primary and secondary methods.

1.7.4.1 Primary data collection methods

- A questionnaire was constructed and was sent to East London citizens who had registered on the project website. The main objective of distributing these questionnaires was to find out from the citizens who have reported how the incentives affected their willingness to participate in the project.

- The second data collection method is conversational analysis. Data was gathered from various academics and experts who have knowledge in this field.

- The third primary data collection method is the observation of the prototype. This includes testing of the crowdsourcing system whereby citizens phoned and reported public safety issues.

1.7.4.2 Secondary data collection methods

Literature from previous studies, journal articles, books, websites and theories relating to this study was reviewed. The literature was also used to develop the model for this study (presented in Chapter 7). The next section discusses the data analysis methods.

1.7.5 Data analysis methods

The data collected by the methods mentioned in section 1.7.4 must be analysed in order to identify patterns (Oates, 2006). These analysis methods are explained in the following sections.

1.7.5.1 Primary data analysis methods

- The data from questionnaires was analysed using SPSS version 22. Descriptive data was presented in the form of graphs, tables or charts.

- Inferential statistics was analysed using Somer's d and Spearman's correlations, which were used to determine the relationship and strength of variables (Pallant, 2010). This makes it easier to interpret the data.

1.7.5.2 Secondary data analysis methods

Secondary data was analysed using the inductive logic which determines what conclusions can be derived from the data that is available (Trochim, 2006). Relevant literature and theories relating to this study will be reviewed thoroughly to determine if there is an agreement between the theory and the conclusion of this study. The next section discusses the ethical considerations.

1.8 Ethical Considerations

This section discusses ethical issues to be considered, as well as ethical responsibilities towards the citizens who will be providing information to increase public safety in East London. These citizens were not forced to participate and they were treated fairly and honestly. The data provided by citizens was accessible only to the responsible people (the research team involved in the smart city project). The data that the citizens provided was kept safe and secure. The collected data was used for the smart city public safety project only, and it is not going to be used for any other purpose. Ethical approval was sought from the University Research Ethics Committee (UREC) and a certificate was granted. The next section discusses the delimitations of this study.

1.9 Delimitation of the study

This study collected public safety data from citizens of East London only; other areas in the Buffalo City Municipality Metropolitan are excluded. This type of data collection is known as participatory crowdsourcing where citizens provide public safety information voluntarily. This study excludes crowdsensing and other smart city elements such as healthcare and transportation.

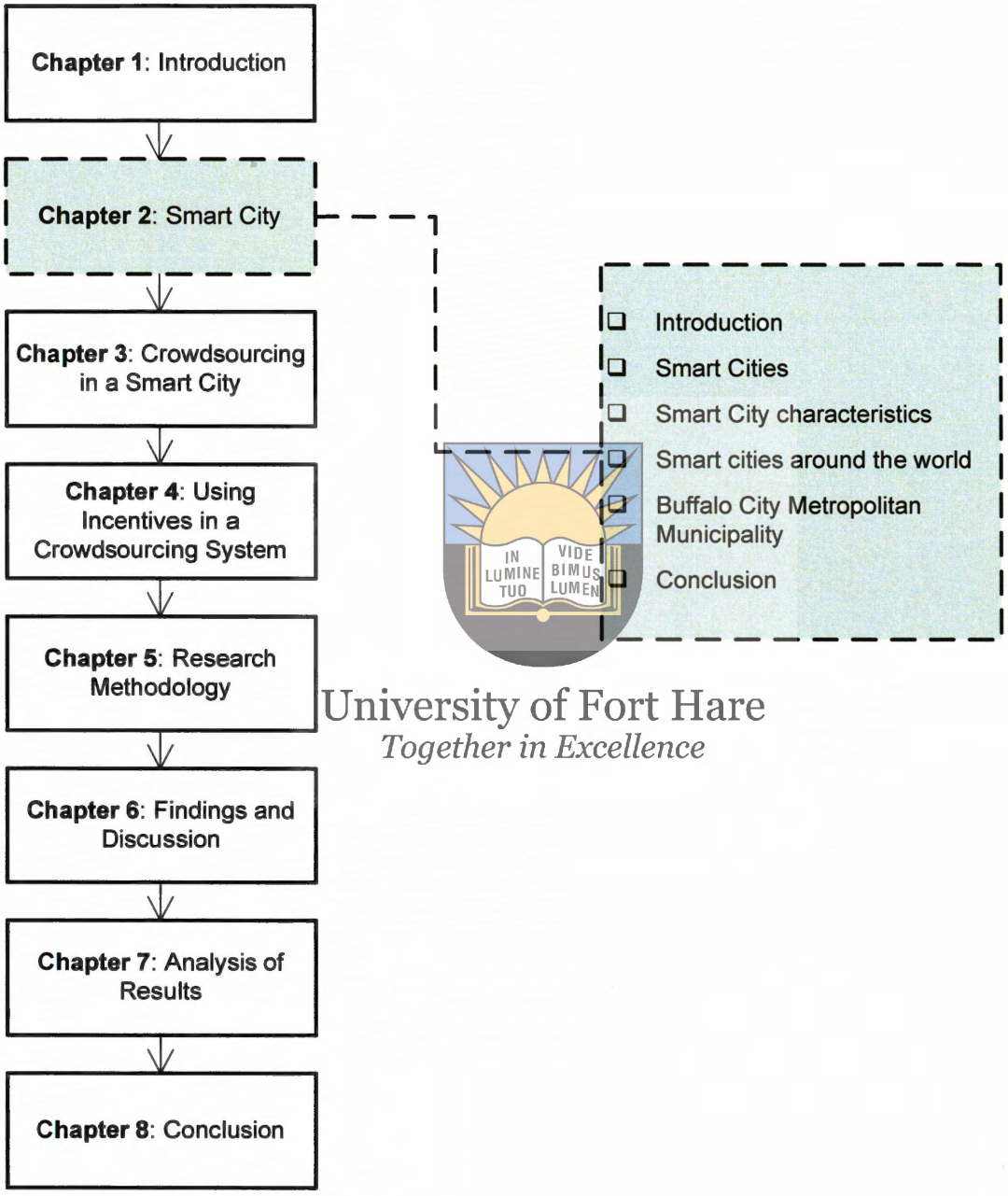
1.10 Summary of the main findings

This study developed a model that will assist in continuous public safety data collection from citizens making use of participatory crowdsourcing. The model consists of three main factors that should be used by the city in order to increase citizen participation, thereby leading to the continuous collection of public safety information. These factors are intrinsic, internalised-extrinsic, and extrinsic. Conversational analysis was done to assist with the refinement of this model. The next section provides an outline of the chapters.

1.11 Outline of chapters

Chapter 1 is the introduction to this study. It consists of the background, statement of the problem, and the research question which was divided into three sub-questions. Chapter 2 discusses the first sub-question which explains the type of crowdsourcing system that should be in place in order to provide meaningful and useful data. Chapter 3 is based on the second sub-question which focuses on how participatory crowdsourcing can be used to add to the data collection for a smart city. Chapter 4 is based on the third and last sub-question which focuses on the incentives that will motivate East London citizens to provide public safety information. Chapter 5 covers the research methodology chapter. Chapter 6 presents the findings from the data collected from the questionnaire, conversational analysis and observations. Chapter 7 provides a discussion of findings and the evaluation of the model is discussed in this chapter. Chapter 8 is the conclusion. The next chapter (Chapter 2) provides a description of a smart city.

2 Smart City



2.1 Introduction

Literature suggests that more than half of the world population is now living in cities rather than in rural areas. This trend of urbanisation is expected to continue in future (Bartoli, Fantacci, Gei, Marabissi, & Micciullo, 2013). There are various reasons why people are moving to live in cities, including to improve their lifestyle and to seek employment (Mondal, 2014).

Urbanisation results in more people depending on and using the limited resources available in a city (Washburn & Sindhu, 2010). This results in the city not being able to manage the available resources. Urbanisation, however, results in an increased amount of threats and risks targeting the quality of life of citizens (Nam & Pardo, 2011). These risks include increased crime rates, accidents and disasters. Therefore, the city has to seek ways to minimise these risks to citizens and to manage the city's available resources efficiently.

Some cities have implemented a smart city approach in order to minimise the risks caused by urbanisation. A smart city uses Information and Communication Technology (ICT) to manage some of its activities (Berst, 2013). Smart cities consist of six characteristics, namely: economy, mobility, environment, people, governance, and living. Each characteristic contains various aspects. This study only focused on the smart living public safety aspect.

The next section provides a definition for a smart city and the three key concepts that are present in a smart city. The benefits of using the smart city approach are also explained in order to have a clear understanding of how smart cities will improve public safety in a city. A brief discussion of the six characteristics of a smart city follows in section 2.3. Section 2.4 will discuss how cities around the world implemented the smart city approach focusing on public safety. The last section provides a brief discussion of public safety in the city of East London, South Africa.

2.2 Smart cities

Harrison and Donnelly (2011) are of the view that smart cities have their origins in the smart growth movement which was introduced in the late 1990s. The purpose of a smart city was to introduce new policies for urban planning, which led to the development of smart cities. Nowadays, smart cities are being implemented in order to improve the quality of lives for citizens as well as for better management of resources. This is supported by Colldahl, Frey, and Kelemen (2013) who identified a smart city as one that has control over all the resources and activities in the city and encourages responsible use of limited resources.

A smart city can therefore be defined as "a city that uses information and communications technology to make its infrastructure, components and utilities in order to be more interactive, efficient and making citizens more aware of them" (Azkuna, 2012, p. 2). Buscher, Doody, Tomordy, Ashley, Tabet, and McDermott (2010) extended the definition of a smart city by stating that it is a city that combines various city systems, making them simpler and more responsive through the use of technology.

A smart city focuses on managing all the city's key areas such as the environment, public health, public safety and other resources. This can be accomplished by making use of technology that will monitor the activities that are happening in the city (Caragliu, Chiara, & Nijkamp, 2009). These include public safety activities such as crime, natural disasters and accidents. These activities will be reported to the city by citizens, making use of various technology devices (such as mobile phones) and applications or platforms (Barbier, Zafarani, Gao, Fang, & Liu, 2012). These will allow citizens to report to the city by posting any activity they witness that threatens public safety. A smart city therefore has to make it possible for citizens to interact with the city (Harrison & Donnelly, 2011).

A smart city is not only defined by the use of technology, it also includes citizens who are aware of how to make use of technology to report public safety issues they observe (Bartoli et al., 2013). Educating citizens allows them to be aware of their responsibilities in a city and allows for effective communication. Citizens' responsibility includes providing public safety information they observe to the city.

Effective communication between citizens and the city will assist in policy making, decision- making and better governance in the city (Bartoli et al., 2013).

According to Colldahl, Frey, and Kelemen (2013), a city is therefore not considered to be smart when:

- There is poor communication between citizens and the city;
- When there is a shortage of resources (such as food, water and energy), and
- When the people in the city are not involved in issues that lead to the development of the city and are unwilling to participate in decision-making.

This section provided an introduction and a brief discussion of a smart city. The next section further explains the smart city key components.

2.2.1 Smart City key components

Literature suggests that there are three major components which contribute to a smart city concept. These include people, technology and the institution, as illustrated in Figure 2-1. The technology component is explained in the next section.

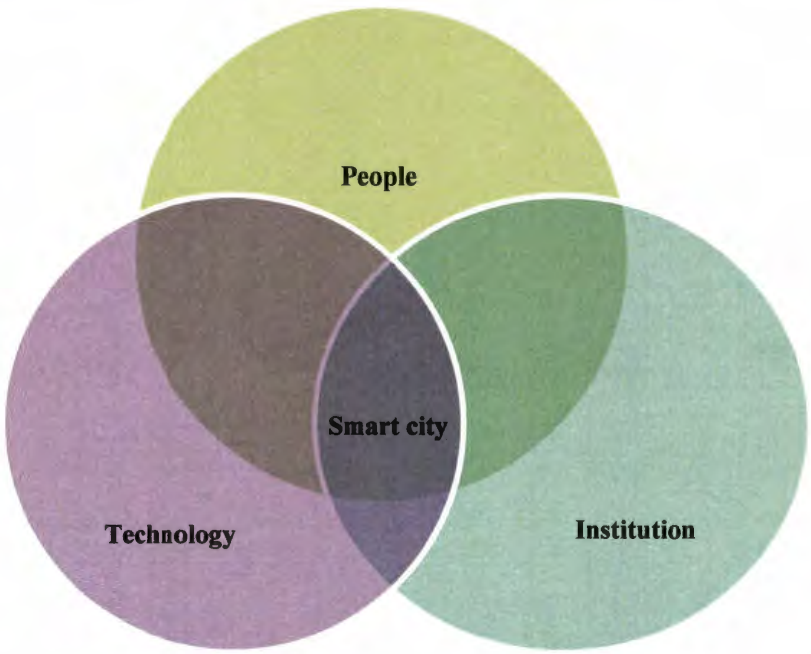


Figure 2-1: Three key components of a smart city concept (Nam & Pardo, 2011)

2.2.1.1 Technology

The first component is technology, which consists of hardware and software infrastructures that allow for public safety information to be collected, processed and analysed in a city (Colldahl et al., 2013). Smart cities focus on using technology because it encourages the use of ICT to gain an insight into what is happening in a city and then make decisions based on the available information (Nam & Pardo, 2011).

The type of technology used in a smart city includes sensors, which collect data from citizens making use of electronic devices such as mobile phones or tablets (Christin, Reinhard, Kanhere, & Hollicka, 2011). Apart from using sensors to collect information, citizens may also voluntarily report any public safety information they witness to the city, thereby acting as sensors. The information collected can be analysed in order to determine how the resources are being used in a city (Harrison & Donnelly, 2011). However, in order to be able to use sensor technology in a smart city, it needs people to install software as well as to operate and manage it.

2.2.1.2 People

The second component of a smart city consists of people. Nam and Pardo (2011) stated that people are the major component of a smart city because they are creative and skilled, thus enabling them to communicate and learn from each other. People will assist in making a city smart by being involved in various issues of the city such as reporting public safety information.

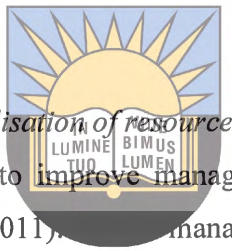
2.2.1.3 Institution

The institution is the third component of a smart city. The institution component has two different definitions: the *smart community,* which focuses on the use of information technology to transform lives within a community, and *smart growth,* which focuses on urban planning to ensure improved quality of life (Kramers, Höjer, Lövehagen, & Wangel, 2014). This component focuses on interconnecting the government with businesses, citizens and their communities to enable growth and innovation (Nam & Pardo, 2011).

Combining and using these three components in a city will make the city smart and be beneficial to both the city and its citizens. The next section outlines the benefits of implementing a smart city.

2.2.2 Smart city benefits

There are various benefits that are associated with implementing the smart city approach which will affect both the city and citizens living in the city. These benefits include: better management of resources, improved living conditions, enhanced communication between the city and citizens, and improved service operations (Berst, 2013).



- *Better management and utilisation of resources*

Smart cities will enable the city to improve management and utilisation of existing resources (Harrison & Donnelly, 2011). Management of resources in a city will ensure that services are always available to citizens.

- *Improved living conditions*

Smart cities ensure that citizens feel secure and have a better quality of life. These cities also enable citizens to have access to better healthcare facilities, clean water and air as a result of reduced pollution (Berst, 2013).

- *Enhanced communication between citizens and the city*

Smart cities enable a two-way communication between citizens and the city. This is as a result of well-functioning ICT services, which allows citizens to report public safety information to, as well as to obtain feedback from the city (Berst, 2013).

- *Improved service operations*

Smart cities have improved service operations such as waste collection, as well as using sensors in the streets to control traffic (Berst, 2013). Improved waste collection makes the city smart because there will not be waste overflowing in the streets. Controlled traffic flow results in improved traffic information which results in drivers making decisions based on real-time information provided by the city (Amoros, 2012). In case

of an emergency in a smart city, the emergency personnel respond more appropriately because they are better equipped and have access to all the information and resources they need (Amoros, 2012).

All the benefits mentioned above will assist in improving the quality of life for citizens living in a smart city as resources are used more efficiently. There are characteristics that distinguish a smart city which are discussed in the next section.

2.3 Smart city characteristics

A smart city possesses various characteristics. In order for a city to be considered a smart city, the following six characteristics must be presented. These include: smart economy, smart mobility, smart environment, smart people, smart governance, and smart living. Figure 2-2 displays the six characteristics of a smart city. This study focused on a subsection of smart living: public safety. The next section will briefly explain each section.

Smart Economy (Competitiveness)	Smart People (Social & Human capital)	Smart Governance (Participation)
• Innovation • Productivity • Labour market flexibility • Entrepreneurship • Trademarks	• Qualification levels • Creativity • Open-mindedness • Participation in public life	• Participating in decision making • Public and social services • Political strategies and perspectives
Smart Mobility (Transport)	**Smart Environment (Natural resources)**	**Smart Living (Quality of life)**
• Local accessibility • Availability of ICT infrastructure • Safe, innovative and sustainable transport systems	• Pollution • Environmental protection • Sustainable resource management	• Health conditions • Individual safety • Education facilities • Social cohesion • Housing quality

Figure 2-2: Smart City Characteristics (Colldahl, Frey, & Kelemen, 2013)

2.3.1 Smart economy

Smart economy refers to the competitiveness of a city. This includes innovation, productivity, flexibility of labour markets, and the city's role in national and international markets (Colldahl et al., 2013). Cities should therefore introduce actions that will create and maintain social network groups for entrepreneurs and act as a team with various stakeholders in order to increase innovation; this will deem a city to be smart (Colldahl et al., 2013).

2.3.2 Smart mobility

Smart mobility refers to transport and the use of ICT in order to manage and access transport services (Colldahl et al., 2013). The ICT systems will also assist in reducing traffic congestion in the city. This is achieved by the use of technology (i.e. sensors) which is used to monitor traffic flow (Ilarri, Stojanovic, & Ray, 2014). An example of a smart city that has installed sensors in order to enable smart mobility (traffic) is Barcelona, Spain.

2.3.3 Smart environment

Smart environment refers to natural resources and urban planning. Smart environment focuses on reducing pollution and the use of new technology in order to manage resources and protect the environment (Colldahl et al., 2013). A major environmental issue that cities are facing is pollution due to poor waste management (Kramers et al., 2014). This is caused by waste not being properly managed by the city. Pollution is harmful to both citizens and the environment because some of the objects in the waste cannot be decomposed and absorbed by the environment. Examples of these waste objects include metal cans, glass and plastics.

Thus for a city to be smarter, the city should make use of energy technologies in order to enable effective management of the use of energy, as well as reduce pollution in the city. Most cities are in search of ways to use ICT to manage waste and reduce energy consumption. This will benefit the society and the environment because of reduced pollution (Kramers et al., 2014).

2.3.4 Smart people

Smart people refer to the educational level of citizens, their cultural awareness, quality of social interactions, and their ability to relate to the external world (Kramers et al., 2014). Well educated citizens are important in a city because they lead to the development of the city. Educating citizens on how to use technology will allow the city to provide access to its resources, and to improve the experience and quality of life of citizens (Azkuna, 2012).

Citizens who are able to use the city systems will benefit because they are aware of how to use the system, making it easier for them to provide public safety reports. Some cities introduced technology awareness in order to ensure that every citizen is computer literate (Azkuna, 2012). Singapore introduced technology in education in order to be sure that every student is computer literate and is able to think creatively. To raise technology awareness and educate citizens, cities need to introduce programmes such as computer-assisted education (Colldahl et al., 2013).

2.3.5 Smart governance

Smart governance includes a functioning administration and efficient delivery of new services to the citizens. Smart governance enables citizen participation in decision making in issues concerning the city, improving accountability, and fostering collaboration (Lin, Zhang, & Geertman, 2014). Enabling citizen participation can be achieved by introducing new technologies that enable the use of a transparent communication channel, which will improve citizen participation in decision- making.

Smart governance also focuses on providing information awareness to citizens about the correct usage of the available resources (Bartoli et al., 2013). This will inform the city about the usage of resources and assist them in managing their limited resources effectively.

2.3.6 Smart living

The smart living aspect is aimed at improving the quality of life of citizens living in a city. Smart living contains several elements that will help to improve citizens' quality

of life. These elements include: city management, housing, education, transport, health care, and public safety (Azkuna, 2012). This project is based on the public safety element. These elements are briefly discussed below.

- City management – focuses on improving the quality of services by the government.
- Education – allows the citizens to be educated on how to use technology systems in the city.
- Healthcare – focuses on providing accurate medical records and quick response to medical emergencies.
- Transport – aims at improving all traffic related services. This encourages the use of public transport to reduce traffic congestion and also reduce transport costs.
- Environment – focuses on improving all the issues impacting the environmental conditions of a city.
- Public safety – focuses on improving the quality of life for citizens by ensuring the safety of citizens.

A city is considered to be smart when it has presented a positive performance in all these aspects. For a city to be liveable, it is important for safety and security of the citizens to be taken into consideration. In the future, the quality of life for citizens will depend on the city's capability to reduce pollution, save water and energy, improve the living conditions, and to increase security for all citizens (Bartoli et al., 2013). This project is focused on improving public safety in a city and ensuring that citizens will have a better quality of life. Public safety is further discussed in the next section.

2.3.6.1 Public safety

Urbanisation has resulted in public safety issues which include crime and accidents (Bartoli et al., 2013). All of these public safety issues negatively impacts the city's resources, as well as the lives of citizens living in a city. Washburn and Sindhu (2010) are of the view that scarcity of resources and services are a result of more people living in the city, leading to high demand of the available resources. Therefore, this will lead

to straining the limited resources available. This scarcity of available resources threatens the safety of citizens, giving a rise to these public safety issues.

The public safety aspect focuses on improving the quality of life for citizens which can be achieved through managing disasters by responding quickly, and reducing crime and accidents by increasing security for all citizens (Bartoli et al., 2013).

Public safety ensures that all citizens feel protected and safe in the city. Public safety can be defined as "protecting the public as well as preventing any events that could place the lives of citizens in danger" (Smith, 2001, p. 2). Public safety focuses on gathering real-time information from the city to predict and respond faster to emergencies and threats (Bartoli et al., 2013). This includes concerns for natural disasters, accidents and deliberately harmful acts by citizens.

In a smart city, public safety information may be collected making use of technology (Matheus & Ribeiro, 2014). In many cases, this public safety information is collected making use of sensors attached to citizens' devices such as a mobile phone. Information can also be collected from citizens who volunteer any public safety information they witness. In this study, citizens are used as sensors who report public safety issues voluntarily. These methods of gathering public safety information from citizens are explained further in Chapter 3.

This section explained the smart living aspects and how public safety can be improved in a city. The next section discusses various smart cities around the world that have implemented the smart city approach.

2.4 Smart cities around the world

Although the smart city concept is still evolving, some cities have already started to implement projects. According to literature, some of the cities are implementing smart cities in order to have an improved higher education sector, technical innovation, as well as designing urban improvement. The following examples show how some cities are using the smart city concept. These cities include Barcelona, Singapore and Rio de Janeiro.

2.4.1 Barcelona

Barcelona is regarded as a pioneer smart city (Ancheta, 2014). The city of Barcelona was the first to introduce the use of a solar thermal ordinance in order to promote low-carbon solutions (Cohen, 2012). These low-carbon solutions resulted in reduced carbon oxide emissions, thereby ensuring reduced pollution in the city.

In order to reduce pollution as well as improve waste management, the city has installed bins that have sensors to detect whether the bin is full so that it can remove rubbish through pipes into the ground (Ancheta, 2014). This improves the reputation of the city because the public will not see overflowing rubbish from bins in the streets.

The city of Barcelona effectively manages its public transport services in order to ensure that citizens have access to public transport. The buses used in the city are hybrid, powered by natural gas in order to reduce pollution in the city (Cohen, 2012). The city of Barcelona has also introduced smart parking for its citizens, which makes use of sensors to detect whether a parking spot is vacant and informs citizens in real time (Cohen, 2012).

Smart cities do not only require technology in order for them to be smart, people also play an important role. Barcelona has provided resources that will make life easier for its citizens by enabling communication between citizens and the city. Citizens can file reports, suggestions or complains to the city administrators by making use of various applications created for citizen communication (Cohen, 2012). An example of an application created for citizen complaints or suggestion is the Bústia Ciutadana application, which allows citizens to report any issues that might affect their safety in the city. These reports filed by citizens will assist the city in addressing issues that are affecting their lives, thereby improving their quality of life.

2.4.2 Singapore

Singapore is a technology enabled city that makes use of data that has been gathered from citizens in the city. The collected data is used to gain insights on the activities of

the city and how services and resources are used (Mortensen, Rohde, Kristiansen, Kanstrup-Clausen, & Lubanski, 2012).

