FACTORS INFLUENCING THE ADOPTION OF LOCATION BASED IDENTIFICATION IN THE KURDISTAN REGION OF IRAQ

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Abstract

Location Based Identification (LBI) can be defined as a string of numeric or alphanumeric characters that are used to define a specific location. Virtually, it is the most compact data element capable of specifying the location of a mail addressee with high precision (Raper, Rhind, & Shepherd, 1992; Zandbergen, 2008). LBI is an essential element of communication between people, public, governmental organisations and business sectors. It plays a significant role in postal services and consequently it is a significant element of social communication and economic development. LBI is a significantly important concept that has been implemented in developed countries. Examples include the American zip code and the UK postcode. LBI is used by governments, organisations, institutions and retailers to keep track of their customers and participants. Today, as a result of continuous development and expansion, LBI needs to be devised to include a more robust sense of adaptation for the growing urban sprawl.

The lack of use of LBI in developing countries is the key point of this research. However, an issue surrounding the designed LBI systems in developed countries is the non-existence of justified design techniques. Hence, the designed LBI systems around the world lack intelligent features such as directional impressions of the codes. In this regard, this study presents a new technique to design LBI systems, where the codes give a view of how far a point is from the centre, in addition to the direction with respect to the centre. The technique is based on a transverse division of the area being designed. Each area is classified numerically, with respect to the four main directions or the compass (North, South, East and West). Moreover, the method indicates the approximate distance from the central point of the area being designed, by dividing the area into concentric zones.

The Kurdistan Region of Iraq has been chosen as a case study to validate the technique. The study begins with a quantitative study and many factors have been considered and examined, which may affect the adoption of LBI in developing countries - specifically within the Kurdistan Region of Iraq. Furthermore, empirically, the main effective factors of LBI adoption have been found. In this regard, the Technology Acceptance Model (TAM) and the Decomposed Theory of Planned Behaviour (DTPB) have been used as base models to test the factors that cause the adoption of LBI system in the region. The latent variables used in this study are government support (GS), self-efficacy (SE), perceived usefulness (PU), perceived ease of use (PEU), compatibility (COM), family and friends (FF), attitude (A), subjective norm (SN), perceived behaviour control (PBC) and behaviour intention (BI). Then another study has been conducted based on an open-ended questionnaire. The aim of this study is to ascertain the impacts of the LBI system in daily life. The study focused on five important points related to the accepted design of the LBI system by the users. The code format, the impact on technology, the necessity of having the system, the impact on the economy and the impact of policy, have all been studied and analysed based on the participants' views. The final study was based on interviews to assess the outcomes of the current research. The participants have been chosen based on their experience and career position. Experts and decision makers in fields related to LBI systems have been chosen. The assessment is based on four different aspects, which are novelty, applicability, scalability and the flexibility of the proposed ideas of this research.

The study is based on the positivism philosophy to observe individuals behaviour toward using the LBI system. However, a deductive research approach has been applied to provide the research hypothesis. In the first and second questionnaire, 236 and 153 respondents are involved respectively. In addition, 7 interviewers have been participated for the study assessment.

The results encourage the Kurdistan Regional Government (KRG) decision makers to develop strategies that may lead to the adoption of LBI in the region. The selection of the design has been analysed to be based on the impact of the proposed system on the different sectors of the daily life. Furthermore, this proposed SR_LBI has been positively assessed by the interviewees and will be beneficial for developing countries that have the desire to start designing their own system.

Table of Contents

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List of Tables

List of Figures

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List of abbreviations

AGFI Adjusted Goodness-Of-Fit Index

AMOS Analysis of Moment Structures

ATB Attitude Toward Behaviour

BI Behaviour Intention

GCS Geographic Coordinate System

CFA Confirmatory Factor Analysis

CFI Comparative Fit Index.

C-TAM-TPB Combined TAM and TPB (Augmented TAM)

DF Degree of Freedom

DTPB Decomposed Theory of Planned Behaviour

FSA Forward Sortation Area

GFI Goodness- of- Fit Index

GIS Geographic Information System

HCDP Human Capacity Development Program

HE higher education

ICOMOS International Council On Monuments and Sites

IDT Innovations Diffusion Theory

ISO International Organisation for Standardisation

IT Information Technology

KRG Kurdistan Regional Government

KRI Kurdistan Region of Iraq

LBI Location Based Identification

LDU Local Delivery Unit

MRA Multiple Regression Analysis

OCR optical character recognition

PBC Perceived Behaviour Control

PEU Perceived Ease of Use

PU Perceived Usefulness

RMSEA Root Mean Square Error of Approximation

SANS South African National Standard

SAT NAVs Satellite navigation systems

SE Self-efficacy

SEM Structural Equation Modelling

SR_LBI Sara Raouf Location Based Identification

SN Subjective Norms

SPSS Statistical Package for Social Sciences

TAM Technology Acceptance Model

TAM2 Technology Acceptance Model 2

TAM3 Technology Acceptance Model 3

TRA Theory of Reasoned Action

TPB Theory of Planned Behaviour

URISA Urban and Regional Systems Association

USPS United State postal service

UTAUT Unified Theory of Acceptance and Use of Technology

ZIP code Zone Improvement Plan code

Introduction

Location Based Identification (LBI)

A good and active LBI system is important for postal services, given that the efficiency of the postal operator depends on having reliable addresses. An active LBI system gives a clear location picture of people and places worldwide. In addition, a system can be utilised to study and manage personal status, health sectors and educational systems (Robards, Gale, & Martin, 2017; Sebake & Coetzee, 2013; Tewolde, 2015). In both developing and developed countries, having an active LBI system needs to be considered an essential issue. As a consequence of the absence of LBI systems in many countries, communication between individuals, organisations and its government and public services cannot be achieved effectively. Billions of people in developing and underdeveloped countries are deprived of this service, and the absence of this service, consequently, affects living standards within these countries (UPU, 2015). The system is also beneficial for governments to plan and implement better public services and policies. In addition, a better economic system can be achieved by using LBI within the financial sector of countries, such as through taxation, etc. (UPU, 2015; Vivas & Lux, 2012).

The history of LBI began thousands years ago. The system began in the form of ancient messengers serving kings and princes. The first known LBI text is found in Egypt, as far back as 255 BC. Religious missionaries and universities played a significant role in developing systems over time, for the purpose of delivering and exchanging news and information. To speed distribution and to organise messenger networks, relay stations were installed along routes of delivery. Eventually, the service provided by messengers developed and subsequently became available for public use (Vivas & Lux, 2012).

The first postal system was established on 9 October 1874, in the Swiss capital Berne, under the name of the “General Postal Union’’. As such, this day has become known as “World Post Day’’. The union developed, and in 1878, its name changed to the Universal Postal Union UPU (UPU, 2015). Currently, 192 countries are members of the union. UPU officiates between postal sector operators and provides postal services and products for its members (UPU, 2015).

The development of LBI systems varies among countries. Different methods have been used to design LBI systems based on different factors, such as national and community factors, the project stakeholders and the purposes behind having an LBI system. According to these factors, different projects for designing LBI systems have been implemented worldwide at different levels of simplicity and functionality. The international support of organisations, as well as academic researchers in this field will be beneficial to push toward further development of location based identification.

Today, as a result of the development of “information and communication technologies’’ (ICTs), the use of electronic based services is considered essential in many sectors of administration, media, business, etc. The term e-government is well-known in today’s environment of globalism and developed governmental systems. E-government is a flexible system that enables individuals and organisations to access government and public information regarding policies or rules. In addition, LBI has also been used to ensure good integration with residents by government sectors and directorates. Having an official address for each individual is a secure and efficient way to ensure one’s identity for legal, governmental and business purposes. An active and efficient LBI is an effective way of eliminating or minimising fake addresses. In the business sector, an accurate address system is helpful for online shopping and communication between the customer and the organisation. The delivery of goods, provision of water, gas and electricity, telephone, the Internet (and many other services), are dependent on an addressing system.

Generally, an addressing system plays a big role in the life of individuals. Having a recognised address gives a sense of having position in the community. Therefore, an addressing system can be considered a right for any individual in the world. An LBI system enables an individual to share his/her location in national and international markets and communities for social and economic benefits.

Problem Statement and Research Questions

Billions of people in the world cannot live as a citizen in their countries. They are excluded from the very simple right of having a legal identity, and “setting up an addressing system is the first step towards tackling that issue’’ (Vivas & Lux, 2012). The face and demographics of many cities has changed as a result of rapid growth, due to either urbanisation within a country or immigration to the country. In recent years, the population of the Kurdistan Region of Iraq (KRI) has increased by around 30% as a result of unlimited immigration to the region from Syria and Iraq. Currently, the population of KRI and many other countries and regions in the world are unknown due to unavailability of developed statistical systems (UN, 2015).

Fast population growth in urban areas of the KRI has resulted in new formal and informal settlements. Many locations within these settlements are unknown, which has a negative impact on the provision of public services. In addition, the efficiency of the business sector is also affected as a result of the absence of an active LBI system, and the health and educational systems cannot provide services equally for all citizens. All governmental and public sector services communicate with their customers based on direct personal contact in public and governmental offices. Activating the LBI system in KRI is a best-fit solution for improving governmental services such as health, education and mail. Secondly, this will reduce daily visitors to governmental, public and private service departments. This will

ultimately save time and money for customers, in addition to the possibility of reducing the number of the existing service points in each district and sub-district.

Applying different LBI systems within one country or region has negative consequences on users and system operators. The negative points can be observed in the cost of design and operation of duplicated information. Three different LBI systems have been applied in the main cities of KRI. This excludes rural and countryside areas, since no addressing systems are currently applied in these places. Because different addressing codes have been used throughout the region, new automated mailing technologies cannot be implemented within KRI until a standardised system has been introduced. Constantly, changing the LBI system over the last few decades in KRI is another reason that LBI system have been neglected by the citizens. In addition, wasting the financial budget on uneconomical or inefficient systems is antithetical to the spirit of public administration and working standards, and as such, these systems are rejected (Amen, Nabi, & Mahmood, Jan 2016).

LBI is one of the few subjects attracting limited academic study and analysis. As such, there is a significant lack of published material on the subject. Conducting studies in this field is essential in order to build a strong reference base for LBI systems, designers and addressing system operators.

Research Aims

- To develop an LBI system that can provide high granularity.
- To test KRI citizens acceptance of the developed LBI system.
- To discover the impacts of the acceptable LBI system in KRI.
- To justify the utility of the developed LBI system in different countries.

Research Objectives

- To propose a new technique for LBI system design (a modified version of the UK postcode system), and provide a sense of direction and distance from the central area within the LBI codes.
- To apply the technique and design a new LBI system for KRI as an alternative to its existing systems.
- To propose a number of hypotheses based on technology models TAM and DTPB to determine the factors of LBI system acceptance.
- To justify the acceptance of a proposed model for KRI by delivering a questionnaire based on TAM and DTPB models.
- To analyse and measure user acceptance using SPSS and Amos graphic.
- To discover the impacts of the acceptable LBI system in the daily life of KRI citizens by conducting a qualitative survey.
- To analyse the discovered themes within the data and measure the impacts of the acceptable LBI system in different aspects of daily life.
- To justify the outcomes of this research by conducting qualitative interviews with decision makers and experienced people in the fields relating to LBI systems.
- To analyse the data and present the advantages and disadvantages of the proposed technique.

Significance of the Study

Adding scientific literature to a very limited resource base on LBI (in general) is one of the main values of this study. LBI design suffers from a lack of information on the related rules and design techniques. Therefore, proposing the SR_LBI technique in the present study is a step toward an improved scientific library on the subject.

LBI is essential in organising and improving individuals' daily life. This research provides a general description of Location based Identification as an academic study. The main types of LBI systems are explained with examples from different countries that have applied LBI. This study will inform nations where an LBI system is absent to design their own LBI

system. The proposed intelligent LBI system, the SR_LBI technique (chapter 3), provides a sense of direction and distance from a defined point within the code. The proposed system is flexible and can apply in LBI design for any area.

The applicability of the proposed LBI system has been tested and Erbil, a city of KRI, has been chosen as a case study. In the present research, the main factors of the Technology Acceptance Model (TAM) have been used to justify SR_LBI in KRI, which are Perceived Ease of Use (PEU) and Perceived Usefulness (PU). Furthermore, the Decomposed Theory of Planned Behaviour model (DTPB) has been used to identify the reasons behind the lack of LBI system use in KRI. In addition, two different quality studies have been presented in this study. The first one discovers the impacts of the applied addressing system in different sectors of daily life, including a comparative study between the current KRI numeric systems and the proposed system using SR_LBI technique. The other qualitative study is an interview study, which assesses the outcomes of the current research through questioning academics, experts and decision makers. These studies make the research a valuable and justified piece of work that can be used as a raw material for further studies in the future.

Methodology and Delimitations Structure

The method of this study is based on the research onion method proposed by Saunders, Lewis, & Thornhill (2008). The research has been divided into three main parts. The first part is a quantitative study to prove the necessity and acceptance of the LBI system with KRI citizens. Then, another study has been design to discover the impacts of LBI systems in daily life. Furthermore, the outcomes of this study have been accessed by experts and decision makers in different countries.

The research hypotheses of the first study have been developed based on the Decomposed Theory of Planned Behaviour (DTPB) and Technology Acceptance Model (TAM), as a part of

the DTPB model. A positivism philosophy has been followed to observe individuals behaviour toward using the LBI system and a deductive research approach has been applied to provide the research hypothesis. This study explores theories of technology acceptance behaviour to develop a theoretical framework and identify factors that influence LBI acceptance. A structured hypotheses based on DTPB and TAM (as a part of the model) have been developed in Chapter 5 - Conceptual Model and Hypotheses. The study follows a deductive approach, using quantitative research to collect numeric data using a questionnaire as a research strategy. A survey strategy has been applied and the selection of this strategy has been justified in Chapter 6 - Methodology. A cross-sectional study, as a time horizon strategy, has been used and the data was collected between, 15th December 2014 and 15th February 2015. The questionnaire has been design using online Google Forms and the generated questionnaire links (In English and Kurdish languages) have been published and shared using emails and online social media, and the data has been subsequently collected using Google Sheets.

The second study has been designed to discover the impacts of the LBI system in addition to a comparative study between the current numeric systems of KRI and the proposed alphanumeric system. Five open-ended questionnaires have been posed using online Google Forms. The generated questionnaire links (In English and Kurdish languages) have been published and shared using emails and online social media and the data has been collected using Google Sheets. A cross-sectional study (as a time horizon strategy) has been used and the data has been collected within 70 days, from 5th November 2016 to 15th January 2017. The data has been analysed based on the detected themes from the responses.

Moreover, the third part of this study aims to provide an independent and impartial assessment for the techniques and arguments raised in the current research. The interview meetings were conducted in March 2017, based on the availability of the interviewees. The

assessment has been carried out based on decisions about the novelty, along with the applicability and the flexibility of the proposed technique.

The Structure of the Research

This thesis has been structured to provide and include a critical review of relevant information about Location Based Identification (LBI) and information technology models. The steps of the research have been presented from the design of the proposed SR_LBI technique, as a method for LBI system design, choosing Erbil as a case study to apply the system and justify the applicability of the system in KRI, by conducting three different questionnaires.

The research consists of seven chapters, in addition to the Introduction and Conclusion, and its framework is presented as below.

Introduction: This chapter provides a brief introduction to the background of the study. In addition, the research problems, the aims and the objectives, the significance and the structure of this thesis are presented.

Chapter 1: This chapter provides reviews of the literature regarding Location Based Identification systems around the world. Then, the purposes of having an LBI system, a discussion on the types of LBI systems, and how a number of countries have applied LBI is covered. In addition, the chapter includes a comparison between numeric and alphanumeric LBI systems, the scalability of LBI systems and the usefulness of LBI systems.

Chapter 2: This chapter provides a background to the Kurdistan Region of Iraq (KRI) and Erbil, the capital of KRI, which is chosen as a case study in this research.

Chapter 3: This chapter provides details on the proposed SR_LBI technique, by applying it theoretically to Erbil.

Chapter 4: This chapter provides a review of the literature related to the significance of technology acceptance models, in addition to extended technology models.

Chapter 5: This chapter provides the study's theoretical framework. The first part includes the key determinants that are expected to influence usage behaviour of LBI in general and the acceptance of SR_LBI in particular. The research hypotheses are proposed based on DTPB and TAM models to prove the acceptance of the proposed technique. Then a qualitative study has been designed to determine the impacts of the proposed LBI system for KRI, through thematic analysis. Finally, an assessment study has been introduced to justify the proposed technique in the current research.

Chapter 6: This chapter provides the present research methodology, methods and justification of the selected choices. In addition, the chapter presents the research process and design, study development, pilot study and population, sample size and data collection, methods for data analysis, and data management and analysis.

Chapter 7: This chapter provides the results of the preliminary data analysis, demographic analysis, the Structural Equation Modelling SEM analysis based on IBM SPSS Amos 22 software and thematic analysis of the qualitative studies.

Chapter Conclusion: This chapter highlights the key findings of the acceptance, impacts and the applicability of the proposed LBI for KRI, based on SR_LBI. In addition, the importance of having LBI systems and the present study's contribution to knowledge will be discussed in detail. Furthermore, the chapter provides suggestions for future studies and the limitations of this study are presented.

1 Chapter One: Location Based Identification

1.1 Introduction

In this chapter, an overview of Location Based Identification (LBI) will be presented. LBI has several different formats, which are either universally recognised or specifically recognised on a national level. For example, a specific location can be identified from a grid reference as a numeric value of latitude and longitude, or can be identified in specific countries, such as through a postcode in the UK, or Zip Code in the USA. In this research, Location Base Identification (LBI) has been chosen as the general name for identifying specific locations.

As a result of rapid technology developments over the past thirty years, the field of communication and networking has become the subject of continuous investigations. For example, smartphones have been designed as personal digital assistants by adding several applications to the original functions of the simple mobile (calling and texting), such as mapping, navigation, social networking, shopping and many other services.

The development of the navigation system has been instrumental in many other developments that satisfy daily working routines. Satellite navigation systems (SAT NAVs) are primarily based on a location based identification system (LBI). The LBI system in developed and most industrialised countries has been active for many years. However, LBI is absent or inactive in many developing countries, as well as some emerging economic countries (Zandbergen, 2008).

In the current climate, LBI is a key instrument for economic and social development. Without LBI, it can be difficult to reach individuals or places, trade outlets cannot be identified by customers, and public services can be slow. For most of society, a person needs an address to be recognised as an individual, as a citizen or as a consumer. For example to obtain a passport, to receive letters, to order goods through the Internet and

get them delivered at home, or to request assistance from the local emergency services, an address is required (Serena Coetzee et al., 2007).

1.2 Location Based Identification (LBI)

Location Based Identification (LBI) can be defined as a string of numeric or alphanumeric characters that are used to define a specific location. Virtually, it is the most compact data element capable of specifying the location of a mail addressee with high precision (Raper et al., 1992; Zandbergen, 2008). The main purpose of the design of an address is to efficiently direct the user to a specified point. This process is beneficial for the description of a location, posting mail and goods, health and emergency services, public services (electricity, water and sewage), banking and finance, tax collection, land and property registration, education, and many others (S. Coetzee & A. K. Cooper, 2007; R. Walker, 2008). Historically, this system is related to the beginning of the discovery of writing. The system has been used in many parts of the world for delivering written documents (Loewe & Shaughnessy, 1999; McClellan III & Dorn, 2015; Peterson, Twitchett, & Mote, 1998). In the eighteenth century, as a result of the expansion of the cities in Europe, street addresses have been introduced to identify individual locations (Serena Coetzee et al., 2010). However, in many developing and Middle Eastern countries, locations are defined by references rather than an addressing system. For the development of a universal addressing system, much effort has been made invested into geographical coordinates (latitude and longitude). However, unfortunately, these attempts were unsuccessful. Unlike computers, humans do not prefer coordinate type addresses, as it is not human-understandable format (S. Coetzee & A. K. Cooper, 2007; Weilenmann & Leuchovius, 2004). Alternatively in the absence of LBI, complete sets of other address elements may be used to serve the same purpose. Vivas and Lubenow (2009) states that with granular LBI, only the code is enough for the postal carrier to deliver mail to an exact destination (Vivas & Lubenow, 2009). LBI

has different names in different countries, such as postcode in the UK, the Netherlands and several other countries such as Austria, Belgium, Canada, and Denmark, whereas it is known as a Zip Code in the USA. In this study the term LBI has been used to define postcodes, postal codes or Zip Codes to prevent confusion (Raper et al., 1992; Union, 2015).

In addition to speeding up mail delivery, LBI systems play an important role in facilitating and organising governmental transactions, such as the collection of taxes, modelling crime statistics, operating geographic vaccination programs and sampling in various demographic studies. The general public. Along with transport logistics operators, are using specialist electronic tools that utilize LBI to locate places easier and faster. For example, tourists may use LBI in their satellite navigation systems to find the most visited and attractive places as well as using them to find accommodation close to those places. A special LBI code may be assigned to an individual address or to an institution that receives large volumes of mail, such as large commercial companies and Governmental public service directorates (Daunton, 1985; Vivas & Lubenow, 2009).

An important concept in the field of LBI is granularity. In designing an LBI system for an area, the greater the granularity, the smaller the area or number of delivery points covered by a single LBI. That is, with full delivery-point granularity, an LBI can be used to identify a single delivery point. With less than total granularity, LBI requires a set of complementary address elements to fulfil the purpose of delivery. When LBI has total delivery-point granularity, the complementary address description is technically redundant, however it may help avoid user and human mistakes and enable addresses to be corroborated (Vivas & Lubenow, 2009).

LBI can be designed using both alphabetical and numeric characters, which is referred to as an alphanumeric LBI format, or when only numeric characters are involved this is is known

as a numeric LBI format (Daunton, 1985; Raper et al., 1992). Each LBI format has advantages and disadvantages. The greatest advantage of the alphanumeric format is the availability to utilise 26 English characters and ten numeric digits, which can generate more LBI codes per digits used, when compared to the numeric LBI format.