Through innovation, the city developed a platform that enables communities and citizens to make use of the data available in order to generate new applications that improve the quality of life (Mortensen et al., 2012). An example is a weather forecast application that provides weather information ten minutes in advance. This application can provide information to the drivers in the city where there are bad weather conditions.

In order for a city to be smart, people need to be computer literate for them to be able to develop their city (Berst, 2013). Singapore introduced ICT in education and ensured that all citizens are computer literate.

2.4.3 Rio de Janeiro

The former capital of Brazil, Rio de Janeiro, was the first smart city in Latin America (Wakefield, 2013). The city developed solutions for public safety challenges such as natural disasters and crime (Buscher & Doody, 2013). Natural disasters left many people homeless and the violence has resulted in many deaths, thereby placing the lives of other citizens in danger. The city of Rio de Janeiro implemented the smart city approach, with help from IBM, in order to improve the quality of life for all citizens (Buscher & Doody, 2013). Therefore, citizens of Rio de Janeiro are able to provide any public safety information they observe through their mobile devices. This helps the city gain perspective of its activities, thereby improving city operations and reacting appropriately.

The city has established an operations centre that is responsible for gathering data from citizens, as well as analysing and monitoring of the data in order to be aware of what is happening in the city (Matheus & Ribeiro, 2014). This is achieved by making use of Closed-Circuit Television (CCTV) cameras installed throughout the city, including sensors and Global Positioning System (GPS) devices installed in the streets (Wakefield, 2013). These cameras, GPS and sensors will help the operators to be aware

of problems such as power failures or car accidents, including the location. This will enable the responsible personnel to react quickly in case of emergency.

The city also created a weather forecasting program that can predict rainfall (Wakefield, 2013). This program alerts the city operators if it has predicted rainstorms that could lead to landslides which place the lives of citizens in danger. City operators have to evacuate all the citizens in that area and be relocated to a safe place.

This section provided an overview of how other cities in the world have implemented the smart city concept. The next section briefly discusses the metropolitan in which the city of East London is located (where this study is being conducted).

2.5 Buffalo City Metropolitan Municipality

This study will be carried out in the city of East London, located in the Buffalo City Metropolitan Municipality (BCMM). The BCMM is located on the coast of South Africa's Eastern Cape Province, formerly known as Ciskei. The BCMM was named after the Buffalo River (The Local Government Handbook, 2014).

Being located in the second largest province in South Africa, the population growth in BCMM for 2014 according to The Local Government Handbook (2014) is recorded at 0.69%. The estimated population of BCMM is 1.4 million people (East London, 2013). These statistics show that people are moving to BCMM every year. As more people move to the city, the safety of the citizens in the BCMM is at threat because of increased crime rates and limited resources to cater for every citizen living in the city (Bartoli et al., 2013).

To manage the city, the BCMM has established various departments. One of these is the Public Safety Department which focuses on providing safety to all citizens by managing crime and natural disasters (Buffalo City Metro, 2014). The Public Safety Department consists of three sub-departments called Traffic and Law Enforcement, Fire and Rescue Services, and Disaster Management Rescue Services (Buffalo City Metro, 2014).

Traffic and Law Enforcement focuses on enforcing by-laws for the municipality, preventing crime, attending to crime complaints from the public, educating the citizens about traffic safety, as well as enforcing traffic laws. The Fire and Rescue Department focuses on fire prevention, fire fighting in case of a fire, and rescuing injured victims. The Disaster Recovery division provides services such as prevention and mitigation of disaster, and provides a quick response and recovery from a disaster. The next section discusses the city of East London.

2.5.1 East London city

East London is a developing city and the biggest city in the BCMM with a population of approximately 755 200 citizens (City Population, 2015). As a developing city, more citizens are moving to East London to search for a better quality of life, resulting to public safety issues. This study refers to East London as the city that consists of various departments that deal with pollution, crime, natural disasters, maintenance and crime.

To improve public safety, the city created objectives that will assist in developing East London to be a smart city. East London's objectives, according to The Local Government Handbook (2014), are:

- To be an organisation that manages its resources efficiently;
- To work efficiently with communities;
- To deliver sustainable infrastructure that support social and economic development;
- To be an institution that renders services to everyone effectively and efficiently; and
- To protect and enhance all natural resources as well as environmental assets within the city.

The BCMM focuses on improving service delivery and the quality of life for citizens in East London. However, these objectives will only be achieved when there is a reduction of the public safety issues in the city. The next section discusses public safety issues that are experienced in the BCMM, specifically in the city of East London.

2.5.2 Public safety issues in East London

Urbanisation has led to increased public safety issues in East London (Lehohla, 2012). The estimated population of East London is over 755200 with a population growth of 0.69% per annum (East London, 2013; ECSECC, 2012). This shows that every year there are more people migrating to East London. As the population increases, threats to citizens will also increase (Washburn & Sindhu, 2010). These challenges include shortages of services (Washburn & Sindhu, 2010). As a way of solving these risks and concerns as well as improving the quality of life for citizens, the East London city should implement the smart city approach, thereby making the city more efficient.

This study is conducted in the city of East London to assist in bettering the quality of life by improving the safety of citizens. This will be as a result of a well-functioning crowdsourcing system that will be presented later in this study, which will enable citizens to provide public safety information they witness. Various public safety issues have been reported daily in East London. These issues include increased crime rates, accidents and natural disasters. These issues are explained below.

- *Crime*

Crime rates have increased as a result of more people living in the city (Washburn & Sindhu, 2010). A crime is an act that is prohibited by the law, which can lead to punishment by paying a fine or imprisonment (Hunter & Dantzker, 2011). Examples of crime includes: murder, rape, drunken driving, and robbery, which will affect the safety of citizens. According to Figure 2-3, the total number of crime recorded for East London in 2014 increased to 7963 from 7858 crimes. This shows that crime is a public safety issue that is affecting the citizens of East London.

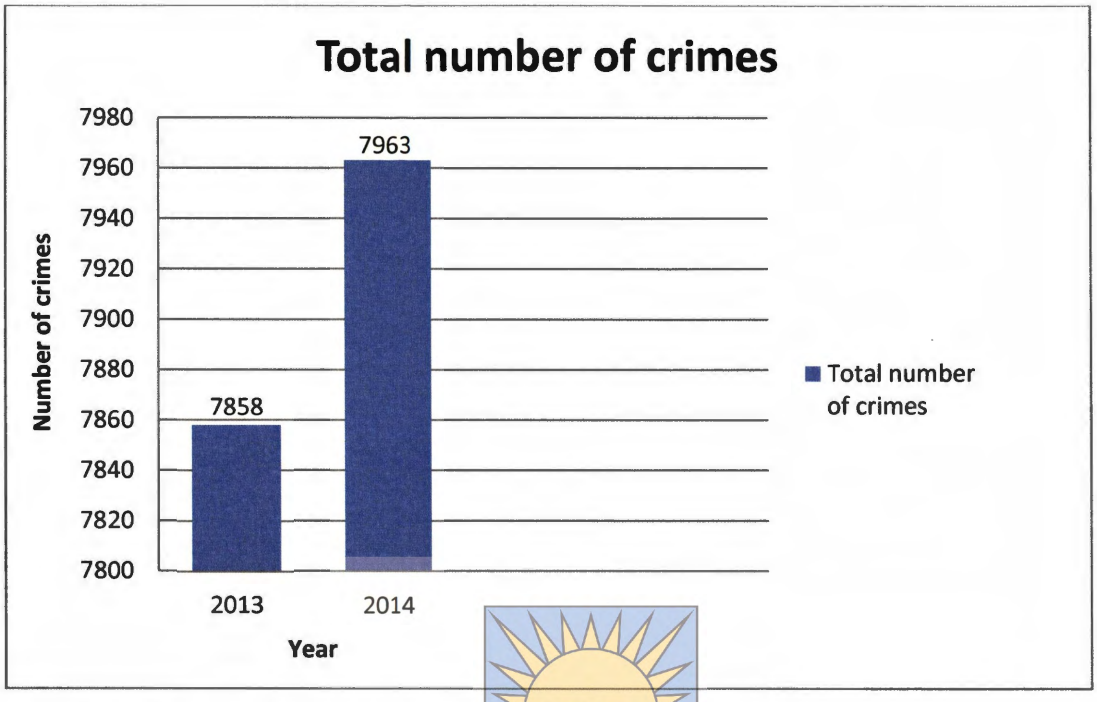


Figure 2-3: East London crime statistics (Crime Stats S.A, 2015)

- *Accidents*

Amoros (2012) defines a traffic accident as "Accidents which occurred or originated on a way or street open to public traffic, which resulted in one or more persons being killed or injured and in which at least one moving vehicle was involved" (p.13). Accidents are caused by many factors including poor road conditions, driving when drunk, and bad weather conditions (Amoros, 2012). All of these factors lead to the safety of citizens being affected, thereby affecting the quality of life for East London citizens.

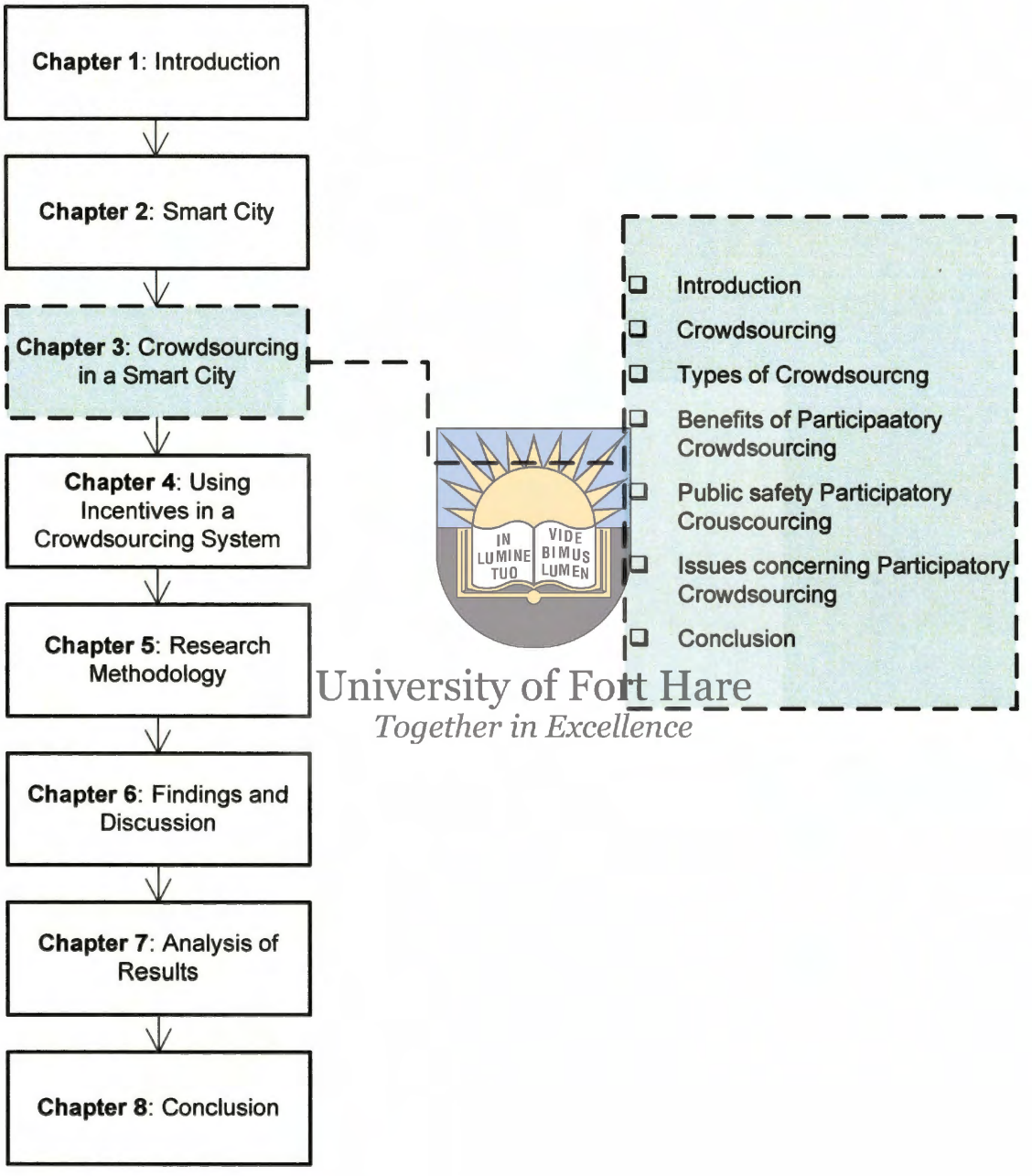
- *Natural disasters*

A disaster is an overwhelming event that has not been planned for that can be either natural or man-made (Ferris, 2010). Natural disasters are as a result of forces of nature, which affects both economic and social development of a region (Ferris, 2010). Examples of natural disasters include: hurricanes, cyclones, floods, droughts, extreme volcanoes, earthquakes, landslides, and tsunamis. The city of East London has recently been affected by floods. These natural disasters affected the safety of citizens because they are uncontrollable and most of the time they leave people homeless and injured (Disaster Report, 2012).

2.6 Conclusion

The issue of urbanisation has brought about public safety challenges to people living in cities. These challenges include scarcity of resources which can lead to crime such as theft, accidents and disasters. The city of East London is currently experiencing these public safety challenges. However, in order to minimise these challenges, some cities have implemented the smart city approach. Smart cities consist of six characteristics (smart economy, smart mobility, smart environment, smart people, smart governance, and smart living) that have to be considered for a city to be regarded as smart. Examples of cities that have used the six characteristics of a smart city include Barcelona, Singapore and Rio de Janeiro. These cities are becoming smart in ways that will enable the city to manage existing resources and better plan for the city's future. The city of East London can implement the smart city approach in order to effectively manage the limited resources and to minimise public safety issues such as crime, accidents and natural disasters. The next chapter discusses crowdsourcing in a smart city.

3 Crowdsourcing in a Smart City



3.1 Introduction

Smart cities enable a city to minimise public safety issues by making use of the three key components: people, institution and technology (Colldahl et al., 2013). These components allow for citizens to report public safety issues they witness and for the city to be able to collect and analyse data.

One of the ways this can be achieved is through crowdsourcing, which allows for large amounts of information to be collected from citizens. The information can be collected in different formats which allows for a city to analyse the public safety information provided by these citizens in order to improve the efficiency of resources.

This chapter focuses on crowdsourcing, with an objective of providing an understanding of participatory crowdsourcing and how it is being used in smart cities with the intention of improving public safety. In the next section, a brief history of crowdsourcing is provided in order to provide a clear understanding of the origin of crowdsourcing and the technologies involved. Crowdsourcing is then defined and the two types are compared. The following section discusses how crowdsourcing is being used in organisations and in cities for public safety. Lastly, public safety participatory crowdsourcing is discussed together with its benefits.

3.2 Crowdsourcing

The term *crowdsourcing* was first used by Jeff Howe in 2006 in Wired magazine to explain how companies were using the Internet to outsource jobs to the crowd. Previously, people and organisations used the term *outsourcing*. Outsourcing enabled organisations to allocate tasks to other individuals or external organisations to be performed on their behalf (O'Connell, 2013).

Crowdsourcing is being used in different contexts all over the world. Crowdsourcing has emerged as a problem-solving strategy in organisations and as a data gathering technique from the crowd. Lebraty and Lebraty-Lobre (2013) define crowdsourcing as "the externalisation of an activity by an organisation to a large number of individuals

whose identities are most often anonymous" (p.17). Crowdsourcing can therefore be seen as a way of outsourcing a task to the crowd.

However, the idea of mining information from the crowd or providing a task to the crowd to solve or complete is not new. Halder (2014) states that the concept has been used for purposes such as inventing new products or services, raising funds and to receive emergency information from the citizens in time. One of the earliest examples of crowdsourcing occurred in the 18th century when the British government requested citizens to find a method to calculate a ship's longitude (Halder, 2014). This helped the British government to acquire the most effective method from citizens.

An example of how crowdsourcing was used to improve public safety was when the United States of America law enforcement created a strategy to gather crime information in 1960 (Grass, 2013). This strategy encouraged citizens to participate by providing any crime related issues they observed in the city to law enforcement agencies in order to reduce the crime rate in their communities. This was a form of crowdsourcing which enabled the citizens to engage with the city on public safety issues.

Nowadays, crowdsourcing is being used all over the world for various tasks by organisations and governments. Some organisations view crowdsourcing as a problem-solving model to generate various solutions to organisational problems or as a production model (Barbier, Zafarani, Gao, Fang, & Liu, 2012). In a city, the city manager uses crowdsourcing as a tool for governance and planning (Bojin, Shaw, & Toner, 2011).

Crowdsourcing can be used as an important tool for gathering public safety information and to have better insights of the activities happening in the city (Sambuli, Crandall, Costello, & Orwa, 2013). The data collected will help to generate new ideas and provide services that will enable citizens to have access to information regarding the city's safety, as well as being aware of all the activities happening in the city. Using crowdsourcing for public safety will help to gather specific information required and will help the city to respond in time in case of an emergency (Halder, 2014).

Crowdsourcing allows for large amounts of data to be collected in different types and formats. In this study, crowdsourcing is used in order to continuously collect public safety information from citizens who report issues they witness. The next section briefly explains the different types of data collected through crowdsourcing.

3.3 Types of Crowdsourcing

Different types of crowdsourcing have recently emerged. These types of crowdsourcing allows for large amounts of data to be collected from the crowd (citizens). Data gathering allows citizens to communicate with the city, and also allows the city to obtain information about the community and how people are living (Halder, 2014).

According to Doan, Franklin, Kossma, and Kraska (2011), data can be gathered using either implicit methods (involuntary crowdsourcing) or explicit methods (participatory crowdsourcing). Implicit data collection methods make use of sensors to gather data, whereas explicit data collection methods request information from the crowd in order for the crowd to provide solutions (Doan et al., 2011). This study used the explicit method to collect public safety data.

As illustrated in Figure 3-1, there are different types of crowdsourcing that can be used to collect different data types. The types of data collected can be in the form of text, audio, video, email, or images.

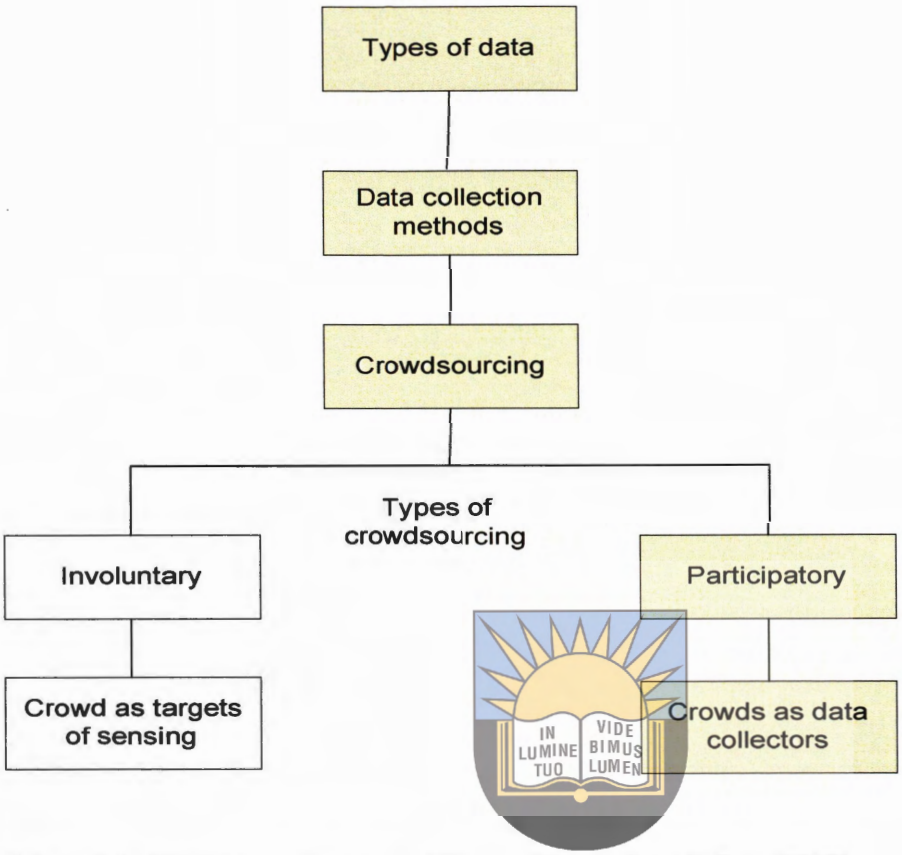


Figure 3-1: Crowdsourcing types (Bhana, Flowerday, & Satt, 2013)

Data can be collected in different types depending on the type of crowdsourcing used. There are two types of crowdsourcing according to Figure 3-1 namely: participatory crowdsourcing whereby the crowd is the natural data collectors and involuntary sensing whereby data is collected through sensors. These two types of crowdsourcing are explained in the next section.

3.3.1 Involuntary crowdsourcing

Involuntary crowdsourcing is known in literature as opportunistic sensing, or crowdsensing (Christin et al., 2011). Involuntary crowdsourcing requires less user involvement because it makes use of sensors to collect information automatically. This type of crowdsourcing allows for sharing of information about a citizen's environment and experiences such as traffic information (Tomasic, Zimmerman, Steinfeld, & Huang, 2014).

The information collected by sensors can include user location, traffic flow and the status of the surrounding environment. The information collected from sensors will

then be processed in order to search for the required information. For example, sensed information can be used to search for a particular licence plate from the data that has been collected from the CCTV cameras (Tomasic et al., 2014). Information collected from sensors can be shared with relevant utility providers, such as municipalities and health care providers, depending on the kind of information.

3.3.1.1 Participatory sensing

Amintoosi and Kanhere (2013) are of the view that citizens can also willingly volunteer public safety information by making use of sensors on devices (such as mobile phone or laptop). This allows for large scale data gathering form the crowd members who willingly volunteer any information in their surrounding environment making use of mobile devices such as smart phones (Christin et al., 2011). Citizens are aware and allow their devices, provided they are connected to the Internet, to provide real-time information regarding what is happening in the city in terms of traffic updates and noise pollution several times a day (Boulos, [illegible] Crowley, Breslin, Sohn, Burtner, Pike, Jezierski, & Chuang, 2011).

However, volunteering public safety information making use of sensors requires participants who have knowledge in using technology devices in order to volunteer information willingly. Some participants might not participate because they need to be motivated to participate (Amintoosi & Kanhere, 2013). This (motivation to participate) is discussed further in Chapter 4. The next section discusses how participatory crowdsourcing is being used in organisations as well as in communities by the government.

3.3.1.2 Uses of Involuntary crowdsourcing

Tomasic et al. (2014) provided an example of an application that uses sensors in order to gather traffic flow information in the streets. The application helps to provide information on which road has more traffic congestion. Applications like the above are also used to collect information about the traffic as well as road conditions such as potholes (Christin et al., 2011). This helps in providing insights on whether traffic accidents and delays in traffic are as a result of a poor road conditions or accidents.

Another example of an involuntary crowdsourcing is the MOSDEN platform which is used to monitor the environment and to manage resources in a smart city (Jayaraman, Perera, Georgakopoulos, & Zaslavsky, 2013). Information regarding the environment is collected from an individual's mobile phone, which can be analysed by the city. Analysed information will provide insights into what is happening in the environment, including the usage of resources, which results in better management of resources in a city. This platform functions by first grouping users based on their current geographic location, then analysing the information based on the different groups available.

All of these applications use sensors to collect data and they require minimum or no user involvement. There are certain problems associated with sensors collecting data without user knowledge which are explained in the section below.

3.3.1.3 Problems concerning involuntary crowdsourcing

Involuntary crowdsourcing collects data from citizens making use of sensors attached to electronic devices. The use of sensors gives rise to involuntary crowdsourcing problems such as: privacy, device failure, and the quality of information collected by sensors.

1. *Privacy*

The first concern associated with involuntary crowdsourcing is privacy. Christin et al. (2011) define involuntary crowdsourcing privacy as the ability of a participant to have full control over the collection of their private, personal and sensitive data. Involuntary crowdsourcing relies mostly on unpredictable collection of data from an individual's device (Shin, Cornelius, Peebles, Kapadia, Kotz, & Triandopoulos, 2011).

In order to be able to access and collect information from a citizen's device, the device has to be connected to the Internet. Therefore, a citizen's privacy is compromised as the device might share personal information such as photographs and the participant's information without the knowledge of the citizen (Tomasic et al, 2014). Shin et al. (2011) agree that it is difficult to protect user privacy because the data collected using sensors includes the location of the user which compromises the user's location privacy.