In Denmark, an agreement has been made between the Danish government and the organization of municipalities to provide address data free of charge for the public and commercial users (Serena Coetzee et al., 2007). Based on a number of Danish business case analyses, addresses have a great impact on society and can be considered a significant part of the infrastructure of modern society (Lind, 2007).

The most complex element of personal information is the address and name format, because they can change often. On the other hand, the expression of a single address and full name can be made in different ways, based on the ways that are often used and recognized by people. These expressions vary from country to country, based on their culture, language, race, religion and geographical location.

More than 130 address formats and 36 name formats are in use around the world (Serena Coetzee et al., 2007). Recently, standards have been developed to include geospatial components, which are applicable to different kinds of services efficiently, such as routing emergency services, delivery of goods, connecting utilities, etc. Many researchers argue that it is the time to bring all these initiatives together and move toward a standard international addressing system (Serena Coetzee et al., 2008; Longley, Goodchild, Maguire, & Rhind, 2015).

1.3 The aims of having a standard for addressing system

The aim of having a standard for addressing system is to creating a master address list without any matches, called geo-enabled address standards, using a unique format

(including abbreviations) in order to be recognised by any automatic mail sorter. To achieve this, an address reference database needs to be created and supported by the available addressing systems around the world. Hence, a standard addressing system can be used as a major reference on the earth's surface to identify any location (Sadeq, 2016).

Since the last decade, the demand for having unambiguous addresses has increased. Hence, building an address standard has been considered at the national level in different countries, in order to develop a database for national addresses, which is essential for improving service delivery. This requirement includes all address elements, such as street names, to be spelled correctly and in solving the problem of duplication, should be associated with a correct location and LBI code, and further correctly linked with the correct geographical coordination. However in some cases, linear referencing is also required to define the location with respect to roads, pipelines, etc. Many steps have been taken to develop the addressing system in order to meet these demands. However, these steps are still considered in the early stages and more effort need to be made towards achieving the main goal, which is an international addressing system (Serena Coetzee et al., 2008).

According to a European survey conducted on addresses and address data (Levoleger & Corbin, 2005), generally, address registers are available in most European countries, however very few publications on address data standards exist. Thus, access to the address data standards of Europe became a very difficult and uphill task (Serena Coetzee et al., 2008).

In many developed countries, their LBI systems were designed many years ago with different structures based on their experience and its acceptability by the users (S. Coetzee & A. Cooper, 2007). Proposing a standard for designing LBI can be useful for both developing and non-developed countries who still do not have their own LBI system (Geelen, 2015).

However, it may be difficult for developed countries to update their LBI system to one that is based on new standards, since changing the LBI system might be unwelcome to users who are familiar with the old system (Tewolde, 2015).

One of the addressing standard is UPU-S42 that approved by Universal Postal Union (UPU) in 2002. The standard provides standard definitions of addressing components and international postal address templates (UPU/PCO, 2006). In 2007, with the participation of many European organisations, INSPIRE data specification on addresses which introduced in Europe to solve many problems that affected some policies relating to the Environment. The problems were the lack of quality, accessibility and availability of spatial information. INSPIRE can be considered as a European interoperable standard. The interoperability of this standard is able to share and exchange spatial data across the Europe. In INSPIRE, the address is considered as an identification of any fixed geographic location. According to this standard, the address can be distinguished and located by an application spatially based on the neighbour addresses and geographic position of the point. The full address has multiple components such as street name, county and country. Each component is defined by four elements which are administrative unit name, area name, thoroughfare name and postal designator. Furthermore, an address has other features such as status, unique identifier and life-cycle data (INSPIRE, 2013).

In 2011, the International Organisation for Standardisation ISO introduced ISO19160 for addressing. ISO19160 cover the conceptual framework of addressing, which is presented in UML format, and planned for other five parts which are practicing addressing assignment scheme, address data quality management, international postal address components and using addresses purposes other than mail. The aim of introducing ISO19160 is to facilitate interoperability across different specifications of addressing system. However, the conceptual model of ISO19160-1 describes the common address concepts, specifications and the relationships among them (ISO, 2015). A South African National Standard (SANS

1883) has been introduced in 2004 by South African Bureau of Standards SABS (Coetzee and Cooper 2007) based on ISO19160-1. The aim of this project was to generate an interoperable system for the data of LBI and geographical information systems (GIS). Computer based software has been used to detect and fix any existing errors in the address data. This work is a good step toward address standardisation especially in South Africa. Coetzee et al. 2011 suggested some principles for the design of National addressing scheme. In addition, the research show that the trade-off between the users' needs, the digital representation of the systems and the physical world should be taken into consideration in the design of LBI system. However, SANS has its own conceptual model and having different conceptual models is the significant challenge in order to generate a unique address standard.

(Tewolde, 2015) believes that the only way to generate a standard system is the design of an interoperable system based on the existing LBI systems all over the world. A semantic approach has been used in that research to facilitate the interoperability of the existing address systems based on ontologies. The suggested interoperable system uses the semantic web infrastructure in order to be accessible by the users in any parts of the world. The research proposed a good solution to combine different existing systems in different countries. However, fixing the problem of duplicated LBI codes and proposing a standard conceptual model for the places that do not have LBI system yet are the major limitations of the research.

There are some principles needed to design a good and effective LBI system. The proposed codes should be public and not "hidden", there should be uniqueness of names (codes) for a country, they should be easy to use and memorise, and they should be structured at least to the level of specific areas within each country (Serena Coetzee, 2012). This research aims to build a base on which to develop techniques that can be used in LBI structure design. The LBI technique proposed in this thesis, and discussed in Chapter 3 SR_LBI

technique, has been designed and tested in Erbil, Iraq (The Capital of the Kurdistan Regional of Iraq). The method has been validated by quantitative and qualitative surveys, as discussed in Chapter 7 Results.

1.4 Types of LBI

According to the last annual report of the Universal Postal Union (UPU) in 2013, 152 of the 192 member countries of the UPU have their own LBI system, and 55 different kinds of electronic services offered by post. However, many of these countries have less than average granularity, or the system only covers rural areas (Union, 2015).

The main purpose of having a correctly identified LBI system is accelerating the process of sorting and delivering mail. Introducing well-organized LBI decreases the delivery cost of mail and parcels for the mailer as well as for the addressee (Sebake & Coetzee, 2013; Vivas & Lubenow, 2009). LBI systems can be classified according to the characters that are used for generating the codes into Numeric and Alphanumeric format, which are discussed below.

1.4.1 Numeric Format LBI

The numeric format LBI consists of a series of digits ranging from 0 to 9, which identify administrative and/or identification areas. The length range of this type is usually between four to thirteen digits. In many countries, such as Mali, Libya, and Iraq, a five digit LBI has been used to define post offices or large areas, which has led to less than total granularity (Union, 2015). Another example is the USA as they designed the ZIP code using only a 5-digit code, then four more digits were added in 1983 (Unioun, 2016). Short LBI codes are usually considered easy to memorise and use by the users. However, due to using limited digits (10 digits from 0 to 9) in their code design, a numeric LBI type cannot define all places within an area using only a few digits. Hence, most countries that use a numeric LBI define specific locations using 9-13 digits. LBI codes with more than five digits are often

divided into two parts, with separation or punctuation. Many countries use a digital LBI format such as the United State of America, France and Germany (Vivas & Lubenow, 2009).

In the USA, a ZIP code (Zone Improvement Plan) has been introduced in 1963 (Brock, 2001). Originally, a ZIP code system was rolled out consisting of five digits. The first digit symbolizes a certain group of states; which divides the USA into 10 large groups of states, numbered from 0 in the North East to 9 in the West, as shown in Figure 1-1 below. Within these large areas, smaller geographic areas were created and identified by the 2nd and 3rd digits of the ZIP code. Finally the 4th and 5th digits identify a post office or local delivery area (Grubesic, 2008; Raper et al., 1992; TTG, 1998).

To make the ZIP code system more specific, 4 digits were added to the system in 1983 by the US postal service (USPS). The new system is known as "ZIP+ 4", often called "plus-four codes" or "add-on codes" (TTG, 1998). The function of the additional four digits is to assist the USPS automated sorting equipment (postman) (Brock, 2001). A delivery ‘sector’, such as city blocks, a group of streets, office buildings, or a small geographical area are identified by the first two digits of the additional four digits. The last two digits represents the specific segment, such as a floor of an office building, one side of a street, a firm, a city council office block or other specific geographical place (TTG, 1998; Vivas & Lubenow, 2009).

The Australian postcode is another example of a numeric LBI that was introduced in 1967. The design is based on 4-digit numeric codes. The first digit indicates the state or territory as shown in Figure 1-2 and the last three digits indicate a delivery area. To reference a specific location, such as a single building or a house, the street name and the location number are used. The Australian LBI is similar to the first segment of the ZIP code of the United States (UPU, 2015; "ZIP POSTAL CODE," 2015).

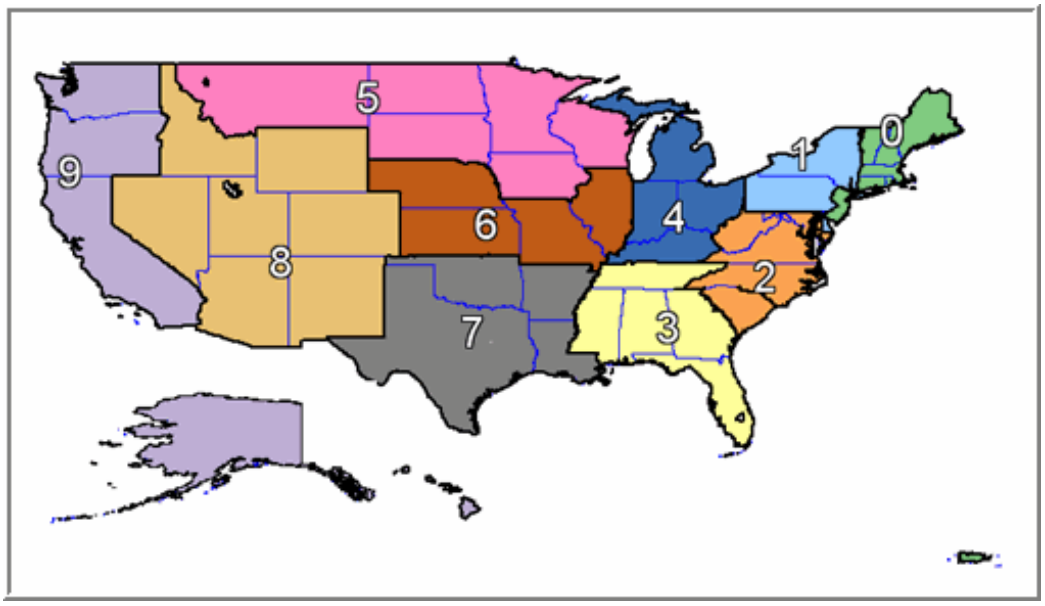


Figure 1-1 ZIP Code of the United States (TTG, 1998)

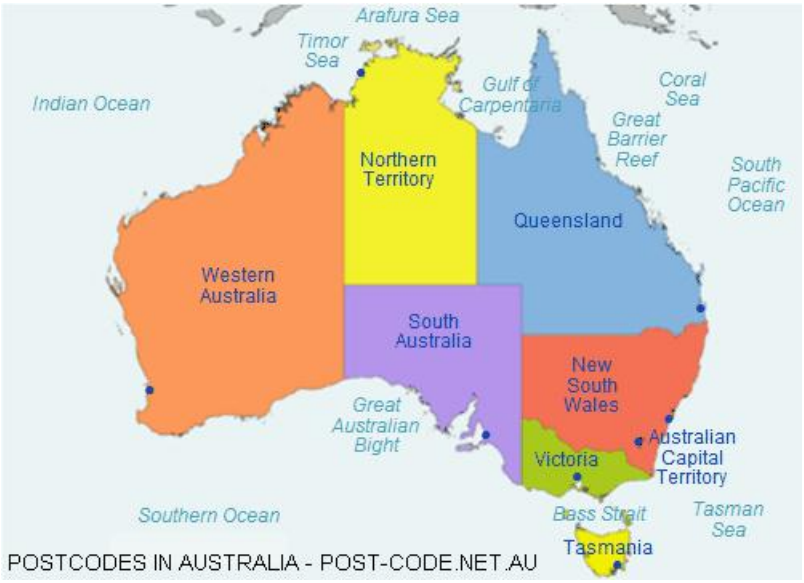


Figure 1-2 Australian LBI system ("Australian postcodes," 2011)

In France, five-digit numeric LBI codes are used. The first two digits define the department that the post office, city or town is located within the country. The department numbers were implemented between 1860 and 1870. In addition, the system is extended to overseas

departments and territories, however the digits 00 are used for Military locations and 20 for all addresses in the island, Corsica. The next three digits of the codes identify the local postal offices that are responsible for mail delivery, as shown in Figure 1-3 (UPU, 2015).

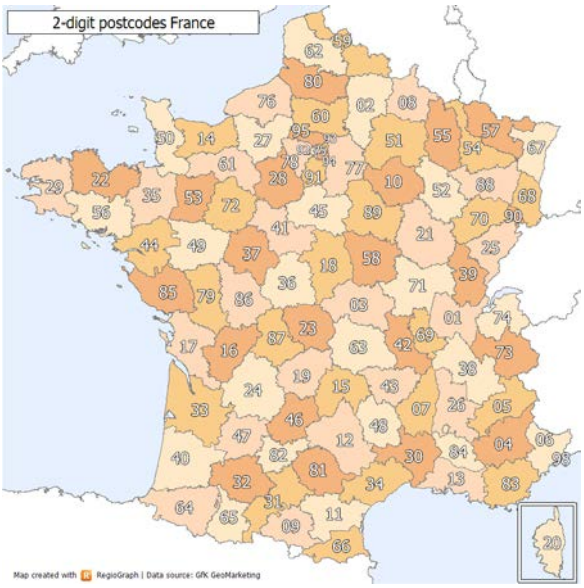


Figure 1-3 France first 2-digit LBI code

The 5-digit US Zip Code has been used by other areas or islands as an LBI. For example, in Guam, the Marshall Islands and Micronesia. However, other areas use the France Code Postal system as their LBI, such as Guadeloupe, French Polynesia, Mayotte and New Caledonia ("Mapanet Geo Postal Codes Database," 2015).

To summarise the numeric LBI system, several examples have been presented to show the general idea of designing an LBI system. In general a country or a region is divided into groups of cities or states and referenced using a number. Each group is subdivided into smaller areas using additional numbers as a reference. The majority of the available numeric LBI systems are designed as 5-numerical characters, which is considered less than average LBI granularity (Unioun, 2016).

1.4.2 Alphanumeric Format LBI

The alphanumeric LBI code consists of both numeric and alphabetic characters. Due to the availability of 26 individual characters in the English language, a significant number of locations can be defined by using codes with a fewer number of characters (short codes). Thus, the alphanumeric format with a mix of characters can generate more than double the amount of individual codes than using the numeric format, with the same number of characters. For example, a two digit numeric format XX can generate up to 10^2=100 codes using 0 to 9 (00 - 99). However, a two character alpha format XX can generate 26^2= 676 codes using 26 English letters A – Z.

The LBI systems of some countries and regions are designed based on an alphanumeric format. The Canadian LBI consists of six alphanumeric characters in the form of “ANA NAN” where “A” represents an alpha character and “N” represents a numeric character. Most of the LBI formats with more than five characters are divided into two sections, which are named the outward and inward part or segment. The first part (outward – on the left) in the Canadian LBI is known as the Forward Sortation Area (FSA) and the second part (inward – on the right) is known as the Local Delivery Unit (LDU). The FSA is a combination of (Alpha-Numeric-Alpha) that represents a major geographic location of urban or rural places. The LDU part consists of Numeric-Alpha-Numeric characters and represents the smallest delivery unit within a specific FSA ("CANADA POSTES," 2015; Vivas & Lubenow, 2009). The LBI structure of Canada is illustrated in Figure 1-4.

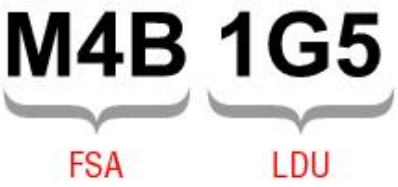


Figure 1-4 LBI structure of Canada ("CANADA POSTES," 2015)

The first segment of LBI (FSA) defines a specific area within a major geographic region or province. This segment is used as a base for the primary sorting of forward mail. The first character of FSA identifies one of the 18 major geographic areas, provinces or districts of Canada, as shown in Figure 1-5.

Figure 1-5 First segment of postcode of Canada (FSA) ("CANADA POSTES," 2015)

The second character of FSA identifies an urban or a rural location. The numbers 1 to 9 identify urban Locations (e.g. M2T) and 0 identifies a rural location (e.g. A0A). The third character of FSA in conjunction with the first two characters, defines an exact area in cities, towns or other geographic areas, as shown in Figure 1-6.

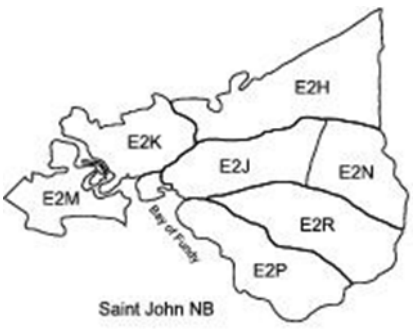


Figure 1-6 Example FSA of Canada ("CANADA POSTES," 2015)

The three characters of the second segment (LDU) in urban areas indicate a specific city block (one side of a street between two intersecting streets), a single building or a large volume mail receiver. In rural areas, LDU, together with FSA, identify a specific rural community ("CANADA POSTES," 2015; UPU, 2015).

Another example of using an alphanumeric LBI is Andorra's LBI system. The system was introduced in July 2004, approximately 11 years after becoming a sovereign nation on 5th May, 1993. The LBI format of Andorra is [AD] NNN for example AD200. AD represents the country code (ISO code) and the first number can be in the range 1-7, which represent the 7 parishes of Andorra. The last two numbers are usually 00 (see Figure 1-7) and the specific location can be addressed by writing street name and the house or building number. 01 is used for the last two digits to identify post offices. For example, a letter sent to a PO Box address in Andorra la Vella parish would require the postcode AD501 (UPU, 2015; Vivas & Lubenow, 2009).

Figure 1-7 Andorra LBI system

The last example of an alphanumeric LBI system is the United Kingdom. In 1959, a full six-digit postcode system was introduced in Norwich in the east of England. The letters NOR represented the city and three characters were used for a specific street. The current United Kingdom LBI system was rolled out across the UK, re-numbering Norwich in 1974 (Amin & Wilson, 2014). The UK LBI consists of two parts separated by a space as in the Canadian LBI. The UK LBI format is more geographically detailed than systems in other countries. The symbol of each city and town can be seen in the beginning of the first part of the code, as shown in Figure 1-8, and the district number at the end of the first part. The second part of the LBI code, together with the first part of the code can define the exact delivery point (area) (Daunton, 1985; Raper et al., 1992).

Similar to the Canadian postcode and other alphanumeric LBI systems, the UK LBI is not designed to identify any specific direction or distance from a specific point. An exception to this can be seen in the capital of England, London. London is divided into 8 districts North (N), North West (NW), West (W), West Central (WC), South West (SW), South East (SE), East (E) and East Central (EC) (Daunton, 1985). The proposed technique in this study (discussed in Chapter 3 SR_LBI technique) can be considered a modified version of the UK LBI system.

Figure 1-8 The United Kingdom LBI system [online UK postcode Image]

To summarise, the alphanumeric LBI system produces a short length code with high granularity. Furthermore, using alphanumeric LBI codes is preferable for many populations, companies and governments, because it is characterised as easier to remember and use than numeric codes (Raper et al., 1992; UPU, 2015; Vivas & Lubenow, 2009).

1.5 Comparison between LBI formats

After explaining the alphanumeric and numeric formats of LBI, a few examples of each format have been discussed. Each system has advantages and disadvantages. The design of an LBI system for a medium sized country area requires at least a 9 digit code format in order to divide the cities and regions into small areas. However, it is possible to address more than double an area using an alphanumeric format LBI for the same code-length.

Although numbers are easy to read and write by users, a long series of digits is difficult to memorise. Phone numbers are a typical example. The LBI code of most countries that use the numeric format is between 4 and 5 digits and only addresses post offices in that area or a wide area with less granularity. To address a whole country in smaller areas, 9-14 numeric characters are required for the LBI code, such as the 9-digit US Zip Code.

However, the alphanumeric LBI code is shorter. As a result, short codes are easy to memorise and use. Using the first character of an LBI as an area code based on the area character helps users to easier remember the code. The survey results of this study, explained in Chapter 7, concluded that 98% of the total participants (more than 254 participants) would prefer to use an alphanumeric LBI format, if they had a choice. Most of the participants found that alphanumeric codes are easy to memorise, because they have less characters than a numeric code. However, the alphanumeric LBI code is more appropriate for English speaking countries than non-English countries. Non-English characters may not be supported by most electronic mapping and recognition systems. Also English characters may not be understood by some non-English users. Furthermore, as a result of some similarities among specific letters and numbers in hand writing, some characters are not used in LBI codes in many alphanumeric systems, such as characters G with C, I with 1, K with some other letters like L or Y, M with N, O with 0 and V with U.

1.6 Scalability of Postcode Systems

Postcode systems of many countries based either on numeric and alphanumeric styles have been discussed previously. Both styles have advantages and disadvantages. The main advantages of numeric postcodes are as follows:

1) The system can be applied in any English or non-English language country, since the majority of people around the world are familiar with English numbers. In addition, most the

educated people are using English numbers on many devices, such as calculators and phones (Union, 2015).

2) Numerical codes are easy to sort and the user can follow the street numbers easily (Vivas & Lubenow, 2009).

However, there are some disadvantages of using numeric system styles, such as:

1) The availability of limited characters (numbers 0 to 9).