2. *Device failure and network problems*

Involuntary crowdsourcing might be affected by the failure of devices. This is because sensing makes use of various sensors from devices such as mobile devices, CCTV cameras and motion sensors. The problem when using these tools to gather data is that if it fails to work, no data will be collected. This becomes a concern because the city needs public safety information in order to be aware of all the activities happening in the city. If there is no public safety data collected, there will not be enough public safety information to respond to in the city.

Electronic devices used for crowdsensing have high maintenance cost (Sennett, 2012). Qualified people are needed to fix the devices, and they are expensive to compensate for maintaining the devices.

Electronic devices need to be connected to the Internet in order to transmit public safety data (Gao, Barbier, & Goolsby, 2011). Failure to connect to the Internet means that no public safety data will be collected. In Japan after the 2011 tsunami, many people were trapped and some even died because the sensors could not communicate or collect information about citizens who were affected because there was a network jam after the disaster (Gao et al., 2011).

3. *Quality of information*

Another concern is the quality of information gathered by sensors. Due to less user involvement, the device is likely to randomly collect information, therefore the information shared by sensors may not be enough to be analysed for public safety issues (Tomasic et al., 2014). If the information gathered is incomplete, the city will not know what public safety issues are affecting the citizens.

This section discussed sensors as a method for gathering public safety information. Several issues were highlighted, which explains why user observation is required to overcome these issues provided by involuntary crowdsourcing. Due to the issues concerned with involuntary crowdsourcing (privacy, device failure and network problems, and quality of information), this study will make use of participatory crowdsourcing. The next section discusses user observation which can be achieved through participatory crowdsourcing.

3.3.2 Participatory crowdsourcing

Crowdsourcing has been used by organisations and governments as a way of reaching out to people to obtain solutions to tasks or challenges. There are different types of crowdsourcing that can be used in different contexts, one example being participatory crowdsourcing. In participatory crowdsourcing, the crowd is represented as natural data collectors as illustrated in Figure 3-1. This means that the crowd provides public safety information willingly, without using any sensors. According to Cilliers and Flowerday (2014), participation is regarded as voluntary because participants can decide on what to report in terms of public safety issues they observe. Therefore, participatory crowdsourcing requires increased user involvement. This study investigates the use of participatory crowdsourcing to continuously collect public safety reports they witness.

Some organisations use crowdsourcing as a production and a problem-solving tool. The organisation lists the tasks they need to [redacted], the reward to be awarded for the task, and the expected date of completion. Interested crowd individuals select the task they are interested in, complete it, and then submit the solution in return for the reward. An example of an organisation that used participatory crowdsourcing to generate ideas from the crowd is a Canadian gold mining company called Goldcorp. The company encouraged crowd members to search for gold deposits and then submit proposals stating potential areas where the gold deposits were found (Brabham D. C., 2008). A prize was awarded to the person who found a location with the largest gold deposits.

Some countries have used crowdsourcing as a tool for acquiring information from the citizens regarding what is happening in the city in terms of public safety. Gathering public safety information from citizens will help law enforcement officers to be aware of issues that are happening in the city and to look for ways to minimises these issues, thereby ensuring citizen safety. Brabham (2010) states that to experience some benefits when using crowdsourcing, it is recommended to collect large amounts of information from individuals from different perspectives.

Another practical example of an organisation that is using participatory crowdsourcing is Amazon Mechanical Turk (AMT). AMT publishes small tasks on their website for

the crowd to access. There is no limit on the required number of participants (crowd) and anyone can participate regardless of skills, by selecting any task they wish to perform from a list of tasks available (Estellés-Arolas & González-Ladrón-de-Guevara, 2012). In return, the crowd receives a small payment as an incentive for completing the task. The payment is a form of motivation to some individuals who perform tasks for money.

3.3.3 Types of participatory crowdsourcing

Participatory crowdsourcing has been used for various tasks whereby a crowd member volunteers information willingly. This type of crowdsourcing has been categorised into four systems: voting systems, information sharing systems, gaming, and creative or innovation system (Yuen, King, & Leung, 2011).

Some countries use crowdsourcing to evaluate the voting process. In countries like India, Mexico, Togo, Sudan and Afgha[illegible]wdsourcing has been used as a way of monitoring elections (Sambuli et al., 2013). These countries used crowdsourcing as a method for collecting data from citizens about the election process.

For information sharing, crowdsourcing focuses on sharing information between the crowd and the city (Yuen, King, & Leung, 2011). This can be achieved by using an effective public safety crowdsourcing system that allows citizens to provide data and the city to respond.

Using crowdsourcing for innovation systems allows organisations to use crowdsourcing as an inexpensive way of solving business problems, designing products, and also as a way of being informed of what the customers think of the products (Yuen, King, & Leung, 2011). Innovation in a city allows citizens to assist the city by developing and updating current services.

Some organisations view crowdsourcing as a way to divide labour. It is important for organisations to consider the type of problem and the solutions they want for that problem when deciding to use crowdsourcing (Brabham, 2013). After considering the problem, the organisation must also consider the communication tool to be used for

crowdsourcing; either through broadcasting the problem on a website or social media. Most organisations use their website as their communication tool for crowdsourcing. Various organisations have also used crowdsourcing for different types of problems, mainly to achieve business goals (Hammon & Hippner, 2012). This approach has been implemented by online companies that use crowdsourcing to achieve business goals by broadcasting the problem to the crowd and motivating the crowd with a reward for completing the task (Brabham, 2013).

Several companies and organisations are using participatory crowdsourcing to acquire information from the crowd. Examples of these organisations include Threadless, InnoCentive, Youtube, Yahoo Answers, and Wikipedia (Brabham, 2013).

Threadless is a web-based company that specialises in t-shirt designs. The company uses crowdsourcing to gather t-shirt designs in the form of an online competition (Hammon & Hippner, 2012). Interested individuals who want to participate in designing t-shirts can join using a valid email address. Once an individual has joined, they become part of the Threadless crowd and they can also create their own t-shirt designs. Finished designs are uploaded to the Threadless website for evaluation. The designs with the most votes are printed on t-shirts and are made available for sale on the website. The designer gets rewarded in cash and Threadless gift certificates.

InnoCentive use crowdsourcing for research and developing scientific problems. Challenges are made available to the crowd on the website. These challenges are grouped according to categories. Interested crowd members select and solve the problem. Once they are done, they submit their solution to the website for evaluation. If the solution meets the requirements, the crowd member is rewarded for providing a solution that works (Brabham, 2013).

Other popular examples of crowdsourcing include YouTube which allows users to post video tutorials on how to perfom certain tasks. Yahoo Answers allows people to post questions and answers. These examples can assist citizens by teaching them how to use their devices to report public safety issues. Wikipedia is another popular crowdsourcing platform, which is an online encyclopedia where anyone can contribute their knowledge. Some crowd members willingly provide their information to Google Earth

by attaching their photos, notes and videos (Boulos et al., 2011). This approach has influenced this study as volunteering public safety information in a participatory issue was chosen to be appropriate. The next section discusses the benefits of participatory crowdsourcing.

3.4 Benefits of participatory crowdsourcing

This section has been divided into two sub-sections. The first part discusses the benefits of participatory crowdsourcing to organisations. The second section discusses the benefits of participatory crowdsourcing to the crowd.

3.4.1 Organisation benefits

Some organisations use crowdsourcing as a production tool to develop ideas on their products or as a problem-solving tool to gather solutions. Using crowdsourcing in a city will provide benefits to the city. These benefits are explained below.

1. *Low cost*

Some organisations have implemented crowdsourcing as a production model to make more efficient use of the crowds' skills, expertise and resources, thereby reducing production costs (Yuen et al., 2011). The organisations can make use of incentives to improve production. Incentives provide a lower-cost option to an organisation than hiring a professional employee to do the job. Therefore the city can continuously collect public safety reports from citizens at a minimised cost.

2. *No supervision*

Another advantage of participatory crowdsourcing is that workers are not bound by a work contract which stipulates how to perform tasks, do not need supervision, and are self-motivated. This increases the employees' willingness to work and allows them to organise and perform according to their individual needs (Yuen et al., 2011). Therefore, the city can focus on how best to manage city resources because they do not need to supervise additional people; citizens provide public safety information.

3. *Brand awareness*

Some organisations are using crowdsourcing as a way of marketing their brand (Schenk & Guittard, 2011). By using crowdsourcing to gather information about a particular product, the crowd will become aware of that product. Therefore, the city can use crowdsourcing as a way of raising public safety awareness among citizens. This result in increased citizen engagement, thereby increasing the amount of public safety information collected from citizens. An example of a company that used crowdsourcing is Lays, which allowed the crowd to create custom flavoured chips and submit them online.

Other organisations use crowdsourcing as a marketing tool because crowdsourcing allows them to be more interactive with the crowds (customers). This might result in the crowd (who are also customers) purchasing and commenting on the product and recommending the product to their colleagues. The next section discusses the benefits of using crowdsourcing to the crowd members.

3.4.2 Crowd benefits

According to Schenk and Guittard (2011), as users become involved in product design, organisations will increase their productivity. This will also help to increase the engagement of a customer, as well as assisting in securing customer loyalty. Customer loyalty will increase as customers are involved because they will feel important by being involved in decision-making and designing the product. Customer relations become stronger because the organisation can interact directly with their customers (crowd).

In a city, crowdsourcing provides citizen engagement which allows for citizens to be included in city issues by providing public safety information they witness. Crowdsourcing also helps to build a relationship between the city and citizens (Schenk & Guittard, 2011).

3.5 Public safety participatory crowdsourcing

Crowdsourcing enables citizens to assist in providing public safety information they witness in their immediate environment. O'Connell (2013) is of the view that

previously, public safety issues were managed by the city only and citizens were not involved, thus leading to more public safety concerns. As crime levels increased, the local municipalities realised the need for citizen involvement and thereby introduced crowdsourcing to gather any public safety issues that citizens observed (O'Connell, 2013). This enabled them to use resources more effectively.

In some countries, applications have been developed for individuals to inform the community if a citizen is in danger or if they witness any activity that might be a threat to their lives (Grass, 2013). The use of participatory crowdsourcing in a city will help the city to prepare for a particular situation affecting the safety of citizens, as well as providing some insights on how to respond to an emergency situation and recover afterwards (Halder, 2014). Participatory crowdsourcing applications will help to respond quickly to any emergency in the city. These applications ought to make it easy for public safety information to be continuously collected from the citizens.

In a city such as East London, crowdsourcing can be used by the city to observe and analyse all the activities taking place in the city. Participatory crowdsourcing provides an opportunity for the city to collect information from the crowd in order to be informed of what is happening in the city (Halder, 2014). An example would be information on the use of public transport in order to be aware of traffic flow or information that could inform environmental policy makers or health practitioners (Brabham, 2013). Chapter 2 discussed that a city is considered to be smart when it can properly protect its citizens from any threats such as crime, accidents and disasters. All of these are public safety issues that endanger the lives of citizens. Therefore, to be able to reduce these public safety issues, participatory crowdsourcing must be used to gather public safety information from citizens.

Some countries such as Haiti, Afghanistan and Chile have used crowdsourcing for disaster recovery by making use of the Ushahidi platform. The main objective of the Ushahidi platform was to communicate with affected citizens and to understand their needs better. This platform allows citizens to contribute any information related to natural or man-made disasters, thereby raising disaster awareness for other citizens. The information can be in the form of messages or emails about any natural disaster and the location from which it occurs. Barbier et al. (2012) agree that crowdsourcing for

disaster recovery allows people to volunteer any kind of information (images or texts) that might be helpful to the community. Once the information is received, it is saved onto the crisis map or timeline (Sambuli et al., 2013). Figure 3-2 shows how the information is plotted onto the crisis map.

Figure 3-2: Ushahidi crisis map showing the areas affected by Tsunami (Meier, 2012)

The information provided by citizens will assist the city to send required resources to the affected areas. The next section discusses the benefits of using participatory crowdsourcing.

3.5.1 Public safety benefits

Using participatory crowdsourcing for public safety has a number of benefits. These include increased citizen engagement, increased citizen awareness of what is happening in their communities, and the public safety information provided by citizens is regarded as first-hand information. These benefits are explained below.

1. *Citizen engagement*

Participatory crowdsourcing helps the municipality or the city to engage with the citizens. Citizen participation provides an opportunity to report public safety issues and provide feedback on the crimes they witness in a city (Rijmenam, 2013). This will help improve the quality of life of citizens.

Enabling citizen participation helps in strengthening the involvement of citizens in making the city smarter (Azkuna, 2012). The information gathered from citizens provides a view of all the activities happening in the city, as well as how citizens live. This information will help the city of East London consider these public safety issues (Rijmenam, 2013). The data collected will also help the city to introduce policies or programmes that will enable citizens to have a better quality of life by taking into account as many views as possible when making decisions (Azkuna, 2012). Data gathering from citizens also strengthens the general interests against individual interest of a citizen which helps to attain the support of citizens (Clay, 2014).

2. *Citizen awareness and feedback*

The second advantage to the municipality for providing public safety information is that the citizens will become more aware of what is happening in the city (Lessl, Bryans, Richards, & Asadullah, 2011). Citizens are the ones observing and reporting all the activities that are happening in the city. Receiving feedback from the city shows that the information provided by citizens has been considered and analysed for public safety (Nov, Naaman, & Ye, 2009).

3. *First-hand information*

By reporting public safety issues they observe, citizens will also provide first-hand information to the city. The information regarding public safety is collected immediately after the incident occurs. This will help the municipality gather real-time information and find ways to minimise public safety issues (Halder, 2014).

3.6 Issues concerning participatory crowdsourcing

There are some challenges associated with crowdsourcing public information from citizens. These concerns affect both the citizens as they are the information givers, and

the city responsible for collecting and analysing this public safety information. These concerns include information misuse and low quantity.

1. *Information quality*

In participatory crowdsourcing, citizens willingly provide public safety information. Some of the information they provide might not concern public safety. This will have a negative impact on the city manager's time to process these reports (Hammon & Hippner, 2012). The time taken to process all these invalid reports will negatively affect service delivery or time to receive feedback from the city.

2. *Low quantity*

Crowdsourcing does not guarantee citizen participation because citizens must volunteer public safety information willingly. This, however, affects the safety of citizens because the city will not be aware of the issues that are threatening the lives of citizens.

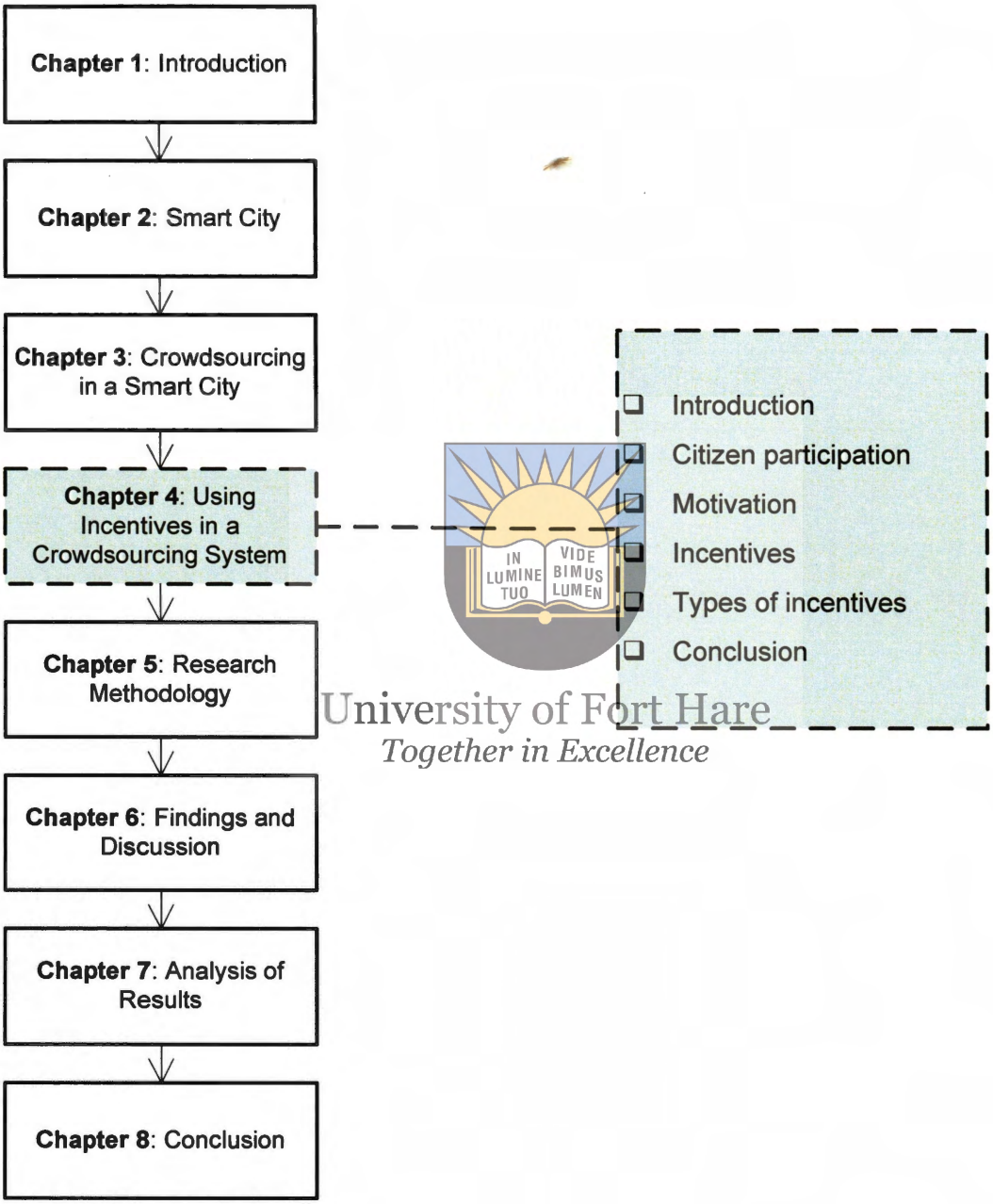
Low quantity can be as a result of low participation from citizens requiring some incentives in return for volunteering public safety information. Other reasons why some citizens do not want to be included in such activities are because they are reluctant to provide public safety information and they feel that the incentives offered may not be enough for the task they have performed, or they do not want to be involved in such activities (Pardupa, 2012). These incentives will be discussed further in the following chapter.

3.7 Conclusion

Crowdsourcing is used for data gathering in a city. Crowdsourcing allows for the crowd to provide public safety information that can be used to assist in emergency needs and provide help to victims in natural disasters, develop new policies, and develop innovative ideas for services in a city. There are two types of crowdsourcing: involuntary and participatory crowdsourcing. Involuntary crowdsourcing makes use of sensors to collect information from the crowd. This type of crowdsourcing has some concerns such as privacy because an individual may not be aware that information about them is being transmitted through sensors attached to their devices. Participatory crowdsourcing views people as sensors and it assists the city to gather public safety

information from citizens. The information collected from participatory crowdsourcing will assist the city and the law enforcement to minimise public safety issues that could threaten the lives of citizens. The next chapter discusses using incentives in a crowdsourcing system.

4 Using incentives in a crowdsourcing system



4.1 Introduction

The previous chapter explained how crowdsourcing can be used by the city to collect public safety information from citizens, with the intention of making more efficient use of limited city resources to improve citizens' quality of life. Thus, citizens need to participate in crowdsourcing projects to provide enough public safety information for the city to make better decisions. However, in order for the crowd to be able to participate, some citizens prefer extrinsic motivation or intrinsic motivation or both.

In order to motivate people, some organisations use incentives as a form of reward to individuals who have participated in their crowdsourcing systems (Rula, Navda, Bustamante, Bhagwan, & Guha, 2014). These incentives can also be used to encourage citizens to provide public safety information they witness to the city, making use of the crowdsourcing applications.

The aim of this chapter is to explain how [illegible]tion will increase citizen participation in a smart city public safety project. In the next section, citizen participation is discussed, explaining how it can be linked to motivation. An explanation of motivation is provided in the following section, as well as the different types of motivators that exist. Next, incentives are discussed, explaining different types of incentives and incentive systems used to distribute the incentives. Lastly, the advantages and disadvantages of using incentives to motivate citizens to provide public safety information are discussed.

4.2 Citizen participation

Participation is the act of taking part in an activity (Nov et al., 2009). The process whereby citizens willingly provide public safety information to the city is known as citizen participation. Holdar, Zakharchenko, and Natkaniec (2002) define citizen participation as "a community based process where citizens organize themselves and their goals in order to work together through non-governmental community organizations to influence the decision-making process" (p.15). People are likely to participate when they are asked to provide information based on their knowledge and abilities (Tomasic et al, 2014). In East London, citizen participation refers to citizens

who participate by providing public safety information to the city making use of a crowdsourcing system.

Citizen participation therefore can be used for various reasons in organisations and communities. In some organisations, citizen participation can be used for assisting and improving scientific research by allowing citizens to provide scientific solutions, monitor animal population, and for city improvement by allowing citizens to provide any information related to the city (Massung, Coyle, Cater, Jay, & Preist, 2013).

Using citizen participation for urban improvement allows the local municipality to collect information from citizens resulting in the development or improvement of the city (Massung et al., 2013). This can be achieved by citizens providing information regarding the safety of citizens, such as public safety issues (crime, accidents and disasters). This public safety information will assist in making the city of East London smarter by using the smart city concept. By using the public safety information provided by citizens to improve the city, the city will ensure that citizens will experience a better quality of life.

According to Kwok, Chui, and Wong (2012), citizens who have reported public safety information are likely to be more satisfied with their actions than those who have not participated. In order to improve satisfaction, citizens should therefore be prepared to work with the city in order to solve issues affecting their quality of life. By providing public safety information to the city, citizens will have increased motivation, as well as a feeling of accomplishment and satisfaction.

Holdar et al. (2002) are of the view that before citizens take part in a crowdsourcing project, they should be educated as to their rights and responsibilities. Educating citizens will provide encouragement for them to provide information about public safety issues they are experiencing in the city.

In order for citizens to participate by providing public safety information, they must make use of crowdsourcing systems. For example, citizens in Hawaii participated by providing public safety reports after an earthquake to the city. The city created a phone line that citizens could use to report any information relating to the earthquake. These

reports helped to inform the city and relevant personnel, such as emergency response teams, to be aware of where assistance was needed.

A further example of where citizen participation was used for public safety was in the Kibera community, Nairobi, Kenya. The community leaders developed a Kibera Map where citizens could provide information about public safety activities that took place in their community (Berdou, 2012). This resulted in a safer community because the community leaders were aware of the issues experienced by citizens and found ways to minimise the challenges.

Braham (2012) discovered that the use of public participation in crowdsourcing assisted in the development of a safer bus stop for citizens in the Next Stop Design project. Next Stop Design is a crowdsourcing model that was developed to gather information and ideas from citizens about a particular bus stop. Citizens were required to sign up to become members and then provide information on past experiences and how to improve the current bus station. Using citizen participation for the Next Stop Design project resulted in a reliable, improved and safer bus station for all citizens.

Nov et al. (2009) developed a model that attempts to explain an individual's willingness to participate in a community by providing or sharing information. This model states that motivation to participate in a community is dependent on an individual's willingness to participate in community issues Nov et al., 2009). This means that the more a person is willing to participate, the more motivated they are. Figure 4-1 illustrates that participation can be achieved by artefact sharing, meta-information sharing, one-to-one connections, and one-to-many connections.

In order to increase the level of participation, the city manager has to find ways to inspire citizens to participate by providing public safety issues they witness. According to Figure 4-1, there are various factors why citizens participate by providing public safety information in a community. These include enjoyment, commitment to the community, self-development, reputation building, and tenure in a community (Nov et al., 2009).