2) To provide an address for an area to identify streets, 9 or more single digits are needed (Union, 2015; Vivas & Lubenow, 2009).

3) It is easy to make mistakes when using a long sequence of digits and it is difficult to memorise (UPU, 2015).

Using alphanumeric system style has some disadvantages such as:

1) Using English letters is not recommended in some non-English countries (Daunton, 1985; UPU, 2015).

2) Finding a specific street manually is more difficult when compared with using numeric codes (Vivas & Lubenow, 2009).

However, many adventages can be highlighted in using the alphanumeric system style such as:

1) Access to 36 different design characters, i.e. the 26 English letters and 10 numeric digits.

2) Based on the alphanumeric style, the same amount of codes can be generated by using less code characters (shorter code length).

3) Choosing letters from the formal name of the area as the area code at the beginning of the code is easy to distinguish and memorise (Raper et al., 1992; Vivas & Lux, 2012).

By using 36 characters of letters and numbers, a two character code can generate (36^2= 1296) different codes. While, in numeric style, by using two digit codes, (10^2=100) codes can be generated. As a result, using an alphanumeric format is more scalable when compared with the numeric format. Finally, a short postcode is more preferable by the users, since generally the short codes are easy to use and memorise. In addition, to the data analysis of the current study, Chapter 7 - Results presents solid agreement with the previous arguments, since the majority of the participants of the study prefer to use alphanumeric codes.

1.7 **Benefits of LBI system**

According to presentations at the Urban and Regional Systems Association (URISA) annual conference 2007, standardised addresses are beneficial to various sectors of the economy, society and governance in case studies of the United Kingdom (Barr, 2007; Nicholson, 2007), Denmark (Lind, 2007) and South Africa (S. Coetzee & A. Cooper, 2007). These benefits can be applicable to any countries worldwide.

As explained in the previous sections, the addressing system has significant applications in the economy sector, in sending invoices, delivering goods, making customer databases and advertisements, encouraging local tourism, creating bank accounts, and so on. Address databases are created through different methods, such as online registrations or paper forms. These databases usually include both intentional and unintentional errors and mistakes. Eliminating these errors could be achieved by capturing addresses based on a standardized system (Serena Coetzee et al., 2008; Sebake & Coetzee, 2013). According to the cost-benefit analysis of Lind (2007), 0.7% of the street names of Denmark are repeated more than once, within a given area. Thus, additional address elements are required, such as the place name, in order to eliminate differences and achieve uniqueness. The study focuses on the annual losses of different sectors, such as a wrong address given to an

ambulance, extra work for mail delivery, inaccurate management of data, etc. The study clearly demonstrated that the cost of a new standard addressing system that eliminates uncertainty in address data is less than the aforementioned losses per annum.

LBI systems have been established in the 19th century for the purpose of mail delivery (Longley et al., 2015). The systems were introduced based on the assumption that every country, area, road and property is unique. Therefore, LBI systems can be represented as a robust method of identification. On the other hand, navigation systems are one of the most useful systems in daily life in developed countries, as a result of the expansion of cities and increases in mobility. In addition to local people in cities using these systems, which are based on LBI systems, they are also beneficial for tourists and visitors. Thus, destinations can be found by using navigation tools in less time and with less effort, which is a good solution for many drivers.

In many countries, their LBI system is the main factor towards economy growth. In South Africa, proof of residential address is required for opening an account in a bank or any other financial institution. However, no street delivery is available in rural areas, which is a significant problem for villagers and negatively affects their economic situations. Since the last decade, the process of providing LBI for rural areas has been continuous by sending welcoming packs through the mail by the African Post Office (S. Coetzee & A. Cooper, 2007). This process will lead to make rural areas a part of modern society.

In addition to using LBI systems in the private sector, the system is particularly beneficial for governmental work. In many countries, many sectors, such as health, education, and public services, are run by governmental departments, and the LBI system is an effective factor in improving these services. Furthermore, the system is the backbone of the department of tax collection, police, statistics and many others. An LBI system that is accessible through web services and IT developers leads to developing applications of e-

Government, which has happened in many European countries, such as the United Kingdom and Denmark (S Coetzee, Cooper, & Lind, 2008; Nicholson, 2007). Finally, addresses are used in many countries to manage the registration of the elections process.

The main goal of having an LBI system is to facilitate the routing and sorting of letters and parcels, anto improve mail delivery. It also represents the natural first step towards – and almost a precondition for – the automated sorting of a large proportion of mail. Although there are systems for reading and sorting addresses without LBI in mail, they are less accurate than systems where addresses are accompanied by an LBI (Vivas & Lubenow, 2009).

LBI is a very useful tool for various economic and social stakeholders. Today, LBI enters most areas of commercial life, such as banks, insurance companies and mail-order firms. LBI can help local businesses distribute information and offers. They also provide a way of gathering statistics and comparing different LBI areas, on any number of levels, to identify market segments. LBI can facilitate international and cross-border mail exchange. In doing so, they help promote the further development of the mail medium (Vivas & Lubenow, 2009).

LBI provides critical information for emergency response, administration, mapping, GIS, research, marketing, routing and navigation, among many other purposes (Vivas & Lubenow, 2009). Addresses are one of the most essential means by which populations conceptualise locations in the modern world (Zandbergen, 2008). In a Geographic Information System (GIS), addresses are converted to features on a map through longitude and latitude numbers (a geocoding process) (Sadeq, 2016).

Another purpose behind having LBI is to save time and money. For example, in the United Kingdom, to apply for a driving licence or any issues relates to driving or the vehicle itself, applicants send their documents to the Driver and Vehicle Licence Agency (DVLA) in

Swansea city by post, without direct contact with the office. Thus, fewer employees are needed to meet the public or have direct contact with them. However, in the Kurdistan Regional Government, there are four main offices in the four main cities for driving and vehicle licenses. Every day, hundreds of applicants directly contact the licensing offices. As a result, more employees are needed to manage the work efficiently, which means spending more money to meet their targets. At the same time, the applicants have to leave their jobs during the day in order to make direct contact with the officers, and this process may take more than a day to complete. Moreover, the transport cost for any visitor is much more than the fee of a first class stamp, if they were to send the application by post.

1.8 Other similar systems

1.8.1 Geographic Coordinate System

The Geographic Coordinate System GCS can be defined as the geographic way to define every location on the ellipsoidal surface of the earth using a set of characters (letters, numbers and/or symbols). The system is based on latitude and longitude values. One of the code numbers represents a vertical position and two or three numbers represent a horizontal position of the point being coded.

As shown in Figure (1-9), the latitude point of any point is the angle between the joining line between the point and the centre of the earth and the equatorial plane. However, the longitude is the angle east or west of a meridian that pass through the point being coordinated to a reference meridian. The meridian that passes through Greenwich in south-east London is considered as the international prime meridian. The Western and Western Hemispheres are determined by prime meridian. These Hemispheres always presented in the maps further west in order to show the whole world in one side (Janssen, 2009; Sadeq, 2016).

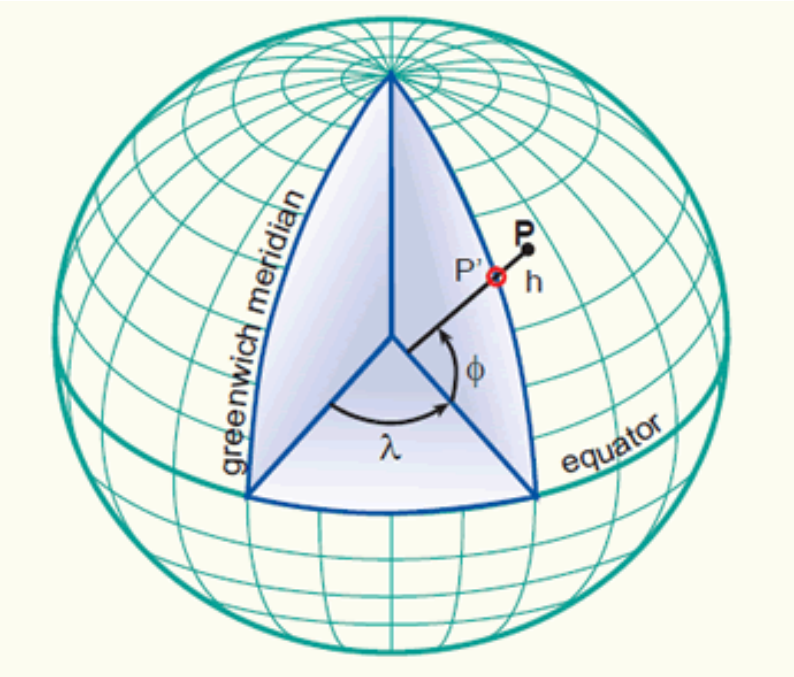


Figure 1-9 Geographic coordinate system (Sadeq, 2016)

Geographic coordinate system has been utilised by (Sadeq, 2016) to design a short postcode system for any cities and countries. The technique of image recognition, and Cadastral maps have been used to detect every single houses. The technique has also been applied to the forest map and unique codes have been generated for every single tree. Erbil city map has been used as a case study and the codes have been generated randomly in alphanumeric format. A letter has been used, followed by 4 digits latitude then 4 digits of longitude codes as shown in Figure (1-10). The author proposed the technique to be an alternative to the traditional addressing system (postcode, street name and property number). However, strong justifications needed in order to support this proposal which is a significant gap in this study.

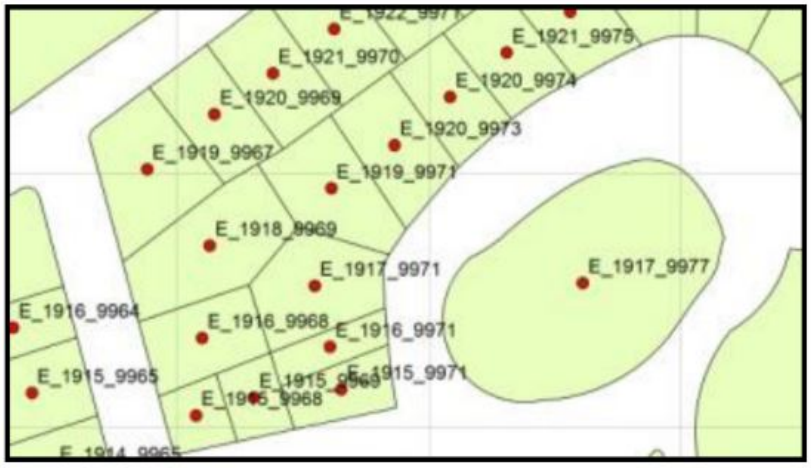


Figure 1-10 A sample of the proposed project by (Sadeq, 2016)

1.8.2 Road Numbering system

Another similar system to LBI is the road numbering system. In the Iraq and Kurdistan region, like many developing countries, the roads are very poorly numbered. However, there are many developed road numbering systems around the world - for example, the United Kingdom, the United States and Germany utilise road numbering and classifications.

Originally in the UK, there were similar roads without any names or numbering, along with poor traffic signs. Then, for road maintenance purposes, action was taken by the local government in 1910 to organise the roads based on a widely understood system. Rees Jeffreys the head of the Roads Board, a governmental department, started work with his colleagues to renovate the old roads and built new ones using the money from petrol taxes and new roads. Due to the unavailability of data about these roads, these efforts were not effective to solve the existing traffic problems (Monterie, 2002; Mulley, 1983; G. Walker, 1956).

In 1913, efforts were rekindled under the supervision of senior engineer, Sir Henry Maybury. They classified and categorised the roads based on how busy they were. Their proposal was submitted in 1914 in order to facilitate works between the central

departments and the local authorities. Each road was given a reference number from its commencement to termination, for example, a single number was given to the Great North Road from London to Inverness. Then, all the roads were classified and marked on a map showing the roads connected with significant and important places together and those that carried considerable traffic were marked with a class I symbol, and the rest by Class II. The letters T (from Trunk) and L (from Link) were used for both Class I and Class II roads respectively. Then, these letters were replaced by A and B. These letters look like an area code in the LBI system. These letters are followed by numbers to split the roads from the junctions. This process will facilitate the process of maintenance requests (Hey, 2010; Marshall, 2016; Mulley, 1983).

The first digit divides the country into 9 zones, A1-A6 (for England and Wales) and A7-A9 (for Scotland). The zones A1-A6 begin from the borders of London and zones A6-A9 start form the border of Edinburgh, as shown in Figure (1-11). The roads have given the numbers clockwise, starting from the north A1 to Edinburgh, ending with A6 to Carlisle, except the A14 road (which is relatively new). However, some of the roads were renumbered recently to prevent confusion with motorways and others have been discontinued due to the replacement with more major roads. Similarly, in Scotland, the roads were numbered starting with A7 to Carlisle (southwest) and ending with A9 to Thurso (north) (Marshall, 2016; memorandum, 1961).

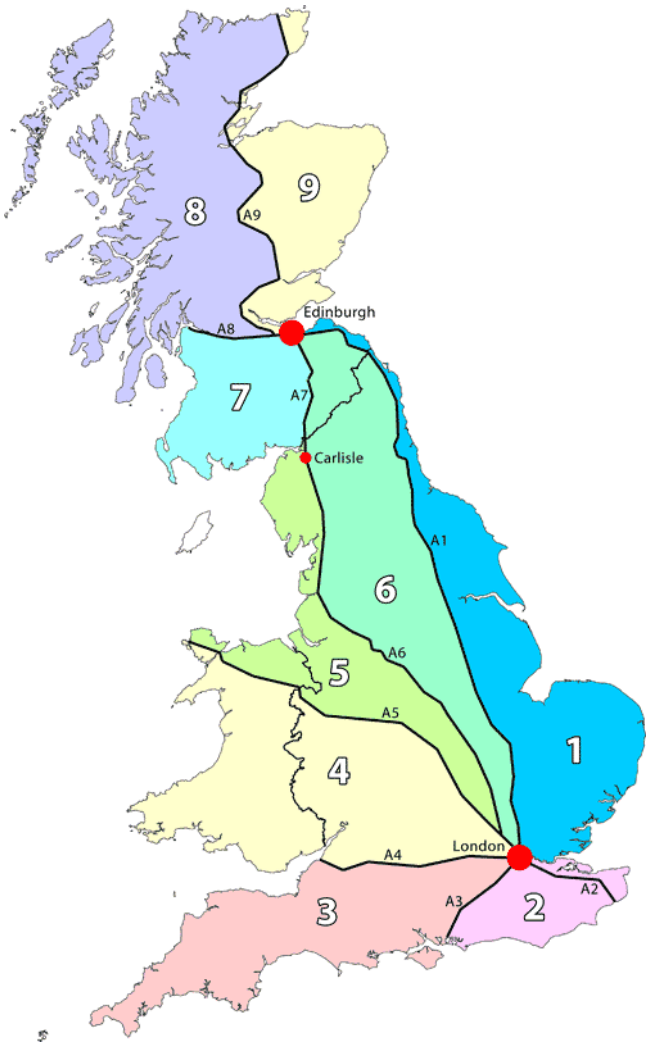


Figure 1-11 The UK A routes (Marshall, 2016)

This plan has been applied to all road types in the UK, such as the motorways (M). To prevent confusion between A and M roads with same numbers, both roads with the same numbers should go approximately in the same direction, except the A5 road, which creates a right angle with M5. Each road can have a 4-digit number in addition to the letter as shown in Figure (1-12). Generally, longer routes have lower numbers than shorter routes (Marshall, 2016; memorandum, 1961).

Figure 1-12 The UK Motorways (Moss, 2014)

In the United States, the road numbers (single or double digits) are based on road directions. The interstate highways have been numbered with odd numbers for north-south routes and even numbers for east-west routes. In addition, according to the northbound and eastbound direction, the numbers increase. The routes with three digits are created with single or double digit routes by pre-appending a digit. Hence, odd numbers represent routes into a city, while even numbers represent routes through or around the city. Each state has been represented as a separate area. Thus, the three digit numbers have been used in each state separately. For example, there are seven interstates numbered with 295.

Regarding the US highways, routes numbered with odd numbers (under 102) represent east-west routes in general, see Figure (1-13). In addition, according to the northbound and eastbound direction, these numbers increase (Monterie, 2002; Weingroff, 1997).

Figure 1-13 An example of US route numbering (McMillin)

Motorways in Germany have been numbered with single digit numbers for long distance routes and by double digit numbers for short distance routes. The three digit numbers represent local connections. In general, the route zone numbers increase according to their southbound direction. Despite few exceptions, the north-south routes and east-west routes are represented by odd numbers and even numbers respectively. The odd double digit route numbers (beginning with the same digit) increase to the east, while the even route numbers increase to the south (Liu et al., 2012; Monterie, 2002; Zeller, 2007).

To summarise, the road and motorway numbering of three different countries have been presented. This design has been used in order to minimise confusion and facilitate finding routes as easy as possible. The idea of using odd and even numbers for routes based on direction is the general key point of the design in all the aforementioned countries. Since

the design of an LBI system has the same aim of minimising confusion and mistakes, adapting this idea will be useful in creating an LBI system design.

1.9 Conclusion

In this chapter, a brief discussion about how developed countries have designed their LBI systems has been presented. The discussion illustrates the importance of LBI in organising many governmental systems, along with company and user applications. Different types of LBI formats, with examples, have been explained. The differences between both numeric and alphanumeric formats are explained in terms of the number of characters used in code generation and their code granularity. The benefits of an LBI system in different sectors has been explained. In addition, LBI systems can be used to organise governmental systems and improve service sectors, such as collecting taxes, health and security systems. Furthermore, road numbering systems, as an example of a similar system to LBI systems in different countries, have been discussed.

2 Chapter Two: Kurdistan Region of Iraq (KRI)

2.1 Introduction

Within Iraq, Kurdistan, as a region, has improved rapidly. The availability of natural resources from oil and gas, political stability and improvements in government, have provided significant incentives for international companies to invest in Kurdistan, and for governments worldwide to open their consuls in the region.

This chapter will present general information on Kurdistan, the KRI in particular. It will also cover language, education, geography and climate. Furthermore, the current LBI system in KRI will be explained in detail and the weaknesses of the system will be highlighted.

2.2 Background of Kurdistan

Kurdistan, which means the land of the Kurd, refers to the geo-cultural region where the Kurdish people reside. The Kurds are an Indo-European people who lived in the mountainous areas of the Middle East about four millennium ago (Abdulla, 2012). However, the exact origins of the term Kurd are unclear (Asatrian, 2009). According to Assyrian underlying toponymal, the name is recorded as Qardu and Kar-da in Middle Bronze Age Sumerian (Reynolds, 2004).

In contemporary terms, the name Kurdistan refers to greater Kurdistan, which includes south eastern Turkey (Northern Kurdistan), north western Iran (Eastern Kurdistan), northern Iraq (Southern Kurdistan) and north eastern Syria (Western Kurdistan) (Abdulla, 2012; Bengio, 2014; Ham, 2010).

Geographically, Kurdistan covers about 390,000 km². Northern Kurdistan is approximately 190,000 km², Eastern Kurdistan around 125,000 km², Southern Kurdistan around 65,000 km² and Western Kurdistan around 12,000 km²(Abdulla, 2012; O'Leary, 2002).

2.3 Kurdistan Region of Iraq KRI

In 1992 the first Kurdistan Regional Government (KRG), was established in Iraq. Today, with a population of 5.2 million and increasing (DMI, 2016), the three governorates of Erbil, Slemaniyah, and Duhok cover approximately 40,643 square kilometres of Southern Kurdistan (O'Leary, 2002).

Mountains are considered an important geographical and symbolic feature of Kurdistan. Historically, mountains protected the Kurds from their enemies, as evidenced by the saying "*Kurds have no friends but the mountains*." (Bulloch & Morris, 1992). The most well-known mountains are Judi, Ararat (both prominent in Kurdish folklore), Cheekha Dar, Zagros, Shingar, Qendil, Shaho, Gabar, Hamrin, and Nisir. Until the 1980s, the majority of the population in the Kurdistan region population lived in villages and in mountainous areas. They were dependant on farming and animal husbandry, mainly goats and sheep, thanks to the land's fertile soil. At that time, the KRI was known as the breadbasket of Iraq (GROUP, 2013). Today as a result of a booming financial situation, the majority of the KRI population reside in the main three cities of Erbil, Sulaymaniyah and Duhok (Major, 1996; O'Leary, 2002).

2.3.1 Language

Kurds have often been called the largest ethnic group in the world without a state. The majority of the people living in the Kurdistan Region of Iraq are Kurds, together with minority populations of Assyrians, Chaldeans, Turkmen, Armenians and Arabs. The most widely spoken literary versions of Kurdish are based on two major dialects of Sorani-Kurdish and Kurmanji-Kurdish. Sorani-Kurdish is spoken in the southern and south eastern parts of greater Kurdistan (Northern Iraq and eastern Iran) and is generally written in a modified version of the Arabic-Persian script. The Latin alphabet is widely used for Internet communication. Some Sorani-Kurdish media and a limited number of Sorani-Kurdish

publications are also written in Latin script. Kurmanji-Kurdish is spoken in the northern areas of Kurdistan (in Turkey, Armenia, Syria and northwest Iraq) and is written in the Latin script, except in northern Iraq, where Arabic-Persian is used. Other spoken Kurdish dialects are Hawrami (also known as Gorani) in the Kurdistan Region of Iraq, and Zaza in the Northern Kurdish area of Turkey. In the KRI, Sorani-Kurdish is spoken in the Erbil and Sulaymaniyah governorates, while Kurmanji-Kurdish is spoken in the Duhok governorate and in some regions of the Erbil governorate (DMI, 2016; Ham, 2010; Sheyholislami, 2011; Soane, 1913). KRG follows the policy of accepting both main dialects in the education system and the media. The primary school Curriculum in the Duhok governorate is based on the Kurmanji-Kurdish dialect, whilst it is based on Sorani-Kurdish dialect in Erbil and Sulaymaniyah primary schools.