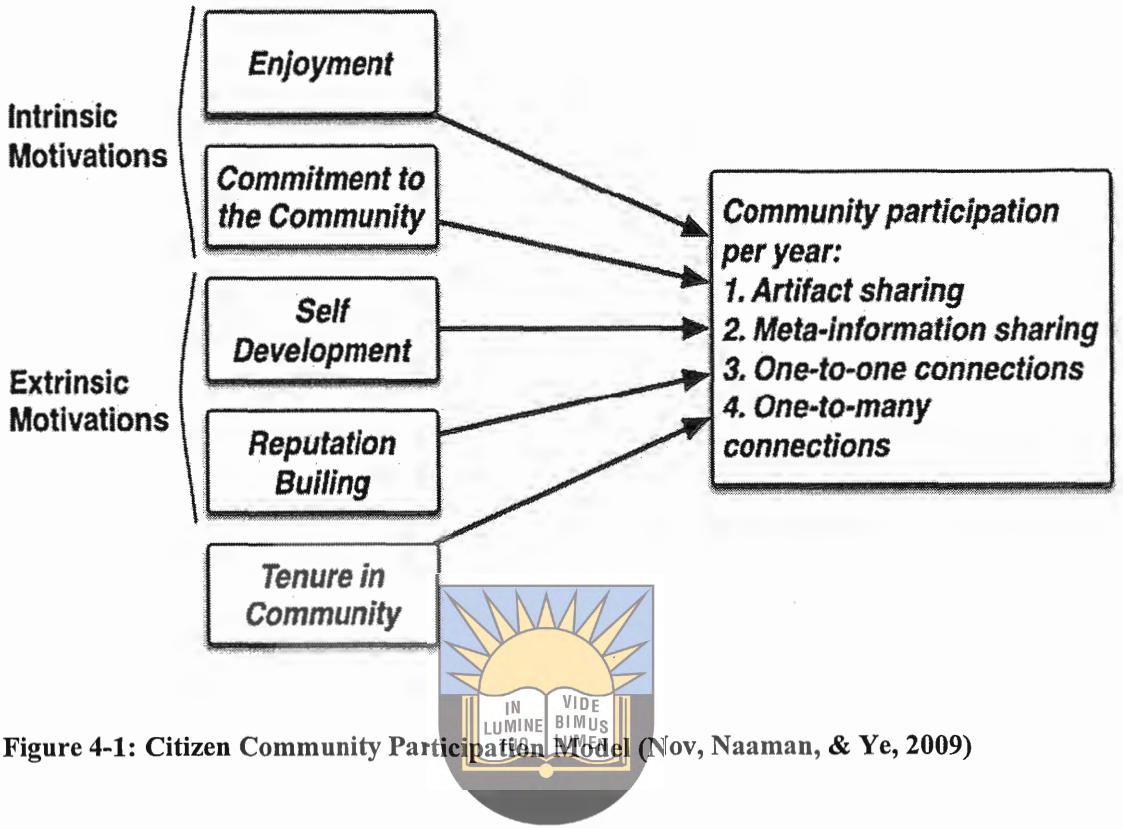


Figure 4-1: Citizen Community Participation Model (Nov, Naaman, & Ye, 2009)

Nov et al. (2009) point out that increased and continuous participation is likely to increase enjoyment for participating in an activity. Enjoyment is one of the most important factors of encouraging citizens to participate in a community (Nov et al., 2009). This is because a person who enjoys performing a task will always participate in that task. This factor includes the satisfaction that a citizen feels when reporting public safety issues to the East London city manager.

Commitment to the community involves the aspiration of the individual to improve the community, as well as ensuring that other community members are living in a safe environment (Nov et al., 2009). A citizen who is committed to their community will participate in a crowdsourcing project in order increase their safety. Furthermore, a committed citizen will make sure they report any public safety issues they witness to the city. Some citizens are even willing to contribute a great amount of time and effort to issues that will improve their community (Massung et al., 2013). This includes investing time to search for issues that are affecting the lives of citizens and reporting these public safety issues to the city.

Some people participate so that they can enhance their self-development and reputation in the community. Self-development focuses on improving the participation skills of an individual in a community Nov et al., 2009). Improving an individual's reputation in a community ensures that a person has developed a higher recognition status than before (Massung et al., 2013). By participating in providing public safety information to the city, some citizens might be focused on improving their status in East London because of the reputation they acquire for taking part in improving the city.

A further reason why some people participate in a smart city project is because they feel that they belong to a community (Nov et al., 2009). In a city, these citizens want to be recognized and find friends who share the same interests as theirs. By participating, these citizens have social interactions with other citizens, thereby creating friendships. These interactions help the citizens feel that they are part of the community (Nov et al., 2009). The next section discusses the benefits of citizen participation.

4.2.1.1 Benefits of citizen participation

Citizen participation provides benefits to both the city and citizens. By allowing citizens to participate in providing public safety information, it allows for two-way communication between citizens and the city (Brabham, 2012). Two-way communication benefits both parties in that the city is able to gather public safety information, and by responding to the information provided by citizens, citizens receive feedback from the city. This feedback may be in the form of communication or by action taken from these reports, which ultimately will improve safety and service delivery in the city (Lourenço, 2010).

Another benefit of citizen participation is that it assists the city to provide transparency in the decision-making process, development of policies, and policy implementation (Holdar et al., 2002). The public safety information that has been provided by citizens will provide a clearer understanding of the public safety issues in the city. This public safety information will be taken into consideration when updating and creating new policies (Brabham, 2012).

These benefits affect both the citizens and the city, and must be experienced so that citizens will continuously provide public safety information. However, in an organisation, employees are motivated either by the nature of their work or by the incentives they are offered after completing their work. Similarly in a city, some citizens are motivated to participate by providing public safety information because of the reward system in place. The next section discusses motivation and how it can be used to encourage citizens to participate by providing public safety issues to the city.

4.3 Motivation

Motivation encourages individuals to perform tasks or activities (Berry, 2003). A person is considered to be motivated when they are excited or inspired to perform in a certain way. An example of motivation would be a student who is motivated to learn new skills in class either to achieve good marks or to gain experience and use skill. However, a person who lacks enthusiasm to complete a task is regarded as unmotivated (Calista, 2009).

The level of motivation varies depending on the person, meaning not every person is motivated by the same item (Gassenheimer, Siguaw, & Hunter, 2013). Therefore, the city must take into consideration that motivation may vary depending on an individual and the tasks to be performed. Thus, the first step is for the city to understand why the crowd is willing to participate in a smart city project (Gassenheimer et al., 2013). This means that the city must first find out what motivates East London citizens to willingly provide information relating to public safety issues in the city.

Motivating citizens to participate in the city is crucial for the success of the public safety crowdsourcing system. Vassileva (2003) is of the view that if there is no participation, the system will not be effective because there is no continuous public safety information collected by the city.

Citizens can be motivated through various types of motivation. The next section discusses the different types of motivation.

4.3.1 Types of motivation

There are different types of motivation that can encourage a person to participate in or contribute to a certain task. These motivations vary in terms of the value they provide and their effectiveness depending on how they are being used (Calista, 2009).

Gassenheimer et al. (2013) categorised types of crowdsourcing motivation into two categories called crowdsourcer motivators and crowd motivators. These categories are further explained in the next section.

4.3.1.1 Crowdsourcer motivators

The crowdsourcer refers to the city. Crowdsourcer motivators focus on factors that motivate the city to gather information from citizens. The crowdsourcer may be motivated for different reasons such as innovation, economic and competitive advantage (Gassenheimer et al., 2013).

Innovation motivators consist of the crowd which are very important as they provide information to the city. In organisations, the crowd is capable of expanding the organisation's knowledge, thereby leading to the development of services Gassenheimer et al., 2013). In a smart city, providing information will assist the city to have an understanding of what the public safety problems are. This will allow the city to make more efficient use of existing resources, and to create new ways to improve the quality of life for citizens.

Economic motivators allow for information to be collected from the crowd at low cost as existing ICT infrastructure can be used (Gassenheimer et al., 2013). The city can gather information at a low cost and use the savings to take care of the public safety issues in the city.

Competitive motivators are more important in organisations. Competitive motivators allow organisations to perform better than their competitors because continuous information gathering from the crowd increases competitive advantage in organisations (Gassenheimer et al., 2013). The next section discusses crowd motivators.

4.3.1.2 Crowd motivators

Crowd motivators focus on motivators that encourage crowd members (citizens) to participate by providing information to the crowdsourcer (Gassenheimer et al., 2013). In a city, the crowd consist of citizens who are willing to provide public safety information to the city. Crowd motivators consist of intrinsic, internalised intrinsic and extrinsic motivators (Gassenheimer et al., 2013). These motivators are further explained in section 4.5.

4.4 Incentives

Incentives are a form of motivation that encourages people to do their best at a particular task. Calista (2009) distinguished the difference between a reward and an incentive. An incentive is something that causes a particular action to happen (Sincero, 2012). An example of an incentive would be money offered to citizens in order for them to provide public safety information. A reward is given after a particular action to increase the chances of that action to be repeated. An example of a reward would be a prize that a student receives for obtaining a high mark for a course and will encourage the student to work hard in order to obtain even higher marks in the future; or in a city, a citizen provides public safety information to the city in order to be awarded airtime.

In this study, an incentive is awarded to individuals who participate by reporting public safety information they witness. An incentive can be defined as "an external reward that will encourage a person to participate in a given task" (Brewer, Hollingsworth, & Campbell, 1995, p. 34). Simply defined, an incentive is a reward that is offered to citizens to encourage them to provide public safety information they observe to the city. These incentives may vary depending on the task to be performed. These can be tangible such as money or gifts, or intangible such as praising someone for completing a task or behaving in a certain way. Incentives will only be rewarded after the task has been completed and only to the person who performed and completed the task (Calista, 2009). In this study, the incentive was offered in the form of airtime to citizens who provided public safety issues they witnessed.

Some organisations make use of incentives to achieve specific goals (Calista, 2009). Sincero (2012) is of the view that in some organisations a reward is used as an incentive to motivate employees to produce the desired outcome (Cherry, 2013). These incentives prevent participants from withdrawing from participation. These incentives can either have a positive or negative impact on individuals.

Positive incentives result in positive satisfaction, thereby motivating people to continue to participate in the project. On the other hand, negative incentives are used as way of punishment or to correct the mistakes of a person in order to produce better results in the future. These categories of incentives can be used in different situations with the aim of encouraging a person's behaviour. In the city of East London, positive incentives are used to encourage citizens to participate in the Public Safety Smart City Project, thus resulting in a better quality of life for citizens.

Some organisations use incentives to elicit employee performance. Wynter-Palmer (2013), however, argues that incentives are not the best way of motivating employees in organisations because workers will only be willing to participate for the rewards they receive after completing a task. Wynter-Palmer (2013) states that an organisation that uses incentives is likely to be negatively affected in terms of production quality, as employees will focus less on the quality of the product and more on completing the task in order to be awarded their incentive. Furthermore, employees may be discouraged to participate in the future if the reward is less than they expected (Wynter-Palmer, 2013). This negatively affects the quality and quantity of public safety information in a city because citizens will only participate to receive the incentive and focus less on the issues. The next sub-section discusses the incentive theory.

4.4.1 The Incentive Theory

The incentive theory is a motivational theory that focuses on rewards and motivation. The theory posits that people are motivated to perform tasks because of external incentives and intrinsic incentives (Cherry, 2013).

Sincero (2012) is of the view that the incentive theory differs from other theories of motivation in that it views the incentive as an item that attracts a person towards it.

This means that in order for East London citizens to participate, incentives have to be offered to encourage citizens to provide public safety information to the city on a continuous basis (Cherry, 2013).

4.4.2 Incentive systems

In order for incentives to be effective, a clear incentive system which shows how the incentive will be distributed have to be developed (Magnusson & Nyrenius, 2011). This indicates that to encourage citizens to participate in the crowdsourcing system, the city of East London has to create an incentive system that will show how incentives will be distributed to citizens who provide public safety information.

Incentive systems are used to ensure that employees perform their best at tasks they take part in (Magnusson & Nyrenius, 2011). The main aims of using incentive systems are for motivating, attracting and retaining participants (Magnusson & Nyrenius, 2011). The incentive system should be able to [illegible] people to participate in the task that is available. The rewards offered should also serve the purpose of attracting new participants and retaining some participants who are in the system already (Magnusson & Nyrenius, 2011). The use of incentive systems in organisations or communities can lead to an increased level of engagement from participants (World Health Professional Alliance, 2008). Therefore, the city will be able to gather information about public safety from citizens as a result of increased level of engagement.

A successful incentive system should allow participants to input information and should be able to motivate the target crowd (World Health Professional Alliance, 2008). There are also other factors that should be taken into consideration in order to have a successful incentive system. These factors include value and time (Magnusson & Nyrenius, 2011).

In organisations, employees feel motivated when the incentive they are awarded is valuable (Magnusson & Nyrenius, 2011). This means that the incentive should be valuable enough to motivate a person to participate repeatedly. The incentive offered to citizens must have a value that will encourage them to report public safety issues, else

they will not be encouraged to participate repeatedly. The incentive can be either intrinsic or extrinsic.

The time factor suggests that after the task has been completed, the incentive should be given as soon as possible (Magnusson & Nyrenius, 2011). This is because an incentive that is given soon after completing a task has the most influence, thus motivating a person to perform repeatedly.

Failure to use these factors could have a negative impact. These include extra costs to the organisation for implementing the incentive system for participants (World Health Professional Alliance, 2008). A city might experience low or no participation if the incentive system is not attractive enough to citizens, and there might not be enough public safety reports.

There are various ways of providing incentives to people for performing tasks. The next section discusses the various types of incentive.

4.5 Types of incentives

There are various types of incentives that can be used to motivate a person to perform a task or an activity. According to the Theory of Incentives discussed in section 4.4.1, there are two types of incentives that can be used to encourage a person's behaviour. These incentives focus on improving a person's performance by using intrinsic or extrinsic incentives (Brewer et al., 1995). Figure 4-2 shows the two major types of incentives.

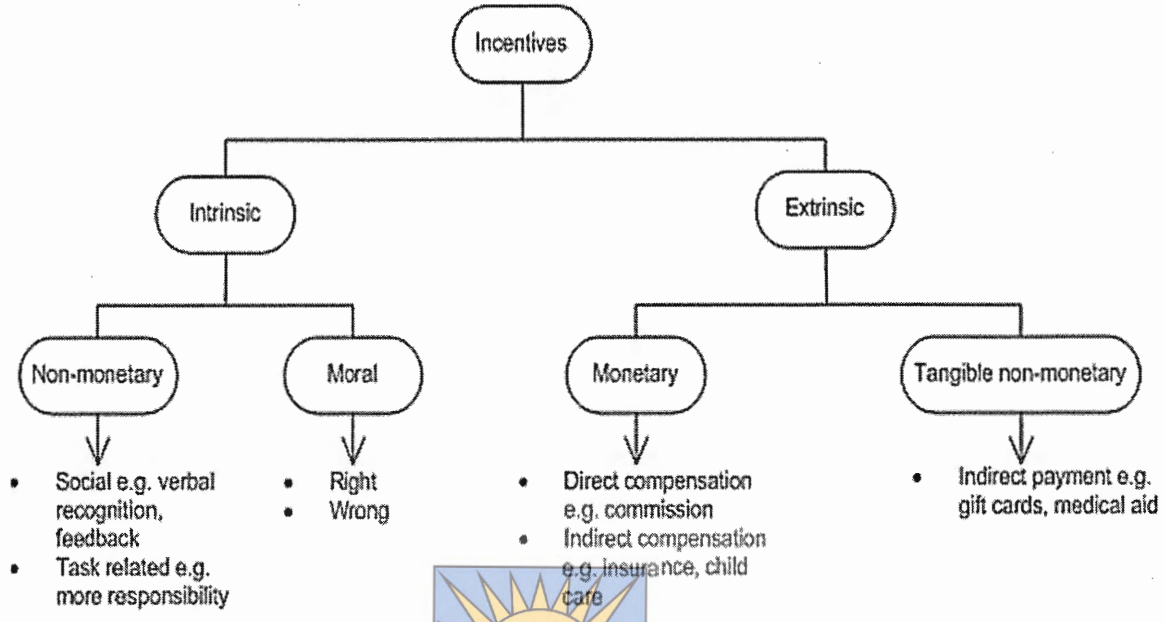


Figure 4-2: Different types of incentives (Brewer, Hollingsworth, & Campbell, 1995)

Literature suggests that intrinsic motivation decreases when extrinsic motivation is used to encourage a person to perform a task. However, other studies argue that the effectiveness of extrinsic motivation varies depending on the kind of intrinsic motivation an individual has (Gassenheimer et al., 2013). The next section further explains these two types of incentives.

4.5.1 Extrinsic incentives

According to Gassenheimer et al. (2013), the crowd may also be motivated by extrinsic motivators, which require an economic advantage such as money or free products from a company. In a community, citizens may be extrinsically motivated by physical incentives such as money or airtime in order for them to provide public safety information.

Brewer el al. (1995) suggest that using extrinsic incentives is more effective than intrinsic because the incentives are always positive. This is because extrinsic incentives focus on linking an individual's performance and external incentives (Brewer et al., 1995). Linking performance and external incentives includes measuring the performance level and the value of the incentive to be offered for the task that was

being performed. Valuable incentives will encourage citizens to continuously participate.

Bhaduri and Kumar (2011), however, argue that extrinsic incentives are conditional based on the availability of the incentive. That means if the incentive being offered is not available or less valuable, people will not participate. Using extrinsic incentives to motivate citizens to participate in providing public safety issues only motivates citizens for a short period of time, thus resulting in limited success in the future.

Examples of these extrinsic incentives include monetary and tangible non-monetary incentives. The effectiveness of these types of incentives will assist by motivating East London citizens to provide public safety information.

4.5.1.1 Monetary incentives

Monetary incentives are also referred to as financial incentives. Monetary incentives enhance an individual's enthusiasm towards the tasks they have to perform, as well as provide recognition after completing a task (Bhaduri & Kumar, 2011). This is because money symbolises achievement and success (Magnusson & Nyrenius, 2011).

The purpose of using monetary incentives is to compensate individuals who have performed a particular task (Lourenço, 2010). Some organisations use monetary incentives as a way of attracting and motivating employees (Narsee, 2014).

Lourenço (2010) is of the view that there is a positive relationship between monetary incentives and performance which will result in completion of tasks. Narsee (2014) further explained that monetary incentives are motivators because they can satisfy the basic needs of people. This is because money is used every day to purchase items that can be used to satisfy the needs and wants of an individual. In a study performed by Massung et al. (2013), data collection from citizens increased because they were receiving money in return. This, however, shows that people were participating in order to be awarded the monetary incentive that was offered.

Therefore the use of monetary incentives will improve an individual's willingness to participate in order to be awarded the incentive (Lourenço, 2010). The next section discusses tangible non-monetary incentives.

4.5.1.2 Tangible non-monetary incentives

Tangible non-monetary incentives are physical incentives which are not in the form of money (Calista, 2009). In a city, citizens who have provided public safety information might be awarded incentives which are tangible but not in the form of money. Examples of these types of tangible non-monetary incentives include indirect payment in the form of airtime, gift cards, medical aid, and transport services.

4.5.2 Intrinsic incentives

Intrinsic incentives are based on the satisfaction a person feels after accomplishing an activity or a task because it is enjoyable (Massung et al., 2013). Intrinsic incentives are not physical because they are based on a person's feelings. Examples of these intrinsic incentives include enjoyment, interest, verbal recognition, feedback, curiosity, and satisfaction.

Intrinsic motivators allow citizens to view their involvement as a way of assisting the city to use resources more effectively, develop relationships with the citizens, and also as a way of enjoyment. Intrinsically motivated citizens are most likely to share information with the public safety crowdsourcing system (Rula et al., 2014).

Berry (2003) is of the view that a person is likely to be more intrinsically motivated if they are performing a more challenging and important task in the organisation. This is because after completing the task, a person feels satisfied for completing a challenging task and the experience that they gain from the challenge. However, some people are more satisfied when they perform tasks which do not require external incentives (Massung et al., 2013). This means that in a city, some citizens obtain their satisfaction from the action of providing public safety information to the city. Thus, external incentives are not required to motivate citizens. This is because citizens are motivated

by the feeling of accomplishment they acquire after reporting public safety issues. Intrinsic incentives are categorised into non-monetary and moral incentives.

4.5.2.1 Non-monetary incentives

Non-monetary incentives are also referred to as non-financial incentives. Non-monetary incentives do not include any cash transactions as a form of motivation (Narsee, 2014). Some organisations have realised that some aspects of the work and the work environment can be enough to satisfy and motivate employees (Berry, 2003).

As illustrated in Figure 4-2, non-monetary incentives can be either social or task-related incentives. Social incentives consist of verbal recognition and feedback. Magnusson and Nyrenius (2011) are of the view that recognising a person's performance and incentivising them is enough to motivate them. Using verbal recognition will increase a person's self-esteem which will motivate them to work harder or to perform the task again (Calista, 2009). Therefore, acknowledging and encouraging a citizen who has provided public safety information increases their self-esteem which will result in motivation and satisfaction.

Providing feedback to people who have performed a task is also a type of social incentive. Providing feedback to a person who is intrinsically motivated is very important. Gassenheimer et al. (2013) noted that if no feedback is provided to a person who is intrinsically motivated, it will reduce their motivation to participate in future. On the other hand, positive feedback to a citizen who has provided public safety information will increase their willingness to provide information again. By providing feedback to citizens, it shows that the public safety information they have volunteered to the city has been analysed and taken into consideration. Providing feedback also assists the city to address issues that were never addressed before (Brabham, 2012).

Task related incentives include more responsibilities, training and participation in decision-making (Calista, 2009). Some people feel motivated and satisfied to work when they have been given more responsibilities. By being able to participate in decision-making, people become intrinsically motivated because they feel more important to be part of the decision-making team.

4.5.2.2 Moral Incentives

Moral incentives motivate people according to their view of what is right or wrong (Collier & Venables, 2014). Some citizens are motivated to provide public safety information because it is the right thing to do in a city. However, as moralities can vary depending on different cultural aspects, these kinds of incentives are dependent on a person's consciousness (Collier & Venables, 2014).

4.5.3 Internalised-extrinsic incentives

Internalised-extrinsic incentives refer to crowds who use their contributions to gain or to improve their reputation in a community with the intention of teaching or influencing other community members (Gassenheimer et al., 2013). In organisations, internalised-extrinsic incentives allow the individual to provide their views on the development of a product or during the product design process, which causes the crowd to have a feeling of ownership and control over the product (Gassenheimer et al., 2013). Similarly in a city, this incentive enables citizens to provide their views on public safety issues to the city. Citizens feel that they have input towards how their safety is managed in the city. This motivator enables the citizens to assist in the running of the city, and also ensures that the desired services regarding public safety are available to all citizens.

4.5.4 Benefits of using incentives

In organisations, using intrinsic incentives will produce high quality output because employees are performing tasks for their own satisfaction (Bhaduri & Kumar, 2011). These intrinsic incentives are also beneficial to communities because they increase individual satisfaction (Calista, 2009). This is because individuals are included in the decision-making process and are also given more responsibilities. This will also provide benefits to the city because motivated and satisfied citizens will continue to provide public safety information.

Using intrinsic incentives to motivate employees in an organisation will help reduce the time of supervision (Calista, 2009). The city will reduce the time for supervising citizens to participate in providing information and use more money on managing the

resources available and improving the quality of life for citizens. Citizens will provide public safety information because they are intrinsically motivated.

Extrinsic incentives assist individuals who have little or no enthusiasm to participate (Brewer et al., 1995). In a city, citizens may not be interested in providing public safety information they witness. Using extrinsic incentives to gather public safety information encourages citizens to participate. This is because some people feel motivated by being awarded a physical incentive in return (Calista, 2009). Therefore, providing extrinsic incentives to citizens will increase citizen participation which results in more public safety information being collected by the city.

4.5.5 Disadvantages of using incentives

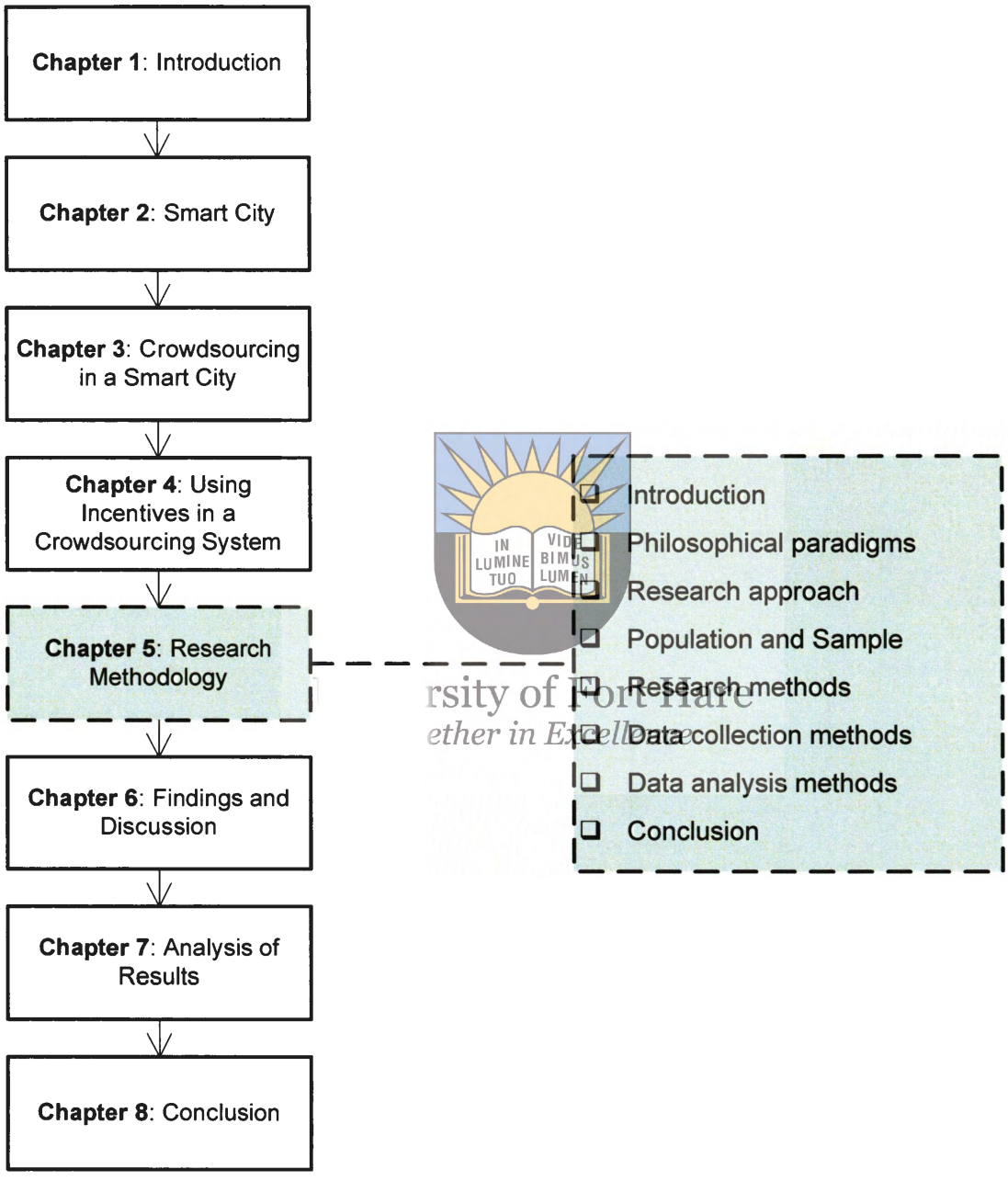
Lourenço (2010) is of the view that using monetary incentives to motivate people will have a negative impact on a person's intrinsic motivation. Monetary incentives may negatively affect people because they [illegible] forming tasks so as to be awarded the incentive in return and not consider the quality of work they produce, as well as their interest and satisfaction when performing. This might also affect citizens of East London by discouraging them in the future because the incentive they received does not equal the amount of effort they used when participating. This will affect the amount and quality of information collected by the city. The information may not be relevant for public safety issues.

4.6 Conclusion

Motivation focuses on encouraging a person to participate in an activity or task. In East London, incentives can be used to encourage citizens to participate by providing public safety information they witness. Increased citizen participation results in more public safety reports collected by the city. In order for the city to gather public safety information from citizens as well as encourage participation, incentives were used. These incentives were used as an incentive to citizens of East London who provided public safety issues they observed to the city. According to the incentive theory, there are two types of incentives: intrinsic and extrinsic. Intrinsic incentives are linked to internal desires of a person. This includes doing something because it is interesting and

enjoyable. Examples of intrinsic incentives include recognition, feedback and morals. Extrinsic incentives are physical incentives that trigger citizens to participate, such as money, gift cards and airtime. Therefore, in order to be successful with incentives, a developed incentive system should be rewarding to citizens. The incentive system should cater for both extrinsically and intrinsically motivated citizens. An incentive system provides a clear understanding of how the incentives will be distributed to citizens who have provided public safety information. The next chapter discusses the research methodology.

5 Research Methodology



5.1 Introduction

This chapter will explain the research methodology used in this study. According to Collis and Hussey (2009), research methodology is defined as "an approach to the process of the research encompassing a body of methods" (p.17). This includes the research methods that were used to collect public safety reports from citizens in East London in order to create an effective crowdsourcing system that allows for continuous public safety data collection.

This research methodology chapter is divided into various sub-sections. The first section will explain the different philosophical paradigms in information systems (IS) research, as well as the underpinning philosophical assumptions. These assumptions include the nature of reality (ontology), knowledge (epistemology), and value (axiology) (Collis & Hussey, 2009). The paradigm used for this research is then further discussed in the following section. Section 5.5 discusses the inductive approach used in this study. The research methods section follows, which discusses the data collection and data analysis methods used in this study. Lastly, ethical considerations followed by this research are discussed.

5.2 Philosophical paradigms

A paradigm contains the framework, assumptions, values and beliefs in which a study is carried out (Joubish, Khurram, Ahmed, Fatima, & Haider, 2011). According to Collis and Hussey (2009), a paradigm is "a framework that guides how a research should be conducted based on people's philosophies and their assumptions about the world of knowledge" (p.17). Some of the philosophical paradigms that can be used when conducting information systems research include: positivist, interpretivist, and critical paradigm. Hevner, March, Park, and Ram (2004) also introduced another paradigm that is used in an information systems research called design science. These paradigms are further discussed in the next section.

5.2.1 Positivist

The positivist paradigm states that reality exits in itself and it views the world as independent of human beings, the researcher's beliefs and personal values (Oates, 2006). This paradigm can therefore be considered as objective in nature.

The main goal of this paradigm is to discover theories based on experimentation and observation (Collis & Hussey, 2009). The positivist paradigm seeks to identify, measure and evaluate any study and to provide a logical explanation for the results, as the researcher makes discoveries by observing and producing models (Oates, 2006). The next section discusses the interpretivist paradigm.

5.2.2 Interpretivist

The interpretivist paradigm is concerned with the understanding of the behaviour of participants from their world (Neville, 2007). Unlike the positivist paradigm, the interpretivist paradigm states that researchers are not neutral; they use their beliefs, people's perceptions or values to shape the research process (Oates, 2006). This makes the research somewhat subjective (Collis & Hussey, 2009).

Interpretivist paradigm can be defined as a study that is focused on providing an understanding of the social context of an information systems research (Oates, 2006). This paradigm assumes that it is necessary for the researcher to undertake research among people in order to understand the differences between people in their communities (Saunders et al., 2007). Oates (2006) summerised the characteristics of an interpretivism paradigm as:

- multiple realities;
- a dynamic socially constructed meaning;
- studying of people in their natural social setting, and
- multiple interpretations.

The next section discusses the critical research paradigm.

5.2.3 Critical research

The critical research paradigm is less popular than interpretivist and positivist paradigms in the information systems field. Critical research is defined as a paradigm that focuses on "identifying power relations, conflicts and contradiction, and empowering people to eliminate them as sources of alienation and domination" (Oates, 2006, p. 296). The critical research paradigm views reality as historically constituted and is produced by people. This paradigm is characterised by emancipation, critique of tradition and critique of technological determination (Oates, 2006). The next section discusses the design science paradigm.

5.2.4 Design Science

The fourth paradigm used in information systems research is called design science. According to Hevner et al. (2004), design science is a paradigm that seeks to extend human boundaries by the creation of new artefacts. In order to create an artefact, design science consists of two activities: build and evaluate (Hevner et al., 2004). The building process is aimed at constructing an artefact for a particular reason, and the evaluation process determines how well the artefact performs (March & Smith, 1995).

The philosophical background of a study affects the way it is conducted. The philosophical assumptions of paradigms include ontology, epistemology and axiology (Collis & Hussey, 2009). Ontology describes the nature of the reality of the world, epistemology explores the knowledge, and axiology focuses on the values provided by the research (Wahyuni, 2012). Table 5-1 provides a comparison of these philosophical assumptions for the four paradigms discussed in section 5.4.

Table 5-1: Philosophical assumptions of paradigms (Collis & Hussey, 2009; March & Smith, 1995)

Paradigm	Ontology	Epistemology	Axiology
Positivist	Reality is objectively given and is measured using tools/objects that are independent of the researcher and his/her instruments.	Researcher is independent of what is being researched.	Research is value-free and unbiased.
Interpretivism	Reality is socially constructed and there are multiple realities due to different human experiences.	Researcher interacts with what is being researched.	Research has value and biases are present.
Critical research	Reality is independent of human thoughts/belief/knowledge of the existence, but is interpreted through social conditioning.	Researcher interacts with what is being researched with focus on explaining the context.	Research is value laden, meaning the researcher is biased by world views, cultural experiences and upbringing.
Design science	Multiple realities.	The deeper understanding of the information leads to the development of an artefact.	Researcher values control over the environment and must have high tolerance for ambiguity.

Positivist researchers view reality as a concrete structure which is objectively given, whereas interpretivist researchers view reality as a projection of the human imagination (Collis & Hussey, 2009). As illustrated in Figure 5-1, this study is in-between these two paradigms, positivist and interpretivist, but leans more to the interpretivist side because reality is viewed as a realm of symbolic discourse.

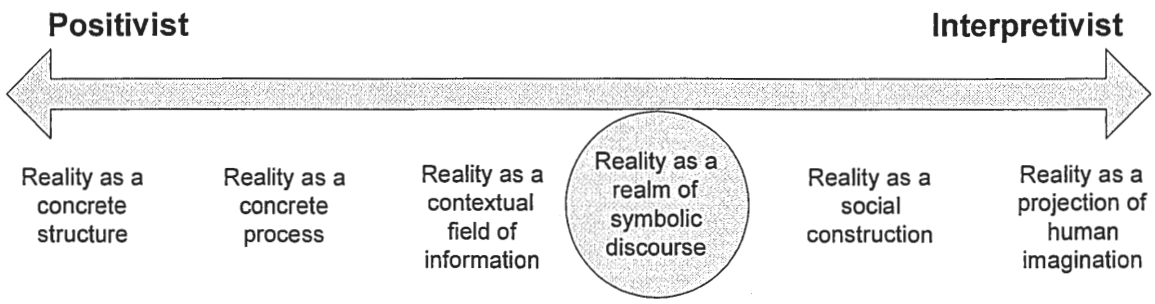


Figure 5-1: Continuum of ontological assumptions (Collis & Hussey, 2009)

This study assumes that reality is transmitted from the public safety information provided by citizens of East London.

There are various factors that are considered when choosing the right paradigm for a study. Oates (2006) mentioned that the choice is dependent on the nature of the research question and personal beliefs or values of the researcher. This research project used the interpretivist paradigm, in which reality is viewed as a contextual field of information (see Figure 5-2). Interpretivist paradigm focuses on a deeper understanding of what is being researched (Collis & Hussey, 2009). This study assumes that reality is transmitted from the public safety information provided by citizens of East London. However, although the interpretive paradigm states that clear understanding of what is being researched involves the use of language, this research project also consists of quantitative data that was collected making use of a questionnaire and it will be analysed in order to support observation, conversational analysis and literature findings.

5.3 Research approach

There are various approaches that can be used when conducting research; inductive and deductive are the most common. The deductive approach includes the use of existing theories from literature. Collis and Hussey (2009) define deductive approach as "the development of a conceptual and theoretical structure which is tested by empirical observation" (p.8). The inductive approach provides a better understanding to the nature of the problem. Collis and Hussey (2009) further describe inductive research as "a study in which a theory is developed from the observation of empirical reality; thus

general inferences are induced from particular instances" (p.8). Table 5-2 provides a summary of the two research approaches.

Table 5-2: Research Approaches (Saunders, Lewis, & Thornhill, Research Methods for Business Students, 2007)

	Deductive	**Inductive**
Logic	When premises are true, the conclusion must be true	Known premises are used to generate untested conclusions
Generalizability	General to specific	Specific to general
Theory	Theory falsification or verification	Theory generation and building

This study makes use of the inductive approach which moves from a particular situation to developing a theory (Saunders et al., 2007). This is because this research project aims to propose a model to ensure a continuous public safety data flow from East London citizens to the city.

5.4 Population and sample

Population refers to a set of people who are under consideration (Collis & Hussey, 2009). The population for this particular study involving incentives consists of citizens of East London who have registered on the project's website. Thus, the population size for this study on incentives consists of 91 participants who have registered on the project's website.

A research sample consists of a group of participants from the entire population that has been selected to participate in the research project (Oates, 2006). Collis and Hussey (2009) are of the view that a sample must be chosen carefully in order to ensure that it is unbiased. The Raosoft calculator was used to calculate the sample size to be used by

using the citizens of East London who registered on the project website. The sample was calculated using the population size for this study, with a margin of error of 5% and a confidence level of 95% (Raosoft, 2004). Therefore, the convenient sample of this study consists of 74 citizens. The next section discusses the research methods.

5.5 Research methods

The main aim of this study is to create a model that will allow continuous data collection from citizens in East London. A research method refers to the tools that are used for collecting and analysing data in a research project (Collis & Hussey, 2009). These methods include mixed methods, quantitative and qualitative methods.

5.5.1 Mixed methods

The mixed methods approach is whereby qualitative and quantitative methods are combined together to complement each other (Bates, 2006). This study used a mixed method approach to gather and analyse data. Combining these two methods for collecting data allows for quantitative data to build upon qualitative data in order to obtain the desired result (Gay, 1976).

There are different mixed methods designs that can be used to collect data in an IS study. These designs include convergent, explanatory, embedded, transformative, multiphase and exploratory (Creswell, 2011). Figure 5-2 illustrates the mixed method design that was used for this study.

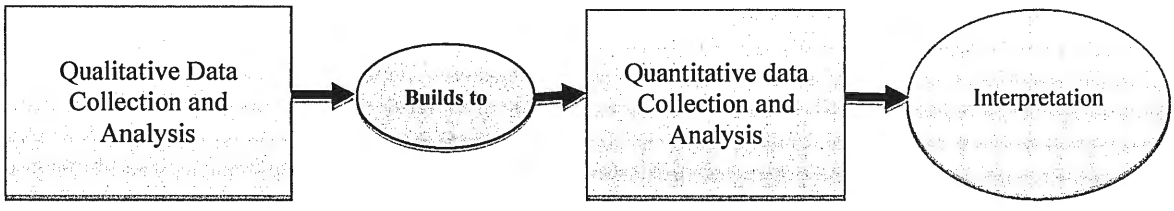


Figure 5-2: Exploratory Design

This study uses the exploratory design which allows the researcher to collect data and analyse it in two phases. Qualitative data is collected and analysed first, building to quantitative data which is collected and analysed in order to test / generalise initial findings (Creswell, 2011). In this study, qualitative data was collected first from literature review, conversational analysis and observation of research project. A questionnaire was constructed in order to assess public safety information. The next section further explains the methods used for collecting data and how data was collected for this study.

5.5.2 Quantitative methods

Quantitative methods are mainly used in positivist paradigm, focusing on testing a theory and hypothesis and making it a more objective method than qualitative data gathering methods (Goldkuhl, 2012). Quantitative methods collect numeric data which can be measured. The aim of using quantitative methods is to collect data in an attempt to explain what is being observed (M & Headlam, 2009). This method uses structured data collection and is based on numbers and mainly generated by questionnaires, experiments and surveys (Oates, 2006). Quantitative data used in this study was collected from questionnaires. These methods are further discussed in section 5.6.

5.5.3 Qualitative methods

Qualitative methods are mostly used in an interpretivist paradigm. These methods collect data as descriptive data and, unlike quantitative data which makes use of statistical and numeric data, cannot be measured precisely (Goldkuhl, 2012). Qualitative methods are exploratory and are used to obtain a detailed description of what is being observed (MacDonald & Headlam, 2009). The data collected is analysed using the interpretative approach, therefore this method is used when there is no intention of statistically analysing data (Collis & Hussey, 2009). Qualitative data was collected from literature review, observation of research project and conversational analysis. These methods are further discussed in section 5.6.

5.6 Data collection methods

When conducting research, data is collected in two forms: primary and secondary data. Primary data is data that has been generated from the original source, for example questionnaires, interviews or experiments (Collis & Hussey, 2009). Primary data is collected for the purpose of a specific study (Driscoll, 2011). Primary data collection methods to be used for this study include both qualitative and quantitative methods. Secondary data is data that has been collected from an existing source for a different purpose (Collis & Hussey, 2009). Examples of secondary data include databases and published journals.

Oates (2006) is of the view that using different types of data collection allows the data gathered to be compared and analysed. Therefore, this study will make use of both types of data collection. The next section discusses the data collection methods used for this study.

5.6.1 Primary data collection methods

This section discusses the primary data collection methods that are used for this study. These include questionnaires, observation of the prototype, and conversational analysis.

5.6.1.1 Questionnaires

Questionnaires may be used to collect data in both positivist and interpretivist studies, with the aim of understanding how participants feel in a particular situation (Collis & Hussey, 2009). The questionnaire can be either close or open-ended, depending on the research being undertaken.

A questionnaire was constructed from literature, conversational analysis, and observations of the prototype. An Internet-mediated close-ended questionnaire was sent to the population sample of 74 citizens who registered on the project website. The main objective of distributing this questionnaire was to find out from the citizens, who reported public safety issues, how the incentives affected their willingness to participate in the project.

5.6.1.2 Observation of research project

The observation method allows for a researcher to collect data by making observations during the study. The observation can be in either a natural or laboratory setting (Collis & Hussey, 2009). Collis and Hussey (2009) are of the view that observations can be conducted in two ways: non-participant or participant. In non-participant the researcher is not involved, whereas in participant the researcher is fully involved.

In this study, observations were done through the testing of the crowdsourcing system, whereby citizens made reports using the Public Safety Smart City project toll-free phone number to report public safety issues they witnessed. Citizens also provided public safety reports using the project's mobi-site that was created for those with access to the Internet. This crowdsourcing system is referred to as the prototype.

5.6.1.3 Conversational analysis

Data can be collected from social interactions (formal or non-formal), known as conversational analysis (Bijana, Flowerday, & Shah, 2011). Several meetings were held throughout the study. This is the data being collected from the feedback that was presented in the various meetings held. In this project, experts in the field of mart cities were invited to provide feedback on the prototype and the model. The feedback assisted in the development of the questionnaire, as well as the refinement of the model.

5.6.2 Secondary data collection methods

Secondary data can be either qualitative or quantitative data. Saunders et al. (2007) categorised secondary data into three different types: documentary, survey-based and multiple-source data. This study used the documentary data include written material (such as journal articles, notices or meeting minutes) and non-written material (such as voice, videos, pictures or drawings) which can be used to provide both qualitative and quantitative data. This study used written data obtained from journal articles to assist in the refining of the model for this study. The next section discusses data analysis methods.

5.7 Data analysis methods

Data analysis involves interpretations from the raw data that has been collected (Wahyuni, 2012). The data collected by the methods mentioned in section 5.8.1 must be analysed in order to identify patterns (Oates, 2006). These analysis methods are explained in the following sections.

5.7.1 Primary data analysis methods

The data from questionnaires will be analysed using descriptive statistics. Descriptive statistics makes use of graphs, tables or charts to represent data. Inferential statistics made use of Somer's *d* and Spearman's correlations, which were used to determine the relationship and strength of variables (Pallant, 2010). This makes it easier for the researcher to interpret the data.

5.7.2 Secondary data analysis

Secondary data will be analysed using the inductive logic which determines what conclusions can be derived from the data that is available (Trochim, 2006). Relevant literature and theories relating to this study will be reviewed thoroughly to determine if there is an agreement or disagreement between the theory and the conclusion.

5.8 Ethical Considerations

This section discusses ethical issues that should be considered, as well as ethical responsibilities towards the citizens who provided information to increase public safety in East London. To be an ethical researcher, Oates (2006) emphasised that researchers should not force participants into participating in the research, and they should respect the participant's expectations of anonymity. Ethical approval was granted by the University Research Ethics Committee (UREC). The following applies to this study:

- Willingness to participate – Citizens were not forced to participate in this research.
- Accessibility – The public safety information provided by citizens is only accessible to the responsible people (the researchers involved in the smart city project and their supervisors).

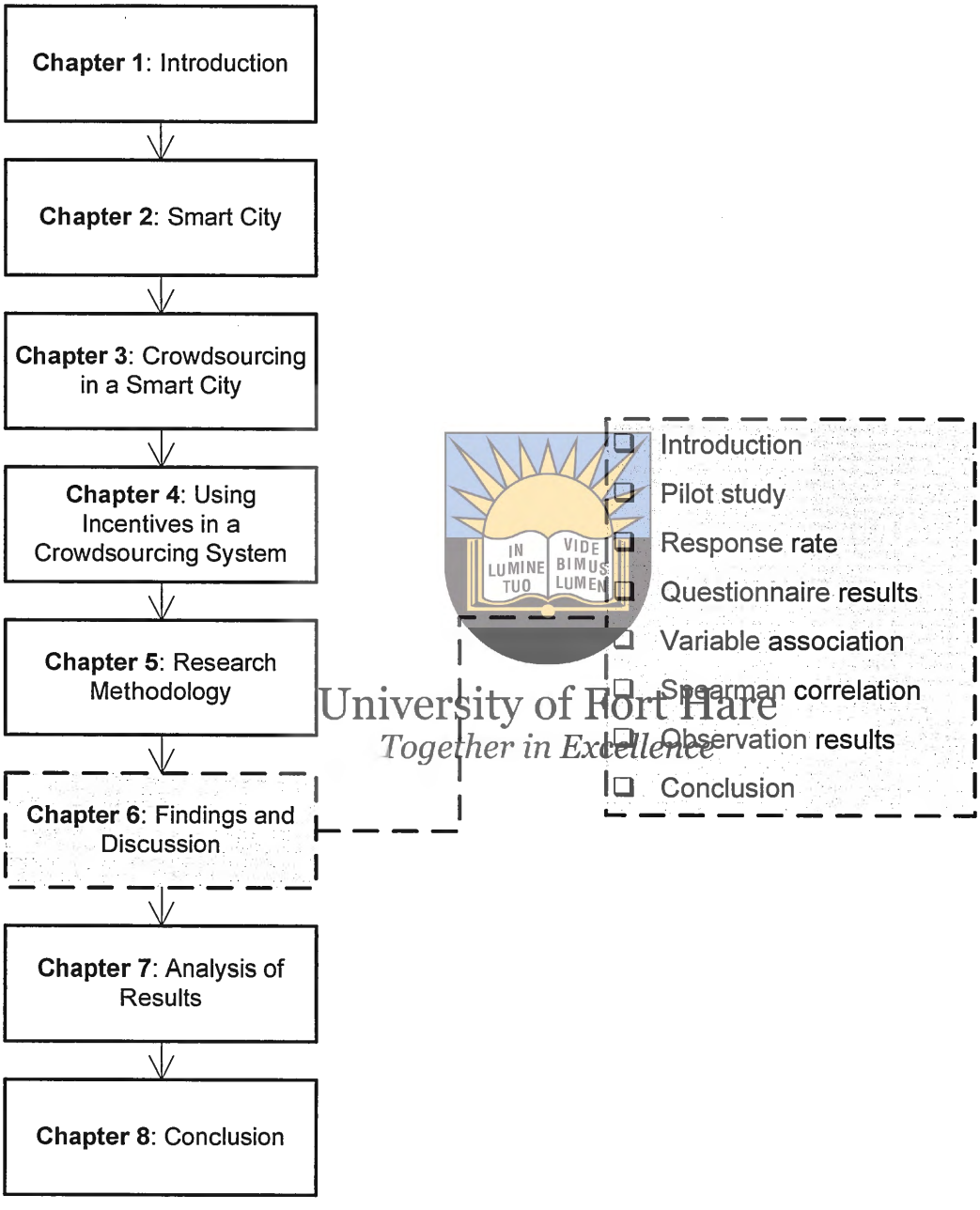
- Anonymity – The participants have the right to anonymity which means that their identity and location remain protected and may not be disclosed without their approval.
- Accuracy – Data provided was recorded accurately; no alterations or additions were made.
- Security – The data that the citizens provided is kept safe and secure.
- Use of data – The collected data is only used for the smart city public safety project and will not be used for any other purpose.

5.9 Conclusion

This chapter discussed the research methodology followed by this study. First, four philosophical paradigms used in an information systems research were briefly discussed in order to align with the appropriate paradigm for this study. These four paradigms include: positivist, interpretivist, critical, and design science. This study used the interpretivist paradigm.

The problem addressed by this study is that there is no effective participatory crowdsourcing system that allows for continuous data collection from citizens. The sample consists of East London citizens who willingly volunteered public safety information. Public safety information was collected using primary data collection such as questionnaires, observation of the pilot study and secondary data collected from literature. The data collected was analysed using a SPSS and inductive logic. The next chapter presents the findings.

6 Findings and Discussion



6.1 Introduction

Chapter 5 presented the research methodology followed in this study, including the data collection and analysis methods. Data was analysed making use of SPSS version 22, descriptive statistics (mean, median), and frequency tables. This chapter will provide an overview of the findings for this study. The discussion of the research findings will be done in the next chapter (Chapter 7).

This chapter consists of a brief discussion of the pilot study, an explanation of the response rate, and a discussion of this study's research instrument; a questionnaire will be provided next. Section 6.4 presents the findings obtained from the questionnaires in the form of figures and tables. The discussions of the findings obtained from the Chi-square test and Pearson correlation coefficient follows in sections 6.5 and 6.6. Section 6.7 presents the findings from observations, and the last section provide a discussion of conversational analysis findings. The next section discusses the pilot study.