Many Kurdish-language media stations have been developed and most of these have satellite channels. Programs are presented on these channels in both dialects of Sorani-Kurdish and Kurmanji-Kurdish. In recent years, the use of both main dialects in the media has emerged among Kurdish people, as most people now understand both dialects. Over the last 15 years, KRG has promoted linguistic diversity and the rights of linguistic minorities. Many schools have been established in the region that teach partially in Arabic, Turkmenia, Assyrian Neo-Aramaic and Chaldean Neo-Aramaic (McDowall, 2003). Furthermore, due to the desire of the people of KRI to learn the English language, many schools have been established that teach mainly in English. Hence, it is expected that proposing an alphanumeric LBI system using English letters will be welcomed by KRI's citizens.

2.3.2 Educational system in KRI

In many countries worldwide, universities are a significant part of higher education (HE). The HE sector in KRI plays an essential roles in developing the country and is part of the country's effort to democratise its political system and modernise its society (Harb, 2008).

Following the old Iraqi educational system, KRG offers free education for all stages of primary, secondary and HE for both its own student population and international students. In addition, there are a number of private schools and universities. The six largest governmental universities are Salahaddin University in Erbil, the University of Sulaimaniyah, the University of Duhok, Hawler Medical University, Koya University and Soran University. These universities offer free undergraduate and postgraduate places in various subjects, leading to specialised diplomas, bachelors, masters and doctorates degrees, in addition to free accommodation for staff and students who come from outside the city (DMI, 2016; Harb, 2008). The free education system in the KRI has a great impact on increasing the percentage of educated people. According to a recent survey by the Ministry of Higher Education in the KRI, the total number of students in higher education institutes in the Kurdistan region is 94,700, of which 48% are female students (MOHE, 2016).

2.3.3 Erbil City the capital of Kurdistan

Erbil, also known as Hawler, is the capital of the Kurdistan Regional of Iraq (KRI). The Administrative structure of Erbil governorate consists of 10 districts and 34 sub-districts. A governor heads the Governorate and Mayors head the districts. Erbil is one of the oldest cities in the world and an ancient home to a Neanderthal culture; archaeological remains have been discovered at Shanidar Cave dating back between 65,000 BC and 35,000 BC. There is also a number of pre-Neolithic cemeteries, dating from approximately 11,000 BC (Solecki, Solecki, & Agelarakis, 2004). In the city centre, there are two well-known historical monuments: The Great Citadel and the minaret at Choli. The citadel of Erbil is the world's oldest continuously inhabited settlement, as shown in Figure 2-1. According to the International Council On Monuments and Sites (ICOMOS), eight thousand years of settlement have been recorded in this area and it was added to the UNESCO world heritage list in June 2014 (McDowall, 2003; McGahey, 2006; Pavelka, Svatušková, & Králová, 2007). The complex design of the buildings and the narrow streets enclosed by town walls are the

main landmarks of the city. The fortifications of the citadel were built in the 12th century and renovations are taking place at the time of writing this. The Choli minaret, which is the last part of the oldest Mosque in Erbil, dating from the 14th century, is considered one of the most significant Kurdish monuments (Pavelka et al., 2007).

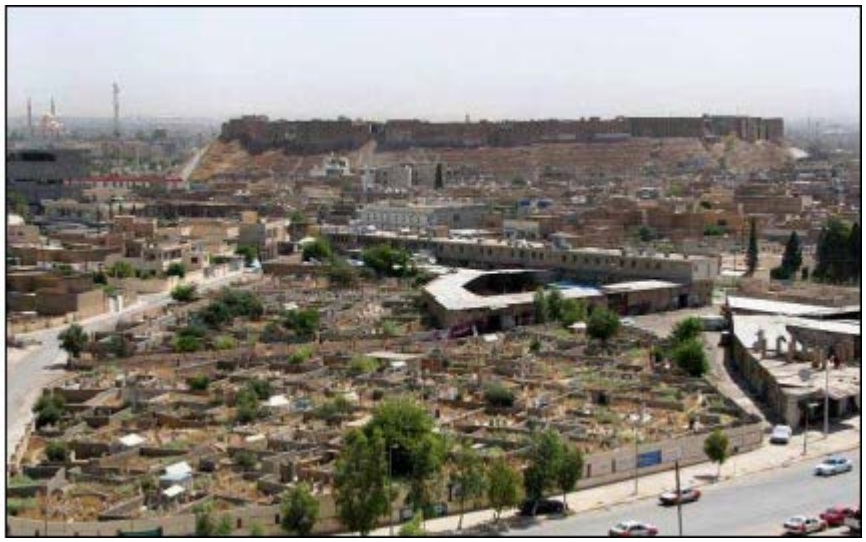


Figure 2-1 Erbil great Citadel (Pavelka et al., 2007)

After the end of Saddam Hussein's Ba'ath regime in 2003, Erbil developed rapidly and many huge projects have been implemented. For example, Sami Abdul Rahman Park, the largest park in the whole of Iraq, is one of these projects. In 2014, Erbil was chosen as the capital of tourism in the Middle East (DMI, 2016). In the last decade, the consulates of many countries have opened in Erbil and many international companies began investing in the area.

2.3.4 Geography and Climate of KRI

The Kurdistan Region of Northern Iraq is largely mountainous country. The area is distinguished by fertile lands, plenty of water, and picturesque nature. On the border with Iran, the highest point is Cheekha Dar, which is claimed to be 3,611 metres high (11,847 ft). The mountains are part of the Zagros mountain range, which have a total length of

1,500 km (932 miles). In addition, there are many rivers flowing through these mountains, such as the Great Zab, the Little Zab and the Tiger River. Having both mountainous terrain and wide open plains, different temperature ranges and many rivers, lakes and waterfalls, makes the region a land of agriculture and a magnet for tourists. Dukan Lake is the largest lake in the region. Between 1954 and 1959, the Dukan Dam was built as a multi-purpose resource for water storage, irrigation and hydroelectricity.

There are also many sacred places in the region belonging to different religions. The Sheikh Wasso Rahman Grave is a sacred place for Muslims. It also named St Raban Boya by the Christian community. The two large highly engraved cave-like chambers that date back to the fourth century AD, are visited by Christians from around the region two weeks after Easter every year (Alkurdi, 2013).

In the last decade, several tourism projects have been implemented. The Korek mountain ski resort, which includes cable cars, is one project that has had a great impact on developing tourism in the region. The town of Shaqlawa, located approximately 50 kilometres north of the city centre of Erbil, is considered a tourist destination for the population of Erbil. Shaqlawa lies at the base of the well-known Mount Safeen. In addition, Gali Ali Beg, Bekhal waterfalls, the hillside town of Rawandoz, Pank Resort and the water source at Jundyan are other well-known attractions around Erbil, which are visited by thousands of the tourists' every year. Erbil also has a museum holding collections of antiquities, statues and remains from the region located inside the ancient citadel.

International tourists suffer from a lack of guidelines and services provided by the government. The inactivity of satellite navigation is one of the major difficulties faced by tourists. Improving the Global Positioning System (GPS) services is a significant strategy that needs to be considered towards improving tourism in the region.

2.3.5 KRI LBI system

KRI as a developing region has great interest in benefiting from any new technologies that will support the local economy. Having an active LBI system is one of the most important requirements that needs to be implemented in the near future. International delivery services such as DHL, TNT, etc use their offices as collection points for international letters and parcels that are sent to the region. The governmental postal directorate runs 77 post offices in the region, 40 in Erbil, 22 in Sulaimaniyah and 15 in Duhok. The service is limited to international post only. Hence, a very limited number of people benefit from this service. In addition, due to an inactive addressing system, the electronic mail system is much preferred by the local residents, and this service is used for sending and receiving parcels. For official use, governmental offices and companies in the region depend on the phone network to contact their customers. Television advertisements are an alternative way for transferring information to KRI residence (DMI, 2016).

Having a postal system is an ideal solution for official and personal communication, which has been used in developed countries for many decades. An effective LBI coding system has not been implemented in the Kurdish Region of Iraq and its people are unfamiliar with the concept of LBI. Any letters or parcels sent to individuals or small organisations are delivered by contacting the recipient's phone number, who then has to go and collect the item. Thus, letters and parcels have a recipient's phone number, rather than a delivery address. This situation has been accepted as inappropriate for a semi-autonomous region that is trying to improve its standing on the international stage. As such, several LBI design projects are under implementation within the KRI. However, the projects focus only on activating a posting and mailing system in the central regions of the three main cities (Erbil, Sulaimaniyah and Duhok). In addition, the governorates of the three cities intend to implement three different projects. That is, there is no cooperation between the three cities on a standard implementation.

In Duhok city, the design is based on an alphanumeric post code system, naming all streets and roads in the English alphabet. However, in Sulaimaniyah and Erbil, the on-going project is a numeric system using 9 digits. According to the main Iraqi addressing system, the KRI addressing system should contain an additional 5-digits to define a city or a town, and should use city specific codes. The first two digits of the city specific codes represent the Governorate code, as shown in Table 2-1. Iraq is divided into 19 Governorates. The next three digits represent a city or town within the governorate. The five digits of the Erbil Governorate start with 44. The last three digits start from 001 for Erbil central and ends with 022 for Altun Copri as shown in Table 2-2. The addressing system designed by the KRI governorates for the three main cities add complementary numbers to the city codes defined by the central government of Iraq.

City name	**Postcode**
Al Anbar	31
Al Quadisiya	58
Babil	51
Baghdad	10
Basra	61
Dhi Qar	64
Diyala	32
Dohuk	42
Erbil	44
Halabja	46
Karbala	56
Kirkuk	36
Maysan	62
Muthanna	66
Najaf	54
Nineveh	41

Saladin	34
Sulaymaniyah	46
Wasit	52

Table 2-1 Iraq first 2-digit LBI for city ("GeoPostcode / Iraq," 2007)

Erbil Governorate	**Iraq LBI system**
Erbil	44001
Salahaddin University	44002
Ain Kawa	44003
Maseef Salahaddeen	44004
Shaqlawa	44005
Hareer	44006
Khaleefan	44007
Soran	44008
Rawendooz	44009
Joman	44010
Galala	44011
Haj Umran	44012
Merga Sur	44013
Seerwan	44014
Debca	44015
Mishtiqa	44016
Deshti Huweer	44017
Kalak	44018
Diana	44019
Mekhmour	44020
Quwair	44021
Altun Copri	44022

Table 2-2 Erbil governorate LBI ("Zip Codes & Post Codes from Around the World," 2015)

2.3.6 Erbil LBI system

One of the main difficulties faced by this project is the lack of published and online documentation about the KRI in general and the LBI system in the region specifically. In October 2013, the author of this study visited the Erbil Governorate to collect data for this research. During this period, two meetings were conducted with the Erbil local government and three different meetings with the Erbil post office manager, directors of department of the post office and the director of GIS (Geographical Information System).