6.2 Public Safety Smart City Project

The Public Safety Smart City Project awarded participants who reported public safety issues they witnessed. The team agreed that awarding each participant an incentive of R10 for a completed report would be appropriate on the basis that if a participant was using airtime to make a report, they would have spent less than R10 airtime on a report. This incentive being offered would encourage continuous participation and more citizens to provide public safety issues.

6.3 Pilot study

A pilot study was conducted in order to validate the questionnaire for user friendliness and ease of use. Team members took part in the pilot study to test and provide feedback, which was taken into consideration and included in the final questionnaire.

6.4 Response rate

As mentioned in the previous chapter, the population of this study consists of 91 citizens who registered and participated in the Public Safety Smart City Project. From these 91 citizens, 74 participants responded to the questionnaire. Thus, the response rate for this study is 81.3%. According to Wenemark, Vernby, and Norberg (2010), a response rate of more than 50% is considered acceptable. The response rate for this project was considered to be acceptable because it was higher than 50%. The reason for such a high response could be that people would like to improve the quality of life in the city they live by reporting public health issues to the crowdsourcing system. The other reason that could motivate citizens to participate in the project could be the airtime incentive which was awarded to a participant who submitted a complete public safety report. Another reason could be that a convenience sample was chosen and people wanted to participate in the project.

From the 74 questionnaires that were [illegible] only 61 were found to be complete. In other words, 17.5% of the questionnaires collected could not be used. The reason for this percentage could have been that some participants found the questionnaire to have too many questions and therefore found it too long to complete. The questionnaire was hosted online and technical problems, such as poor network connectivity or slow processing devices, could have influenced the completion rate of the questionnaires. The next section discusses the findings obtained from the questionnaire.

6.5 Questionnaire findings

This section presents the findings of this study. The findings have been categorised as follows: demographics (age and gender), thoughts on the crowdsourcing system, intrinsic incentives, and internal extrinsic and external incentives. In the next section, age and gender are presented in the demographics.

6.5.1 Demographics

The demographics of the respondents consist of age and gender. This study population consisted of 54.1% female and 45.9% male participants. There was not a big difference

between female and male participants. This implies that that there was equality in terms of participation between males and females. Both males and females were aware of the Public Safety Smart City Project, and therefore reported issues they witnessed. Figure 6-1 illustrates these findings.

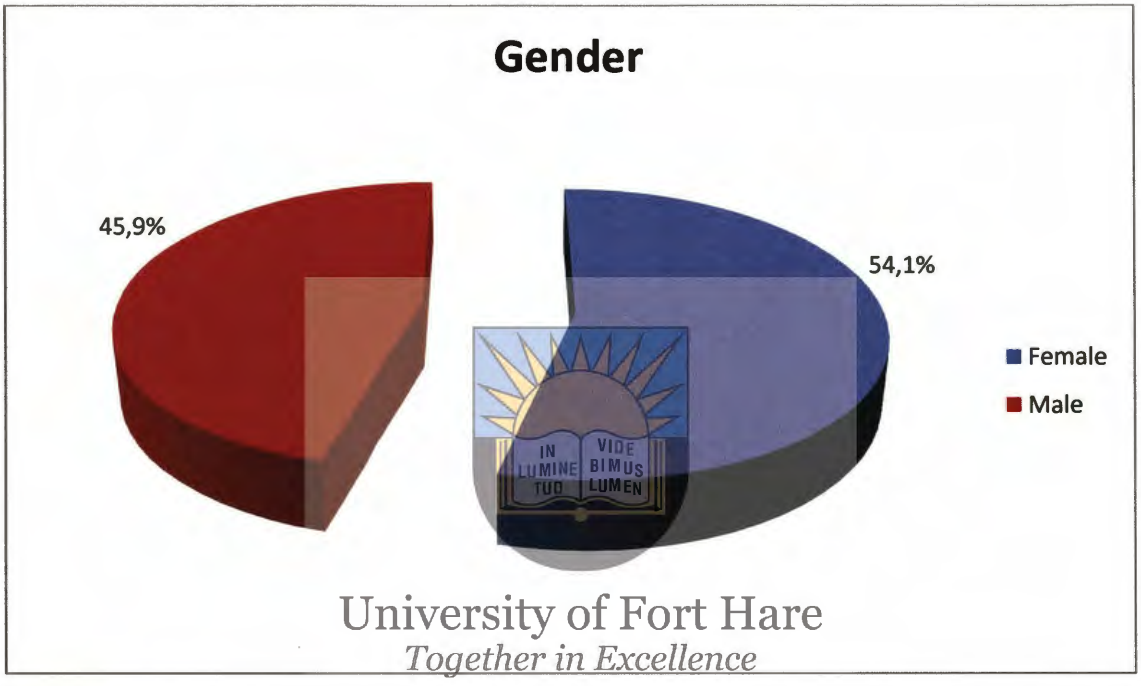


Figure 6-1: Gender

The age groups were divided into two categories: under 30 years of age and over 30 years of age. The distribution shows that the first group had the most participants (72.1%), while the latter group only had 27.9% of the participants. The age groups of participants are presented in Table 6-1.

Table 6-1: Participants age group

Age Group	**Frequency (n)**	**Percentage (%)**
Under 30	44	72.1
Over 30	17	27.9
Total	**61**	**100.0**

This section only provided the demographic details of participants. The next section presents findings obtained from the crowdsourcing questions.

6.5.2 Thoughts on the Crowdsourcing system

The first item requested participants to indicate whether the public safety project was a useful way to act on issues that may pose personal risk to them. Most participants found the public safety project to be a helpful way of reporting issues they observe in the city. Findings indicate that majority of participants (59%) strongly agree that calling the public safety project line helps to report issues that impose risk on their lives, while 36.1% of the participants indicated they agree with the statement, and 4.9% of the participants did not have an opinion on the matter. These findings are illustrated in Table 6-2 below. The mean for this question was 1.46 (Strongly agree) and the median was 1.

Table 6-2: Useful way to act on public safety issues

Response	Frequency (n)	Percentage (%)
Strongly Agree	36	59
Agree	22	36.1
Neutral	3	4.9
Total	61	100

Participants were asked if they found the Public Safety Smart City Project to be useful for reporting issues. The majority of the participants (52.5%) agreed that the project was useful, while 45.9% indicated that they strongly agree with the statement, and 1.6% of the participants were neutral. This clearly indicates that participants found the system to be useful for reporting public safety issues that place their personal lives at risk. Table 6-3 presents these responses made by participants. The mean for this question was 1.56 (Strongly agree) and the median was 2.

Table 6-3: Usefulness of the project

Response	Frequency (n)	Percentage (%)
Strongly Agree	28	45.9
Agree	32	52.5
Neutral	1	1.6
Total	**61**	**100**

Participants were requested to provide how many times they reported public safety issues they witnessed in the city. Table 6-4 presents the number of reports made by participants per week. Majority of participants (70.5%) indicated that they reported public safety issues 0-2 times per week, while 26.2% reported 3-4 times, and 3.3% indicated they reported more than 5 times per week. This indicates that people are concerned about their safety and therefore participated in the project. The mean for this category was 1.33 (Strongly agree) and the median was 1.

Table 6-4: Number of reports made per week by participants

Number of reports	Frequency (n)	Percentage (%)
0-2	43	70.5
3-4	16	26.2
5+	2	3.3
Total	**61**	**100**

This section presented findings from the crowdsourcing questions. The next section presents findings obtained from the several Likert questions.

6.5.3 Incentives of the Crowdsourcing System

The first item on this category asked participants if they would report public safety issues every day in the future. As illustrated in Figure 6-2, the majority of participants agreed with this statement (55.7%). This clearly indicates that most participants are willing to contribute public safety information to the participatory crowdsourcing project so as to improve their quality of life by making the city smarter. The mean for this question was 2.46 (Agree) and the median was 2.

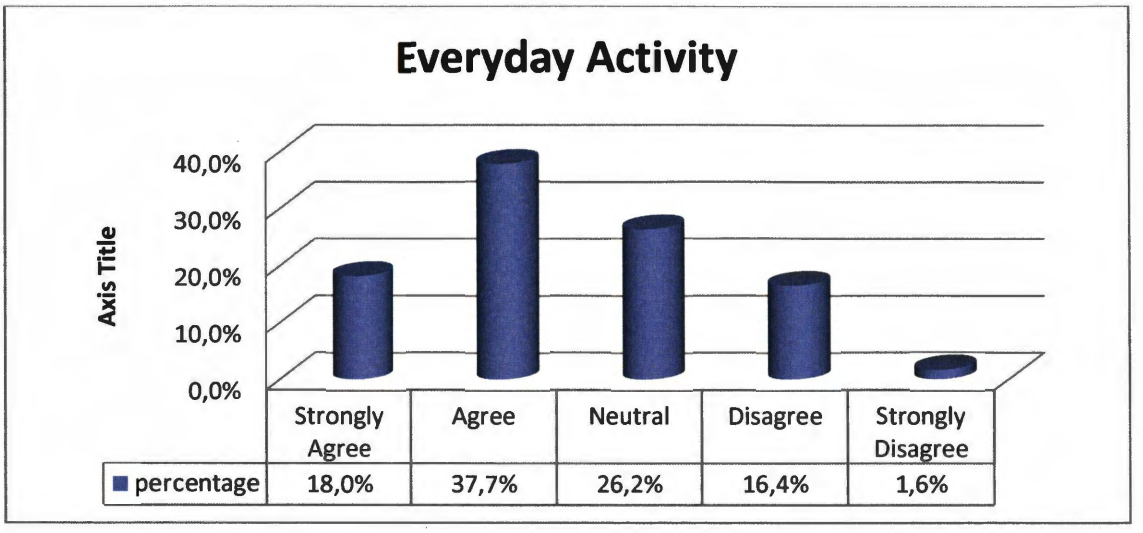


Figure 6-2: Participation as an everyday activity

Participants were asked if they would have reported public safety issues if incentives were not offered. The findings indicate that most participants (83.6%) would have reported public safety issues even if they were not rewarded the incentive. It can be concluded that most participants were driven by intrinsic motivation in order to have a better quality of life in the city. Table 6-5 depicts these findings.

Table 6-5: Participating for Other Incentives

Response	Frequency (n)	Percentage (%)
Yes	51	83.6
No	1	1.6
Maybe	9	14.8
Total	**61**	**100**

Participants were asked how fair the incentive offered for this project was. Majority of the participants (45.9%) strongly agreed that airtime was a fair incentive. This question had a mean of 1.8 (Strongly agree) and a median of 2. The findings for this item are provided in Table 6-6.

Table 6-6: Incentive Fairness

Response	Frequency (n)	Percentage (%)
Strongly Agree	28	45.9
Agree	21	34.4
Neutral	9	14.8
Disagree	2	3.3
Strongly Disagree	1	1.6
Total	**61**	**100.0**

Participants were asked how quickly they expected to receive the incentive for reporting public safety issues. The findings (refer to Table 6-7) indicate that 47.5% of the participants would prefer to receive the incentive anytime, 18% of the participants indicated they would prefer being awarded just after the report, and 34.4% indicated sometime later. It can be concluded that the majority were not concerned about the time it takes to be awarded the incentive. The mean for this question was 2.30 (Agree) and the median was 2.

Table 6-7: Awarding of Incentive

Response	Frequency (n)	Percentage (%)
Just after the report	11	18.0
Sometime later	21	34.4
Anytime	29	47.5
Total	**61**	**100.0**

Participants were asked what type of incentives they expected to be rewarded after providing public safety reports. The findings indicate the smallest percentage preferred money (19.7%), while intrinsic incentives such as feedback and feeling of accomplishment recorded 32.8% and 23.0% respectively. These findings are presented in Table 6-8. From these findings it can be concluded that the majority of participants provided public safety issues for intrinsic factors.

Table 6-8: Incentive Type

Incentive type	Frequency (n)	Percentage (%)
Money	12	19.7
Airtime	15	24.6
Feeling of accomplishment	14	23.0
Feedback	20	32.8
Total	**61**	**100.0**

Intrinsic rewards

Participants were asked what factors motivated them to participate in the Public Safety Smart City Project. Participants had the option of choosing more than one option. Majority (82%) indicated that they reported in order to make a difference in the community. The other factor was to receive feedback about the public safety issues they reported from the city. The findings demonstrate that 34 out of 61 (55.7%) indicated that they reported in order to receive feedback. This question had a mean of 1 and a median of 1. These findings are depicted in Figure 6-3.

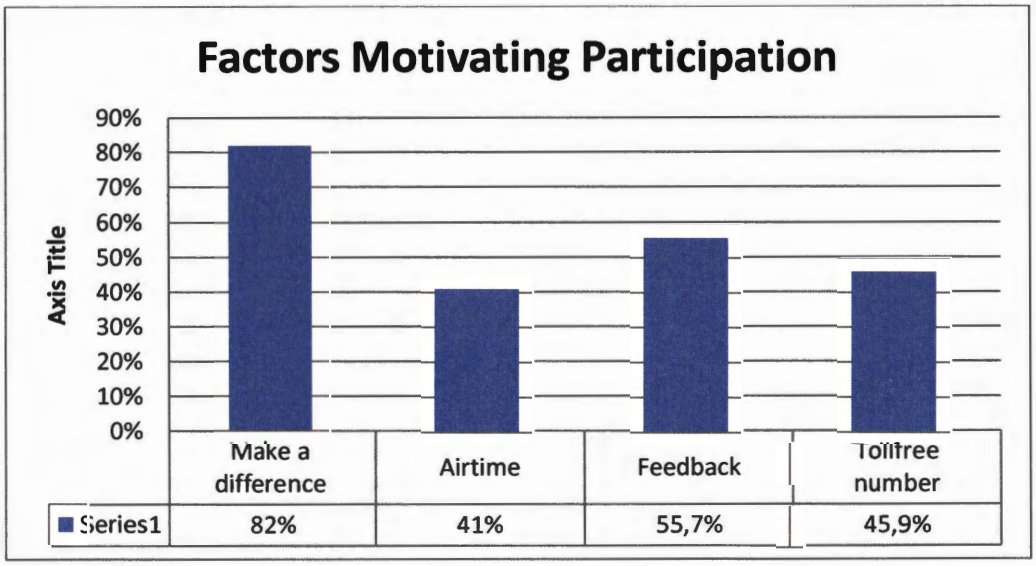


Figure 6-3: Factors Motivating Participation

Participants were asked if they were concerned for the safety of other citizens. The findings indicate that most of the participants were concerned for the safety of other citizens. Table 6-9 presents that the largest number of participants (91.8%) agreed that

they were concerned for the safety of other citizens, while 6.6% of the participants indicated they were not sure (maybe), and 1.6% of participants indicated that they were not concerned about the safety of other citizens. This question had a mean of 1.11 (Strongly Agree) and a median of 1.

Table 6-9: Concern for safety of other citizens

Response	Frequency (n)	Percentage (%)
Yes	56	91.8
Maybe	4	6.6
No	1	1.6
Total	**61**	**100.0**

Internalised Extrinsic Rewards and Extrinsic Rewards

Some of the participants were motivated by internalised extrinsic incentives. A person who has internalised extrinsic motivation participates in an activity to encourage and influence citizens to participate in the community in order to make a difference (Gassenheimer et al., 2013). On the other hand, some were motivated by extrinsic incentives, which are physical items that encourage citizens to take part in an activity (Bhaduri & Kumar, 2011).

As presented in Table 6-10, findings indicate that 54.1% of participants will always report public safety issues, 31.1% of participants indicated that they will report public safety issues most of the time, 11.5% of participants will provide these issues half of the time, and only 3.3% will provide public safety issues once in a while. This shows that most participants are concerned about public safety issues in the city and therefore they will reduce them by reporting any information they observe, even if there are no incentives to be awarded. The mean for this question was 1.64 and the median was 1.

Table 6-10: Willingness to continuously provide public safety issues

Response	Frequency (n)	Percentage (%)
Always	**33**	**54.1**
Most of the time	**19**	**31.1**
Half the time	**7**	**11.5**
Once in a while	**2**	**3.3**
Total	**61**	**100.0**

Participants were asked the factors that motivated them to participate in the Public Safety Smart City Project. The findings point out that 28 out of 61 (45.9%) participants indicated that they were able to provide reports making use of the toll free Public Safety Smart City Project number. These findings are illustrated in Figure 6-3. The mean for this question was 1 and the median was 1. Findings also indicate that 25 out of 61 (41%) were motivated by the airtime incentive offered for participating in the project. The mean for this question was 1 and the median was 1.

The next questions asked participants if the incentive offered was appropriate for providing public safety information. Majority of the participants agreed that the incentive was appropriate: 75.4% of participants responded 'yes', 16.4% were not sure, while 8.2% indicated that the incentive was not appropriate (Refer to Table 6-11). The mean for this question was 1.33 (Strongly agree) and the median 1.

Table 6-11: Incentive Appropriateness

Response	Frequency (n)	Percentage (%)
Yes	46	75.4
Maybe	10	16.4
No	5	8.2
Total	**61**	**100.0**

Participants indicated that they reported public safety issues for a number of reasons. The questionnaire asked if the participants reported public safety issues in order to be awarded the airtime incentive. Table 6-12 illustrates that 34.4% of the participants responded 'yes', while 42.6% indicated that they did not report to the crowdsourcing project in order to be given the airtime incentive. The mean for this question was 2.08 (agree) and the median 2.

Table 6-12: Participating for Airtime Incentive

	Frequency (n)	Percentage (%)
Yes	21	34.4
Maybe	14	23.0
No	26	42.6
Total	**61**	**100.0**

This section presented the findings that were obtained from the questionnaires (descriptive statistics). The next section presents findings obtained from inferential statistics.

6.6 Variable association (Chi-square tests)

Chi-square tests enable researchers to investigate the association between two variables (Saunders et al., 2007). The Somer's *d* method was used to test for questions that were statistically significant. Somer's *d* is used to measure the strength of variables whereby both variables are at least ordinal. Somer's *d* was used for this project because it shows association between two variables by indicating the extent to which a change in one variable affects the other (Saunders et al., 2007). Age and gender were measured against various variables. These are discussed below.

Age

- The question "*I would be willing to use this system in the future as I perceive it to be useful to me*" was statistically significant when measured against age ($d=0.257$; $p<0.05$). Those participants who were younger than 30 years of age were in the majority and agreed that reporting public safety issues became part of their everyday activity. It can therefore be concluded that age affected participation.

- Participation as an everyday activity was statistically significant when measured against age ($d=0.342$; $p<0.05$). Findings indicate that the majority, participants who are under 30 years, agreed that reporting public safety issues became part of their everyday activity. It can therefore be concluded that age affects participation as an everyday activity.

- Continuous participation was statistically significant when measured against age (d=337; p<0.05). Based on the findings, the participants younger than 30 years of age (64%) indicated that they are willing to report public safety issues in the future. Only 23.3% of the participants older than 30 years participated and agreed to provide public safety in the future. Thus it can be concluded that age affects intrinsic motivation amongst participants.

Gender

- Participants that reported public safety issues for intrinsic reasons was statistically significant when measured against gender (d=-*0*.246; p<0.05). Female participants (52.4%) agreed that providing public safety issues make them feel better, thereby increasing their intrinsic feeling, whereas only 42.6% male participants agreed to this statement. It can therefore be concluded that gender affects participating for intrinsic feeling.

- Incentive appropriateness was statistically significant when measured against gender (d=-0.258; p<0.05). Female participants replied "*yes*" when they were asked if the incentive was appropriate (45.9%), 29.5% male participants responded "*yes*" to the statement. However, 8.2% male participants indicated that the incentive was not appropriate. Therefore, it can be concluded that the appropriateness of the incentive offered varies according to gender

- Incentive fairness was statistically significant when measured against gender (d=-0.256; p<0.05). Females agreed that the airtime incentive was fair (47.5%), whereas males recorded 32.7%. This shows that females were satisfied with the incentive that was offered for providing public safety issues they witnessed. The next section discusses the Spearman correlations.

6.7 Spearman correlations

Correlation allows for the strength of the relationship between two variables to be measured (Saunders et al., 2007). Spearman correlation was used to test for the direction and strength of relationship between perceived usefulness and other variables. According to Pallant (2010), the strength of the relationship can be categorised into:

- weak/small=0.10 to 0.29;
- medium = 0.30 to 0.49, and
- strong/large=0.50 to 1.0.

Thus, a value of +1 represents a perfect positive correlation (variables are related, as one increases the other increases) and -1 represents a perfect negative correlation (variables are also related, but as one increases, the other decreases) (Saunders et al., 2007). The categories apply for negative values as well. These variables are outlined below:

- The relationship between increased participation and a useful way to report public safety issues indicated a positive correlation ($r=0.409$; $p<0.05$). The strength of the relationship was medium. Participants found the project to be a useful way of reporting public safety information they witnessed, thereby resulting in increased participation.

- The relationship between increased participation and usefulness of the project indicated a positive correlation with a medium relationship ($r=0.378$; $p<0.05$). This indicates that participants found the project to be a useful way to reduce public safety issues in the city. This therefore resulted in increased participation so as to have a better quality of life.

- The relationship between increased participation, and participating for intrinsic reasons indicated a positive correlation with a medium relationship ($r=0.398$; $p<0.05$). This result indicates participants' intrinsic reasons to report public safety issues will affect their participation rate.

- The relationship between increased participation and participation as an everyday activity indicated a positive correlation with a strong relationship ($r=0.584$; $p<0.05$), with increased participation associated with a high level of everyday activity. This means that participants were willing to provide public safety reports so as to have reduced public safety issues in the city, or in order to be awarded the airtime incentive.

- The relationship between increased participation and participating for airtime incentive indicated a negative correlation with a medium relationship ($r=-0.305$; $p<0.05$). This indicates that the participants' motivation to receive an incentive will affect the participation rate, resulting in lower participation if there are no incentives offered to participants.

- The relationship between increased participation and participating for other reasons indicated a positive correlation ($r=0.266$; $p<0.05$). This indicates that participants will provide public safety information even if they are not offered any incentives.

- The relationship between increased participation and willingness to continuously provide public safety reports indicated a positive correlation with a medium relationship ($r=0.464$; $p<0.05$). This indicates that participants will continuously report public safety issues in the future.

- The relationship between increased participation and incentive award indicated a negative correlation with a medium relationship ($r=-0.325$; $p<0.05$). This indicates that participation rate was influenced by the time the incentive was offered to participants.

Table 6-13 summarises the Spearman correlations between increased participation and different variables as discussed above.

Table 6-13: Spearman correlations between increased participation and other variables

Factors	Variables	Increased participation		
Intrinsic	• Useful way to report public safety issues	0.409**		
	• Usefulness of the project	0.378**		
	• Feeling of accomplishment	0.398**		
Internalised-extrinsic	• Participation as an everyday activity		0.584**	
	• Willingness to continuously provide public safety reports		0.464**	
Extrinsic	• Participating for airtime incentive			-0.305
	• Participating for other reasons			0.266
	• Incentive award			-0.325

**p<0.05 (2-tailed)

6.8 Observation findings

During the study, some observations of the prototype were done. Observations were based on how the prototype functions in terms of continuous public safety data collection from citizens. Observation of this prototype led to the development of some questions that were included in the questionnaire. Some of the questions were to find out if citizens participated for intrinsic, internalised-extrinsic, or extrinsic incentives.

6.9 Conversational analysis findings

Conversational analysis is the data collected from social interactions – formal or informal (Drew, Chatwin, & Collins, 2001). Several meetings and workshops were held during the project in order to observe and gather feedback from various experts in the smart city field as well as the team members. The feedback from the meetings and workshops was used to develop the research instrument (questionnaire) which will be used to refine the model. These findings obtained from conversational analysis are

categorised as mobi-site, call process, and incentive to be offered. These findings are discussed in the following sections.

6.9.1 Mobi-site/ Website

Discussions were held regarding the appearance of the mobi-site and how participants should make their reports. It was discussed that all participants should register first on the project mobi-site. Participants were asked if they have registered on the mobi-site, if 'yes' then they proceed with their report, else they will have to register first before they can report public safety issues. The registration process required them to provide their phone number to receive the airtime incentive if their report was complete.

6.9.2 Call process

The issues discussed during the meetings include the process (number of prompts) that should be followed when the citizen makes a report on the project line. The team agreed to minimise these steps so that the citizen will not have to spend a lot of time waiting to make a report. Figure 6-4 illustrates the flow diagram for the steps to be taken when making a report.

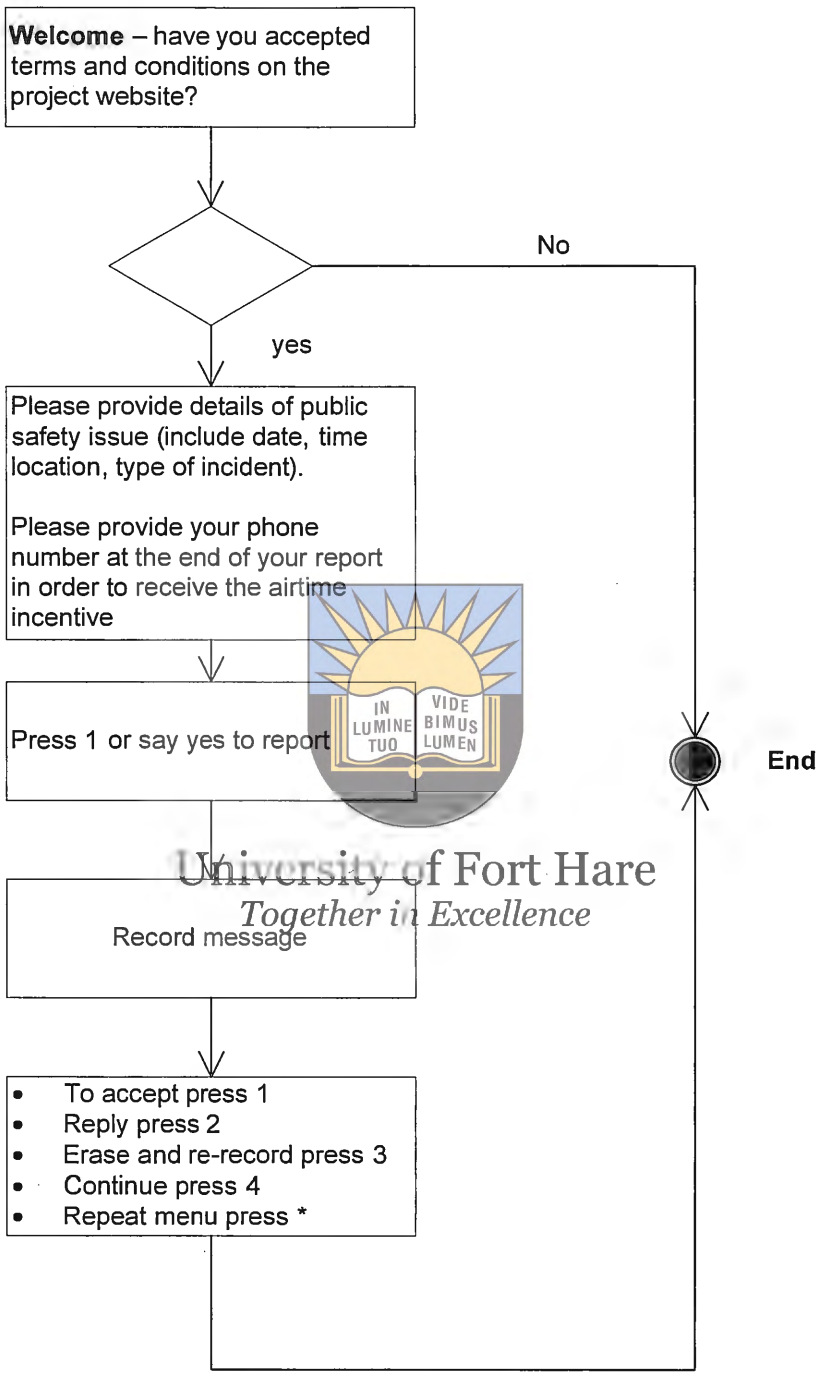


Figure 6-4: Call process

6.9.3 Incentives to be offered

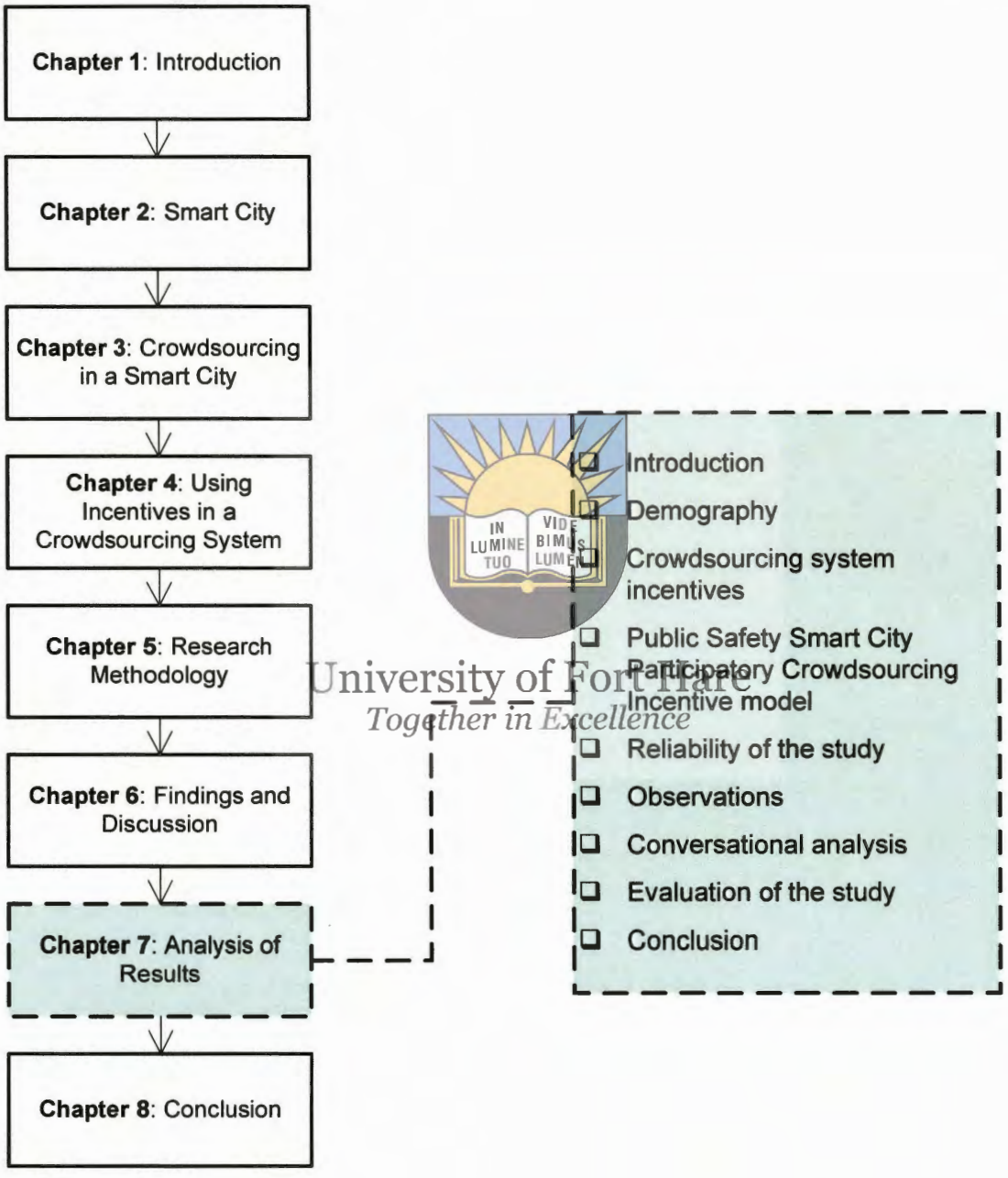
During the meetings held with the project team, there was a discussion of how the incentives should be offered to each participant. Discussions included the amount of

airtime that would be offered and if it was too much or too little. This was going to affect the participants when they called to report public safety issues they witnessed.

6.10 Conclusion

This chapter focused on presenting the findings of the Public Safety Smart City Crowdsourcing Project. The response rate for the questionnaire on incentives for this study was 81% and was considered acceptable. The findings from the questionnaire were categorised as demographics, crowdsourcing, intrinsic, internalised extrinsic and extrinsic findings. These findings were presented in the form of text, graphs and tables (descriptive statistics). Chi-test square was used to test whether the relationship between variables were statistically significant. Findings show that everyday activity, concern for other citizens, response from BCMM and toll free number were statistically significant when measured against age. Incentive appropriateness was statistically significant when measured against gender. Spearman correlation coefficient was then used to investigate the direction and st[illegible] variables. Findings from observations focused on the ease of use and friendliness of the prototype. Conversational analysis insights included the welcome message and incentives to be offered. The next chapter will provide a description of the findings.

7 Analysis of Results



7.1 Introduction

The previous chapters explained how the data for this project was collected using the mixed method approach making use of various methods such as a questionnaire, conversational analysis and observations of the prototype. This chapter provides the analysis and discussion of the findings presented in Chapter 6.

The first section discusses the demographics. This is followed by a discussion of the crowdsourcing system. Section 7.4 discusses the contribution made by this project: the proposed model. This is then followed by a discussion of the findings obtained from observations and conversational analysis (section 7.5 and 7.6). The next section discusses demographics.

7.2 Demographics

This project's convenient sample consisted of both male and female participants who were selected to represent the population. As mentioned in Chapter 5, the population for this research project consists of participants who registered on the website in order to provide public safety issues. These participants are citizens of East London only.

Appropriateness of incentive proved to be statistically significant when measured against gender. Participation for both men and women was almost equal. Both men and women found the airtime incentive that was offered to be appropriate for reporting public safety issues.

Participants were concerned about the safety of other citizens in the city. It can be concluded that all citizens, regardless of their age or gender, are concerned about their lives in the community. The city therefore becomes safer once the city acts on these issues by introducing new ideas, policies or programmes that will ensure better management of the city's resources (Harrison & Donnelly, 2011). This results in a better quality of life for citizens. The next section discusses the incentives of the crowdsourcing system.

7.3 Crowdsourcing system incentives

This section discusses the participants' views on the incentives used to motivate citizens to provide information in the Public Safety Smart City Project. It was discussed in Chapter 3 that participatory crowdsourcing can be used as an important data collection tool in a smart city (Nov et al., 2009). Most respondents thought that the public safety project is very helpful in terms of reducing public safety issues that were reported because the city would be informed of the issues affecting citizens and therefore would be able to act on reducing these issues. As a result, more than ninety per cent of the respondents agreed that they would use the crowdsourcing project in the future. This indicates that they found the system to be effective in terms of reporting public safety issues they witness.

As mentioned in Chapter 3, using participatory crowdsourcing allows for citizens to be included in city issues (O'Connell, 2013). Citizens develop a relationship with the city by reporting public safety issues they [illegible] Majority of the participants indicated that the Public Safety Smart City Project was a useful way to act on issues that may pose risk to citizens. Thus, participants feel that using a crowdsourcing system will alert the city of the issues they are facing and therefore provide solutions on how to overcome these issues. This is mainly because previously there was no effective way of reporting public safety issues they witnessed to the city.

Majority of the participants indicated that they reported every time they witnessed public safety issues. This could be as a result of citizens observing public safety issues repeatedly. Another possible explanation could be that participants reported public safety issues in order to be awarded the incentive every time they provide a complete report and receive free airtime of which they can use for their personal lives. South Africa is amongst the countries that have the highest call rates in the world (News24, 2014). Therefore, using the toll free number meant that participants were not charged when they called to report public safety issues.

7.3.1 Intrinsic incentives

It was discussed in literature that some people take part in activities in order to have and enjoy a feeling of satisfaction after they have completed that activity (Magnusson & Nyrenius, 2011). These feelings are referred to as intrinsic incentives. Participants provided public safety issues they witnessed because of their concern for the safety of other citizens in the city. This shows that most participants were concerned about the safety of other citizens and therefore provided any public safety issues they witnessed to make the city smarter and have a better quality of life. These participants were intrinsically motivated; as a result they participated in order to be satisfied by their actions, and enjoyed the feeling of achievement.

Participants indicated that they would provide public safety reports even if they were not offered an incentive. Participants also indicated that they expected to receive the incentive anytime. The reason could be that participants were not so concerned about receiving the incentive, but were motivated by a better quality of life. This shows that some citizens are in need of a better quality of life and therefore would provide any report to the city on public safety issues that place their lives at risk. This is supported by O'Connell (2013) who mentioned that the local government introduced crowdsourcing in order to gather safety issues from citizens, which assists in the management of the use of the city's resources more effectively.

7.3.2 Internalised-extrinsic and extrinsic discussion

Internal extrinsic factors allow a participant to take part in an activity in order to influence other citizens to make a difference in the community (Gassenheimer et al., 2013). Some of the participants (54.1%) had internalised-extrinsic motivation when they indicated that they will always provide public safety issues they witness, as well as reporting public safety issues in order to make a difference in their community. This shows that participants took part in the public safety project in order to maintain their reputation and to make a difference in the city.

It was discussed in literature (Chapter 4) that extrinsic incentives are awarded to people who participate in an activity and expect to acquire a physical incentive in return

(Pardupa, 2012). Participants indicated that the incentive was appropriate for providing public safety reports. Findings indicate that a small percentage (24.6%) of participants were happy with the airtime incentive they received after providing public safety information, while the remaining were not so concerned about the incentive. These participants also found the incentive to be fair for their effort used to report public safety issues.

Some participants indicated that they were motivated by different factors. Some indicated that they were motivated by the toll free number and some by the airtime incentive that was issued for each complete report. A smaller percentage indicated that they preferred to receive the airtime incentive just after the report. This shows that these participants probably only provided public safety issues with the intention of being awarded the incentive. However, those participants who preferred the incentive indicated that it was fair. It can be concluded that using monetary incentives will assist some of the extrinsically motivated citizens who provided public safety information to continuously participate in order to be awarded the incentive. Continuous participation by citizens will also assist the city to make it safer because they will have an idea of what is happening in the city and will find ways of reducing these issues. The next section discusses the proposed model.

7.4 Public Safety Participatory Crowdsourcing Incentive model

Chapter 3 provided a discussion of smart cities: how they use technology and communication to facilitate better management of resources. Thus, in order to communicate with citizens, the city should use participatory crowdsourcing to collect public safety reports and provide feedback to citizens (Brabham, 2012). However, the challenge identified by this study is that there is no effective crowdsourcing in place that allows the city to continuously collect public safety information from citizens. A model was developed in order to provide a solution to the challenge as well as to accomplish the objective of this project: to develop a participatory crowdsourcing model that allows for continuous public safety information from citizens.

According to Olivier (2009), in information systems, a model can be developed using literature review and observations of a prototype. The proposed model for this project was derived from the findings of the literature review, observations, questionnaire and the incentive theory. Spearman correlation was used to test for the direction and strength of relationship between perceived usefulness and other variables. The figures in the model represent the relationship between variables, whereby weak/small (r=0.10 to 0.29), medium (r=0.30 to 0.49) and strong/large (r=0.50 to 1.0). The categories apply for negative values as well, which indicates that as one variable increases, the other decreases (Pallant, 2010). The proposed model is presented in Figure 7-1.

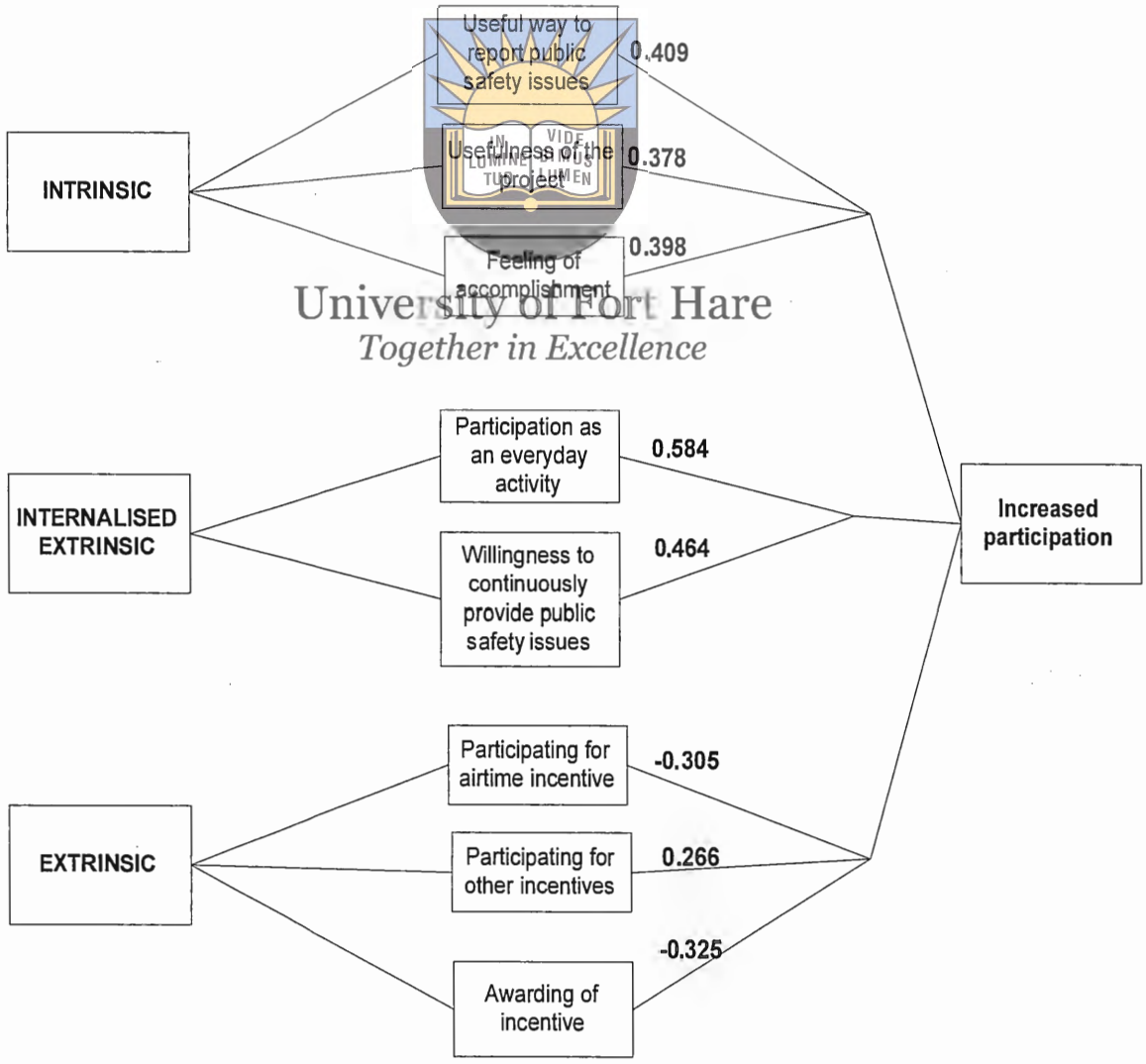


Figure 7-1: Smart City Participatory Crowdsourcing Incentive (SCPCI) Model

The model identifies factors that encourage citizens to continuously provide public safety issues they witness to the city. The figures in the model represent the relationship between variables, whereby weak/small (r=0.10 to 0.29), medium (r=0.30 to 0.49) and strong/large (r=0.50 to 1.0). These factors include intrinsic, internalised-extrinsic and extrinsic incentives, of which each contains some elements. These factors will now be discussed in the next sections.

7.4.1 Intrinsic factors

As mentioned earlier in Chapter 4, intrinsic incentives provide the internal feeling that a citizen feels after reporting public safety issues they observe (Magnusson & Nyrenius, 2011). In order for the Smart City Participatory Crowdsourcing Incentive (SCPCI) model to be effective, the city has to offer intrinsic incentives for participants that are intrinsically motivated. The next section discusses the usefulness of the project.

7.4.1.1 Usefulness of the project

This factor focuses on how the project was useful to citizens in terms of reporting public safety issues. Participants found this project to be useful in terms of reporting issues in order to make the city safer because there was no effective crowdsourcing system in place that allowed them to communicate these issues to the city. The BCMM departments (see section 2.5) are not functioning properly because there is no continuous flow of public safety information from citizens. The Public Safety Smart City Project made it easy to report public safety issues because participants used the project's toll free number and the mobi-site, which worked effectively by continuously collecting information provided by citizens. This is because participants had to use their mobile devices to make a report. However, in order to collect public safety information continuously from citizens, the project team had to make sure that the participatory crowdsourcing system functioned well. The next section discusses the useful way to act on public safety issues factor.

7.4.1.2 Useful way to act on public safety issues

This factor focuses on the value of the crowdsourcing system to participants. Based on the findings (Chapter 6), there was a high level of participation because participants felt

that they should report any issues that place their lives in danger. This indicates how uncertain citizens are about issues threatening their lives. Citizens therefore found the system as a useful way of reporting public safety issues in order to reduce these issues. This factor must be taken into consideration for an effective participatory crowdsourcing project.

According to Brabham (2012), citizen involvement in city issues will allow them to use the crowdsourcing system to report issues they observe. This results in continuous public safety information being provided by citizens. Therefore, it is necessary for the city to include citizens when solving city issues such as public safety issues.

7.4.1.3 Feeling of accomplishment

Citizen participation is increased if participants experience feelings of accomplishment after providing public safety reports. A feeling of accomplishment is important for intrinsically motivated participants who would like to provide public safety information they witness. This is because this factor is associated with the satisfaction a participant acquires after providing public safety information, with the help of a well-functioning crowdsourcing system. The next section discusses the internalised extrinsic factors.

7.4.2 Internalised-extrinsic factors

Internalised-extrinsic includes two factors that will encourage continuous public safety collection. These factors are participation as an everyday activity and willingness to provide public safety information. The next section discusses everyday activity.

7.4.2.1 Participation as an everyday activity

As pointed out in Chapter 3, participants need a system that is well functioning and improves their performance in order for them to report public safety issues on a regular basis. This will allow for continuous public safety data collection, which gives insights as to what is happening in the city. By providing public safety information every day, the city will be able to use the information provided to create measures that will help reduce these issues in the city. Observation findings show that participants were providing public safety issues they witnessed on a daily basis.

Everyday activity is one of the factors that ensure that the SCPCI model is effective. This allows for the city to gather public safety information continuously from citizens. Collecting public safety issues regularly will assist the city to update/create new policies that will help reduce these issues, thereby making the city safer for citizens (Harrison & Donnelly, 2011).

7.4.2.2 Willingness to continuously provide public safety issues

This factor is important for the SCPCI model because it allows for public safety data to be collected continuously from citizens that are willing to make change in the city. The SCPCI model suggests that the willingness to provide public safety issues continuously will more likely affect citizen participation. Meaning, citizens will provide public safety information they observe regardless of whether they are offered incentives, resulting in continuous public safety information being collected from citizens by the city. The next section discusses the extrinsic factors.

7.4.3 Extrinsic factors

The city should also make use of extrinsic factors in order to collect public safety information continuously from citizens. The extrinsic factors consist of participating for airtime incentives, participating for other reasons, and when to be awarded the incentives. The next section discusses participating for the airtime incentive.

7.4.3.1 Participating for airtime incentive

Chapter 4 discussed various types of incentives, and it was found that some participants participate in order to be awarded an incentive. Participating for an incentive had a negative relationship. The SCPCI model illustrates that participating for the airtime incentive is a less likely way to increase participation. This means that majority of the participants did not report in order to be awarded the airtime incentive, although there were some who were motivated by extrinsic incentives.

This has been supported by Brabham (2011) who stated that various interviews and surveys have been conducted in order to find out what motivates people to participate in

a crowdsourcing project. It was discovered that there is no single motivator that encourages all the participants and achieves the same satisfaction. Therefore, the BCMM must incorporate incentives for those participants who are encouraged by incentives to provide public safety information.

7.4.3.2 Participating for other incentives

The proposed model recommends that there is a positive relationship between increased participation and participating for other incentives. Chapter 4 discussed that participants prefer different incentives depending on the person. Some prefer monetary incentives (money) and some prefer non-monetary incentives (for example gift cards). Findings from Chapter 6 (see Table 6-5) confirm that some of the participants preferred to be awarded money instead of airtime.

7.4.3.3 Awarding of incentive

As illustrated in Figure 7-1, this factor had a negative medium relationship. This indicates that the level of participation is not affected by the time the participants receive their incentive. Thus, citizens will provide public safety issues they witnessed even if they are not awarded incentives just after providing reports.

From the model, it can be seen that intrinsic factors had stronger relationships as compared to extrinsic factors. This indicates that participants preferred intrinsic incentives more than extrinsic incentives. The next section discusses the reliability of the study.

7.5 Reliability of the study

Cronbach's alpha coefficient was used in this project to determine the reliability of the factors identified in the model. Cronbach's alpha coefficient is used to measure the internal consistency of a scale (Pallant, 2010). The values of 0.70 and above represent a good level of reliability, whereas values between 0.50 and 0.69 are considered to have an acceptable level of reliability (Pallant, 2010). However, values below 0.50 are considered not acceptable.

The factors that were used in this project include intrinsic, internalised-extrinsic and extrinsic factors. The intrinsic factor had a Cronbach's alpha coefficient of 0.69, the internalised-extrinsic factor had a Cronbach's alpha coefficient of 0.62, and the extrinsic factor had a Cronbach's alpha coefficient of 0.58. These three factors can thus be considered to have an acceptable level of reliability. The next section provides a discussion of observations.

7.6 Observations

According to the Visiting Committee on Advanced Technology (2012), when reporting issues, any system being used for public safety must be easy to use so that participants will be able to complete their reports. The prototype was effective and it was able to continuously collect public safety information from citizens of East London. It can therefore be concluded that participants found the study to be easy to use and user-friendly.

7.7 Conversational analysis

Conversational analysis allowed for data to be collected from the meetings that were held with project team members and various experts. The data collected was then used to improve the prototype in terms of the appearance of the mobi-site (information required from the participant and the order in which it should be in), the number of steps (prompts) to be taken to complete a report if the user used the toll free number, and the amount of the airtime incentive to be awarded.

Two professors from the United Kingdom and a visiting professor from Nelson Mandela Metropolitan University (NMMU) attended the Public Safety Smart City Project workshop and also provided their feedback on the crowdsourcing system. Their feedback included the discussion of other functions that can be added or removed from the system and the friendliness of the system. The feedback from the workshop was also used to develop the research instrument which will be used to refine the model. Observations from the workshop led to the development of some questions that were included in the questionnaire. Some of the questions were to find out if citizens participated in order to be awarded the incentive.

7.8 Evaluation of the study

Once data has been analysed, there are various criteria can be used to evaluate the quality of the data that was collected for the research project. This section will discuss the evaluation of this project. Lincoln and Guba (1985) and Oates (2006) suggest that there are set criteria that can be used to evaluate both a qualitative and quantitative research project. These criteria are presented in Table 7-1 below. This study made use of the interpretivist paradigm and therefore used the criteria to evaluate an interpretic study. These criteria include trustworthiness, conformability, dependability, credibility andtransferability.

Table 7-1 Evaluation of positivist and interpretivist research (Lincoln & Guba, 1985; Oates, 2006)

Positivism	Interpretivism
Validity	Trustworthiness
Objectivity	Conformability
Reliability	Dependability
Internal validity	Credibility
External validity	Transferability

Trustworthiness focuses on data accuracy. To ensure trustworthiness in this project, data was collected from East London citizens who made use of the project's toll free number and the mobi-site to report public safety issues they witnessed. The data collected can be trusted because it was provided by citizens who are threatened everyday by public safety issues in the city.

Conformability focuses on whether the research process has been described fully, and it is possible to assess whether the findings flow from the data (Collis & Hussey, 2009). Data was collected using different methods, thereby making it posssible to develop and refine the model for this project.

Dependability focuses on whether research processes are systematic, rigorous and well documented (Collis & Hussey, 2009). In this project, literature was reviewed and findings from a questionnaire and conversational analysis were used to develop and refine the model. To ensure depandability in this project, a theory that has been tested by other studies previously was used.

Credibility can be achieved by engaging with participants (Morrow, 2005). In this project, credibility was achieved by collecting data from multiple sources such as observation of the prototype, literature, questionnaire and conversational analysis.

Transferability focuses on whether findings can be applied to another or similar situation, which can be achieved by providing all the information about the research methods (Collis & Hussey, 2009; Morrow, 2005). This project focused on increasing citizen participation to provide public safety data in East London. However, the Public Safety Participatory Crowdsourcing Incentive model can be used in other cities other than East London and can also be applied to other smart city aspects such as transport, healthcare, education, energy, waste management. This will assist a developing city to become smarter in all aspects.

The application of the criteria discussed in this section indicates that this project can be considered dependable and credible. The next section provides a conclusion for this chapter.

7.9 Conclusion

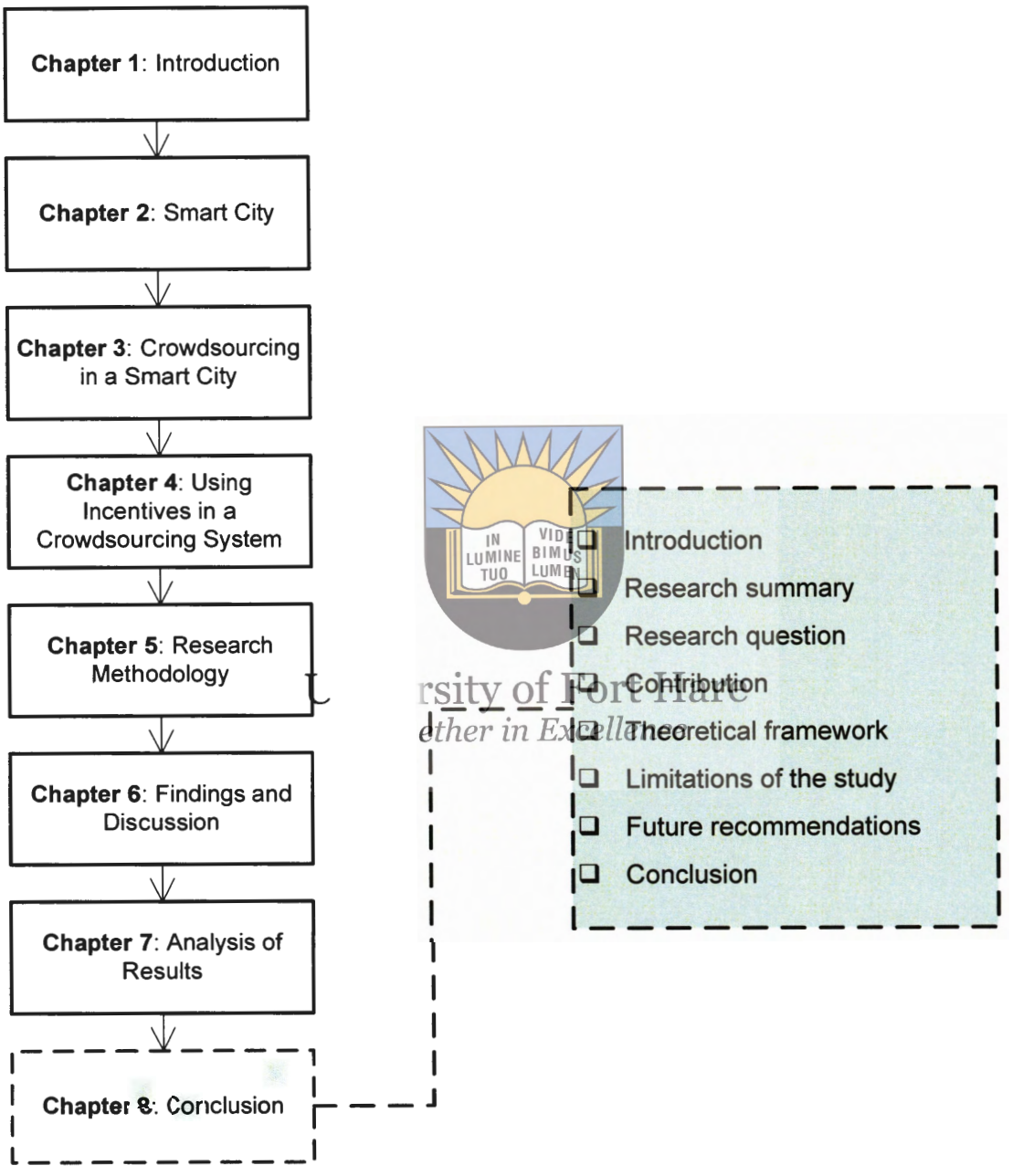
This chapter provided discussions of the findings presented in Chapter 6. Both males and females took part in this project and had an almost equal participation rate. Participants provided their thoughts on the crowdsourcing system. Majority of the participants preferred intrinsic incentives, meaning they reported public safety issues in order to have a better quality of life.

The Smart City Participatory Crowdsourcing Incentive model was presented and discussed. The model consists of three factors which are: intrinsic, internalised-extrinsic and extrinsic. These factors will assist the city to collect public safety

information continuously from citizens. The usefulness of the project to provide public safety issues increases citizen participation. After participating, participants experience the feeling of accomplishment, resulting in participating every day and thereby continuously providing public safety issues to the city. However, the airtime incentive did not affect citizen participation as it had a negative relationship and some participants indicated they preferred other incentives. Awarding of incentive also had a negative relation, meaning that participants did not expect to receive the incentive just after reporting the issue.

The study was considered reliable as it had a Cronbach's alpha coefficient of more than 0.50. Evaluation of the study proved that this project can be considered dependable and credible. The next chapter provides a summary of all the chapters.

8 Conclusion



8.1 Introduction

Chapters 6 and 7 provided the findings as well as the analysis and discussion of these findings. This chapter will provide a summary of this research project, which was carried out to develop an incentive model that will assist the city to collect public safety issues continuously from citizens. A summary of the chapters is provided in section 8.2. Research questions are addressed in section 8.3, followed by a discussion of the contribution. The theoretical framework is discussed in section 8.5; the limitation and recommendation of future research are then discussed in section 8.6. The next section provides a summary of the chapters for this research project.

8.2 Research summary

An increase in urbanisation has resulted in more citizens living cities, thereby straining the limited resources available in a city. Therefore, this is a contributing factor that leads to an escalation of public safety issues in a developing city. These public safety issues negatively affect citizens' quality of life in these cities. These public safety issues include: crime (such as theft), accidents and natural disasters. However, in order to minimise these public safety challenges, some cities have implemented the smart city approach. Smart cities allow the city to effectively manage the limited resources of a city. This can be achieved by using participatory crowdsourcing. Citizens can use participatory crowdsourcing by willingly reporting any public safety issue they witness to the city.

In order to address the current issue, literature review was done and data was collected using various methods so as to develop a model that allows the city to gather data continuously from citizens. The model assists to provide incentives that will motivate citizens to provide public safety reports. This project was then divided into chapters so as to provide a solution to the current problem.

The research problem is that there is no effective crowdsourcing system in place to allow for continuous public safety data collection from citizens in a developing country (see section 8.3). The objective of this project was to develop a crowdsourcing system that would assist in improving public safety data collection from citizens. The

significance of the study is to ensure that East London citizens will have better quality of life. Focusing on the problem led to the integration of the literature, theory and previous empirical work.

Smart cities were defined, benefits were highlighted, as well as how other cities around the world are using the smart city concept, although they are still evolving. Implementing the smart city approach benefits both the city and the citizens. The benefits include better management of resources, improved living conditions, improved services operations, and enhanced communication between citizens and city. The public safety aspect was discussed further, which focuses on improving the quality of life of citizens. This led to a discussion of East London and the city's public safety issues. Public safety issues experienced in East London include crime, accidents and natural disasters. The city of East London can implement the smart city approach in order to effectively manage the limited resources and to minimise public safety issues such as crime, accidents and natural disasters.

There are two types of crowdsourcing involved which makes use of sensors, and participatory crowdsourcing, which views citizens as sensors. Crowdsourcing allows for the crowd to provide public safety information that can be used to assist in emergency needs and provide help to victims in natural disasters and develop new policies and innovative ideas for services in a smart city. An example that was discussed is Amazon Mechanical Turk, which makes use of crowdsourcing to the crowd for incentives. The information collected from participatory crowdsourcing will assist the city and law enforcement to minimise public safety issues that could threaten the lives of citizens. Participatory crowdsourcing provides benefits for both citizens and city such as allowing for citizen engagement, citizen awareness, provides first-hand information to the city, and feedback to citizens. These benefits will assist in making the city smarter.

It was discussed that citizen participation can be increased through incentives. The city can make use of incentives in order to gather more public safety information. These incentives can be internal, internalised-extrinsic or extrinsic incentives. Intrinsic incentives are linked to internal desires of a person. This includes doing something because it is interesting and enjoyable. Examples of intrinsic incentives include

recognition, feedback and morals. Extrinsic incentives are physical rewards that trigger citizens to participate, such as money, gift cards and airtime. Therefore, in order to be successful with incentives, an incentive system can be developed for rewarding citizens. An incentive system provides a clear understanding of how the incentives will be distributed to citizens who provide public safety information. However, people have different preferences, so the type of incentive to use may vary according to people. Therefore, the city can use these three types of incentives to increase citizen participation, thereby collecting more public safety information.

8.3 Research Methodology

The interpretivist paradigm was chosen to be the most appropriate for this project. The interpretivist paradigm focuses on the understanding of the behaviour of participants from their world. This project used the mixed method approach following the exploratory mixed method design. Secondary data was collected from existing literature and primary data was collected [redacted] online questionnaire, observations and expert reviews. The questionnaire was developed from literature review and observations. Data collected from questionnaire investigated how effective the incentive offered to citizens was. Participants preferred different incentives such as intrinsic, internalised-extrinsic or extrinsic incentives. Observations were done to investigate if the crowdsourcing system was easy to use and user-friendly. The participatory crowdsourcing was found to be easy to use as well as user- friendly. Quantitative data was analysed making use of SPSS version 22 and presented making use of descriptive statistics (mean, median) and inferential statistics. This makes use of graphs, tables or charts to represent data, thus making it easier to interpret the data.

8.4 Discussion and results

The purpose of this study was to find effective ways of continuously collecting public safety information from citizens. In order to achieve this aim, it was important to find out what the citizens thought about the current crowdsourcing system, as well as incentives offered for providing public safety issues. The findings assisted in the development and refinement of the model that can be used for effective data collection in a developing country. A summary of descriptive and inferential statistics was

provided in this chapter. Participants indicated that they will keep on providing public safety issues in the future as majority found the system to be a useful way of minimising these issues in the city. Some participants indicated that they participated in order to be awarded the airtime incentive, whereas some reported in order to have a better quality of life.

Various factors used in a model that can be used by the city were identified that will assist in continuous public safety data collection from citizens. The model was developed and refined from findings of literature review, questionnaire, conversational analysis and observations. The Smart City Participatory Crowdsourcing Incentive (SCPCI) model consists of intrinsic, internalised-extrinsic and extrinsic factors. Intrinsic factors suggest that citizens provide public safety information to the city in order to have a feeling of accomplishment or have a better quality of life.

In order for the model to be effective, intrinsic factors should include: usefulness of the project, useful way to report public safety issues, and feeling of accomplishment. The internalised-extrinsic factors suggest citizens to provide public safety information in order to gain reputation as well as influence other citizens to participate. Internalised-extrinsic factors include participation as an everyday activity and willingness to provide public safety issues continuously. The extrinsic factor encourages citizens to provide public safety information by means of awarding physical incentives. Extrinsic factors include participating for an airtime incentive, participating for other incentives and awarding of incentive. The next section discusses the research question.

8.5 Research question

Urbanisation has increased which has added to the escalation of public safety issues in a developing city. These public safety issues negatively affect the quality of life of citizens. The main challenge is that currently there is no effective way for the city to collect these public safety issues from citizens continuously. The collection of public safety information will inform city management. However, the main question investigated in this project was: ***What factors must be in place to ensure continuous data collection through an effective crowdsourcing system for a smart city public safety project in a developing country?***

The main objective for this research project was to develop a model that will assist the city to collect public safety information continuously from citizens making use of participatory crowdsourcing. Three sub-questions were identified in order to answer the main research question. These sub-questions are discussed below.

- **What type of crowdsourcing system should be in place to provide meaningful and useful data for a smart city public safety project in a developing country?**

This question was addressed in Chapters 2 and 3, which provided a discussion of how other countries are using crowdsourcing in order to collect information from citizens. Chapter 2 provided a discussion of smart cities around the world, as well as various public safety projects that are implemented in order to make cities smarter. It was found that a developing city can implement the smart city approach in order to collect public safety information from citizens. This is because smart cities allow for communication between citizens and the city by making use of technology, thereby making communication easier. Chapter 3 discussed various crowdsourcing approaches used by different organisations and countries in order to gather public safety data. Some examples of public safety participatory crowdsourcing were provided. The use of participatory crowdsourcing will assist the city to have better insights of what is happening in the city as they will receive first-hand information from citizens.

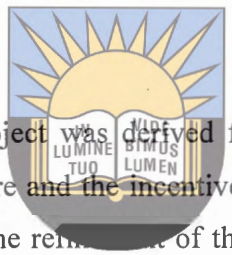
- **How can participatory crowdsourcing be used to increase the collection of meaningful data required for public safety in a smart city?**

The second sub-question was addressed in Chapter 3 where benefits of using participatory crowdsourcing were discussed. It was discussed that crowdsourcing can be used in different contexts, whereby citizens provide public safety information willingly. An example would be Amazon Mechanical Turk whereby participants select tasks they want to perform. The city can use participatory crowdsourcing as a way to reach out to citizens in order to gather public safety issues threatening their lives. Using participatory crowdsourcing enhances citizen engagement, which gives an opportunity for citizens to provide public safety issues they witness. By engaging with the city, citizens also become aware of all the public safety issues that are taking place in the city.

- **What kinds of incentives are effective in encouraging citizens in a developing country to participate in providing information about public safety?**

This question was addressed in Chapter 4 where citizen participation and different types of incentives were discussed. The findings (Chapters 6 and 7) indicate that various incentives such as intrinsic, internalised-extrinsic or extrinsic can be used to encourage citizens to provide public safety information they witness. These types of incentives were included in the model as they were considered important for continuous data collection from citizens. The next section discusses the contribution for this study.

8.6 Contribution



The proposed model for this project was derived from the findings of the literature review, observations, questionnaire and the incentive theory. Figure 8-1 illustrates the process that was followed until the refinement of the model. Literature was reviewed during this project, leading to model development. Findings from questionnaire were analysed which then led to the refinement of the model. Observations and conversational analysis were done from the beginning to the end of the project, also leading to the refinement of the model.

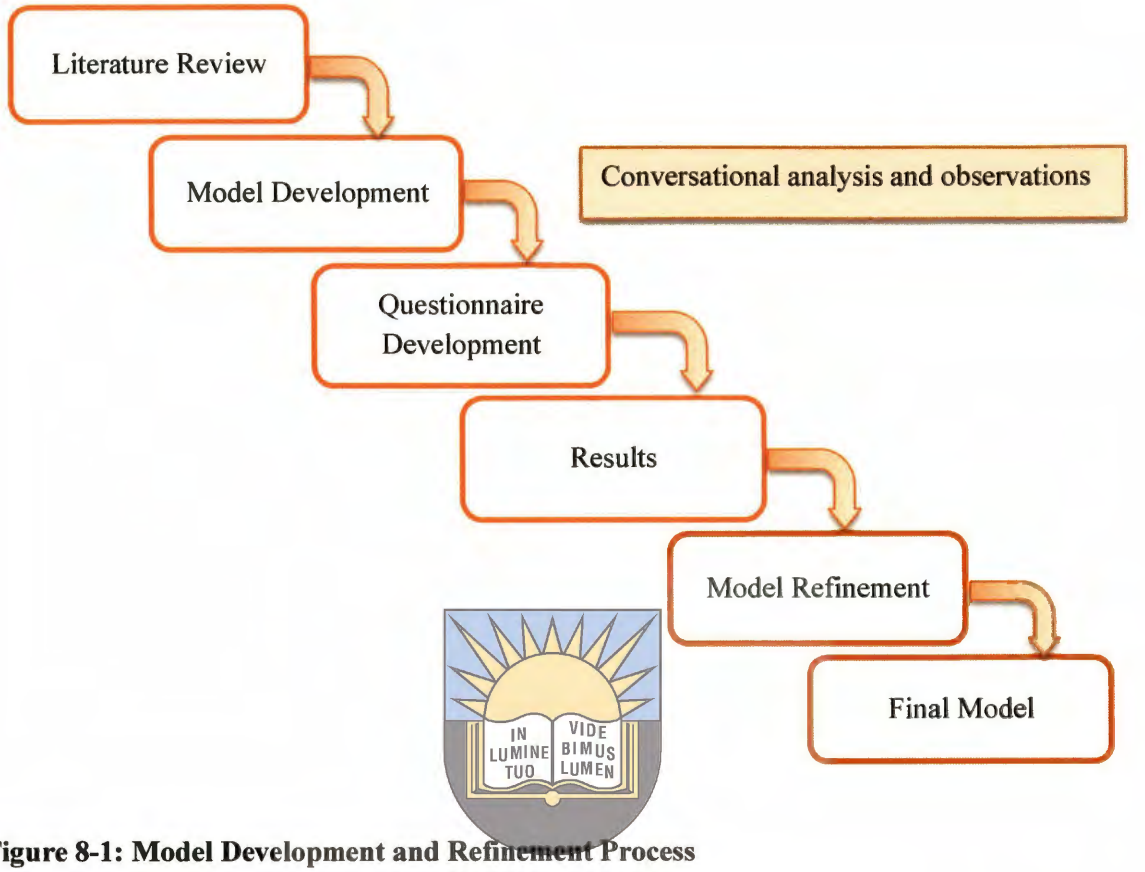


Figure 8-1: Model Development and Refinement Process

This study explained how incentives can be used to encourage citizens to provide public safety issues they witness in order to make the city smarter. It was found that participatory crowdsourcing (section 3.3.2) can be used as it allows citizens to willingly report issues they witness. Using participatory crowdsourcing provides benefits both to the city and citizens such as citizen engagement, citizen awareness, providing first-hand information, as well as feedback to citizens.

It was also found that citizen participation can be increased by finding ways to inspire citizens to provide public safety issues, such as using incentives (section 4.2). Increased citizen participation will benefit the city and citizens. Different types of incentives were discussed (section 4.4), followed by the incentive theory.

The overall contribution of this study provides the Public Safety Participatory Crowdsourcing Smart City model to allow for effective public safety data collection. This will assist the city to have better insight of the activities happening in the city and therefore find better ways of reducing issues. The city will also find ways of managing its limited resources.

8.7 Theoretical framework

The incentive theory was used in order to develop the PSSCC model. The incentive theory suggests that people are motivated to perform tasks because of external incentives or intrinsic incentives (Cherry, 2013). The incentive theory is used to encourage participants to perform tasks because of intrinsic or extrinsic factors. This theory was considered to be appropriate for this study because it focuses on using incentives as a way of encouraging citizens to participate. Thus, incentives keep the crowdsourcing model active with continuous reports flowing in from the public. This means that in order for East London citizens to provide public safety issues, there were incentives offered in order to encourage them to participate. These incentives offered to citizens were both intrinsic and extrinsic, namely airtime, feeling of accomplishment and better quality of life. The next section discusses the limitation of this study and recommendations for future research.

8.8 Limitations of the study

The limitation was that there were fewer respondents on the questionnaire that was sent out to participants. This study only focused on participatory crowdsourcing. As discussed in section 1.9, crowdsensing and the use of sensors was not included in this project as participants were required to report willingly. Using sensors could allow for more public safety data to be collected from citizens.

8.9 Recommendations for future research

The model developed in this study can be applied to other smart living aspects (such as health and transport) besides public safety. Future research could focus on the appropriate incentive systems that were mentioned in section 4.4.2. This will guide future projects on the right/correct incentives that should be offered to participants for completing a task. The next section concludes this chapter.

8.10 Summary

This dissertation discussed the factors that can be used by the city to collect public safety information from citizens continuously. The public safety smart city participatory incentive model was developed to assist the city. This will assist in making the city of East London smarter. Thus, citizens will experience a better quality of life due to less public safety issues, and the city will have better management of resources.

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10 List of Acronyms

AMT	Amazon Mechanic Turk
BCM	Buffalo City Municipality
BCMM	Buffalo City Metropolitan Municipality
CCTV	Closed-Circuit Television
GPS	Global Positioning System
ICT	Information and Communication Technology
IS	Information Systems
IT	Information Technology
SAPS	South African Police Services
SCPCI	Smart City Participatory Crowdsourcing Incentive
SPSS	Statistical Package for Social Sciences
SMS	Short Message Service

11 List of definitions

- **Citizen participation** – the process whereby citizens willingly provide public safety information to the city

- **Conversational analysis** – a technique used to obtain information from voice technology experts in the telecommunication industry.

- **Cronbach's alpha** coefficient – used to measure the internal consistency of a scale

- **Crowdsensing** – use of sensors to automatically collect data from people

- **Crowdsourcing** – the externalisation of an activity by an organisation to a large number of individuals whose identities are most often anonymous

- **Deductive approach** – the deve[illegible]a conceptual and theoretical structure which is tested by empirical observation

- **Incentive** – a thing that encourages or motivates an individual to perform or do something

- **Inductive approach** – a study in which a theory is developed from the observation of empirical reality; thus general inferences are induced from particular instances

- **Motivation** – encouraging individuals to perform tasks or activities

- **Paradigm** – a way of examining social phenomena from which particular understanding of these phenomena can be gained and explanation attempted

- **Public safety** – protecting the public as well as preventing any events that could place people's lives in danger

- **Smart city** – a city that uses information and communications technology to make its infrastructure, components and utilities in order to be more interactive, efficient and to make citizens more aware of them