It was discovered in these meetings that the implementation of the new LBI system for Erbil began in the middle of 2013. The project is supervised and funded by the Erbil governorate. The new design is a redeveloped version of the existing numeric codes that were used by the Ministry of Municipalities for lands and houses. The numeric system implemented in Erbil follows the old Iraqi LBI system, as the KRI still considers itself to be a part of Iraq. Furthermore, KRI is a neighbour with Iran and Turkey, who also have numeric LBI systems. As shown in Table 2-2 above, Erbil has a 5-digit numeric code. This is the numeric code given to the Erbil Governorate city centre and neighbouring areas by Iraqi government. The code 44 represents any area of the Erbil Governorate, as shown in Table 2-2. The address format consists of four sections, as shown in Table 2-3. The first five digits of the address represents the city code, beginning with 44 for Erbil and the last three digits represent a district. The last three sections of the code (an additional 9 digits) have been introduced by the Erbil directorate of GIS (Geographical Information System).

As an example, consider Table 2-3 and Figure 2-2 of the Erbil city centre. The city centre is zone 1, with 11 neighbourhoods. Therefore, the second section of the LBI code is 1, followed by 2 digits. Zone 2 represents neighbourhoods between the inner and middle ring roads (Known locally as the 60-meter road, and the 100-meter road), Zone 3 represents neighbourhoods between the 100-meter road and the outer ring road (120-meter road). Zone 4 is the largest zone, which includes undeveloped and partially built areas on the edge

of the city. The third part of Table 2-3 is a Street or Alley Code, with a length of 3-digits. As a result, 999 different street addresses can be located in one neighbourhood. Finally, 3 additional digits have been selected to address properties in each street/alley, which means 999 individual properties can be addressed.

City Code	Zone with Neighbourhood or District Code	Street or Alley Code	Property Number
5-digits	3-digits	3-digits	3-digits
44001	104	002	015

Table 2-3 Erbil LBI system

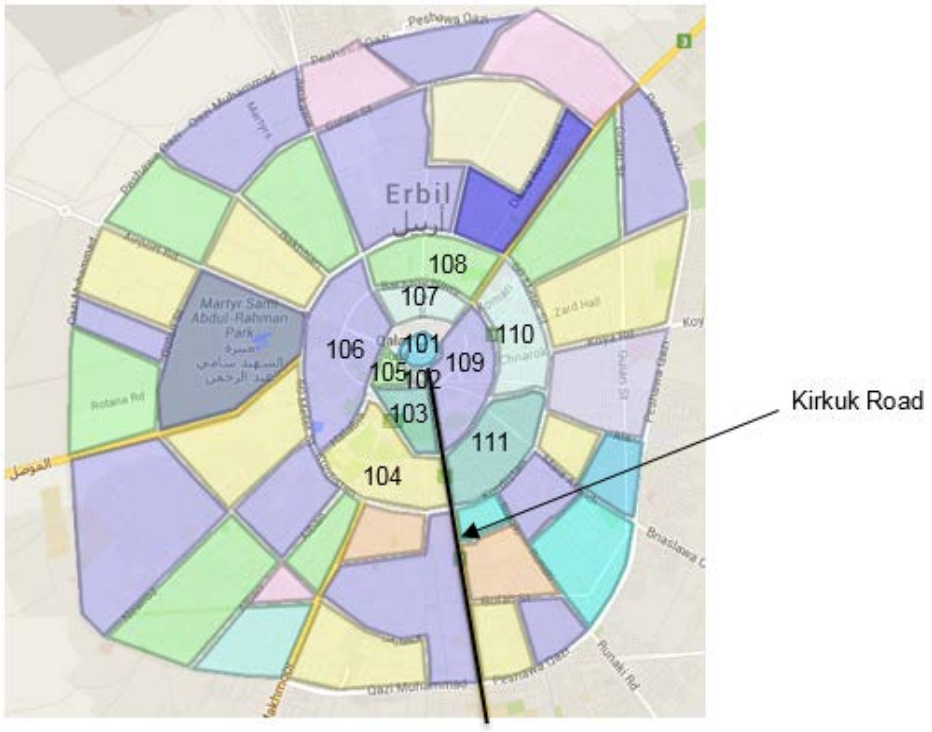


Figure 2-2 Erbil applied LBI system

At the moment, most streets of the Erbil city centre are labelled using a printed plate with the neighbourhood's name and/or code and street number. Figure 2-3 shows the plate label

of alley 2 of zone 1 and neighbourhood 04. Furthermore, the last three digits are displayed on individual houses, property or places.

Figure 2-3 A sample of Erbil addressing label

2.4 Conclusion

To conclude, the KRI is a Federal region in north Iraq that has achieved significant improvement in recent years. In this chapter, the general background of Kurdistan and the KRI region has been discussed. In addition, languages and accents in the region have been considered. The region is distinguished by its rich natural resources, which give the region a great willingness to invest in further development. Rather than exporting its natural resources, the region's targets are its alternative resources, such as tourism, agriculture and industry. LBI is a desired system for the region, which would contribute towards government plans in improving its service sectors. However, as discussed, the three main cities of the region do not have a standard LBI system. For this reason, the next chapter will include a proposed LBI system for KRI and discuss the steps required to applying the system in the real world. The city of Erbil will be used as an example of designing and applying the system.

3 Chapter Three: SR_LBI technique

3.1 Introduction

In this chapter, a new technique (SR_LBI), for the purpose of developing LBI systems for any area, region or country is defined. The SR_LBI technique is based on both the direction and distance from an (area or city) centre, using alphanumeric codes. The method has been theoretically applied to Erbil, the capital of the KRI, for the purpose of advising the local authorities within the Kurdish region and subsequently the whole of Iraq of a simplified solution to LBI.

Proposing an LBI system using an alphanumeric format, containing English alphabetic characters and numeric digits (instead of a singular numeric format), could be considered unusual for non-English countries. However, the majority of KRI citizens are familiar with the English alphabet, as discussed in Chapter 2 - Kurdistan Region of Iraq. Moreover, due to globalisation, the invention of the Internet and smart devices, the citizens of KRI use English in their daily lives as a language of communication in social media, alongside their natural Kurdish language. A survey was conducted where several hundred KRI residents were asked about the proposed alphanumeric SR_LBI for KRI. This will be discussed further in Chapter 7.

During the progression of this study, the main limitations of this study were:

1. Unavailability of a standard method or technique for designing LBI. A bespoke system is often designed in each country according to a prearranged plan.
2. A lack of scientific research about LBI systems and the unavailability of resources in this area. However, this project aims to contribute towards this field.

3.2 Research Hypotheses

To design an LBI system for any area, the following questions are considered:

- Can LBI codes provide a sense of direction and distance from a defined set point?
- Are all the codes unique within a given country?

3.3 SR _LBI

The SR_LBI technique is based on an alphanumeric format, which is used to generate LBI codes. As explained in Chapter 1, Section LBI Alphanumeric Format, in addition to using digits (0-9), an alphanumeric system can use 26 different characters of the English alphabet and can generate more LBI codes for fewer characters when compared with a purely numeric system. In a numeric system, the characters are limited to 10 digits (0-9), which leads to less codes being generated. To achieve short LBI codes with high granularity, an LBI system for a city or town can be designed using 5 to 7 alphanumeric characters. Six different possible formats will be proposed, which will be applied as a standard SR_LBI format, for a country, a region or an area.

The SR_LBI format can be one of the following formats:

- LN NLL
- LNN NLL
- LNL NLL
- LLN NLL
- LLNN NLL
- LLNL NLL

L, above, represents a Letter and N represents a Number. SR_LBI formats consist of two parts separated by a space. The first part, known as the outward section, represents a city character and a zone, while the second part, known as the inward section, represents a direction and a specific street/location.

The first outward character may include any of the 26 English alphabetic letters. Because the first letter represents a city or area code and, after applying the system, citizens will be aware that all codes begin with a letter followed by another letter or a number. However,

only 20 letters have been used in the remainder of the outer/inner codes to avoid confusion between some similar letters and numbers, such as 0 and O, 1 and I, U and V, N and M, C and G. As a result 30 alphanumeric characters have been used, which consist of 20 letters, A, B, C, D, E, F, H, J, L, N, P, Q, R, S, T, U, W, X, Y and Z, and 10 numbers (0-9).

Having more than one format possibilities gives the method a flexibility that is applicable to both very small towns and very large cities. For small areas, the formats (LN NLL or LLN NLL) can be used. Thus by using 5 to 6 digit alphanumeric codes, the areas can be divided into 10 zones. Whereas, the big cities or areas need more codes which (LN NLL or LLN NLL) formats enable to provide them. Consequently, other presented formats might be applicable, such as LNN NLL, LNL NLL or LLNL NLL. The probability of generating addresses for each format will be discussed in the later sections. In addition, in many countries, such as the United Kingdom, the number of the areas (cities and the towns) is far more than the 26 available English letters. Therefore, more than one character is needed to define the areas. Having the choice between L and LL in the beginning of the LBI format enables the designer to identify larger areas with single letters L and smaller areas by double letters LL.

The proposed method in this research is flexible and adaptable with different city styles, to give a sense of direction and distance from the centre of the city or town. The design can be achieved according to the following steps:

Step one: Divide the city using two division diagonals passing through the centre of the city, dividing the city into four parts (North, East, South and West) as shown in Figure 3-1. The diagonals can be selected according to the available streets or roads, depending on the urban geography.

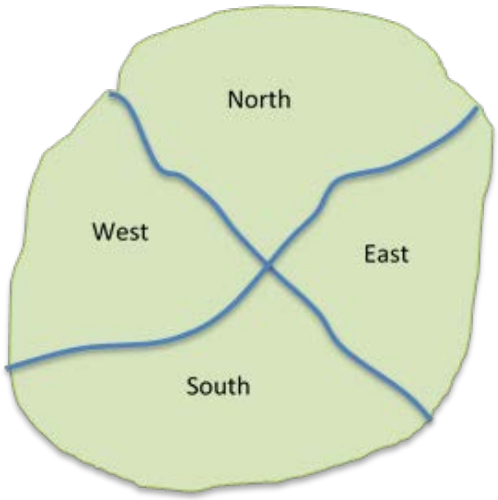


Figure 3-1 Area Sectors

Step Two: All inward codes have the same format of NLL. To satisfy the aim of direction, the first character in the inward part (xxx Nxx) can be classified according to the main four directions.

Northern Numbers: Numbers 1 and 2 represent the places that are located in the North part of the city or town.

Eastern Numbers: Numbers 3 and 4 represent the places that are located in the East part of the city or town.

Southern Numbers: Numbers 5 and 6 represent the places that are located in the South part of the city or town.

Western Numbers: Numbers 7 and 8 represent the places that are located in the West part of the city or town.

The Northern numbers are illustrated in Figure 3-2. Furthermore, the second and third inward positions LL will be one of the 20 chosen alphabet letters.

As pointed out in the literature review, alphanumeric codes are easier to memorise and remember than numeric codes. Using a 3-digit alphanumeric for the inward part instead of three numeric NNN or alpha LLL codes will reduce confusion and mistakes when using the code. In addition, two numbers have been used to represent each of the four directions, instead of (N, S, E and W) to increase the probability of generating additional codes. For example, for the north, 1xx and 2xx are used for the inward part of the code. Using Nxx instead will reduce the generated codes by half and the format changes to an alpha format. In addition, odd and even numbers are used to define vertical roads or streets. Odd numbers represent vertical roads or streets and even numbers represent horizontal roads or streets.

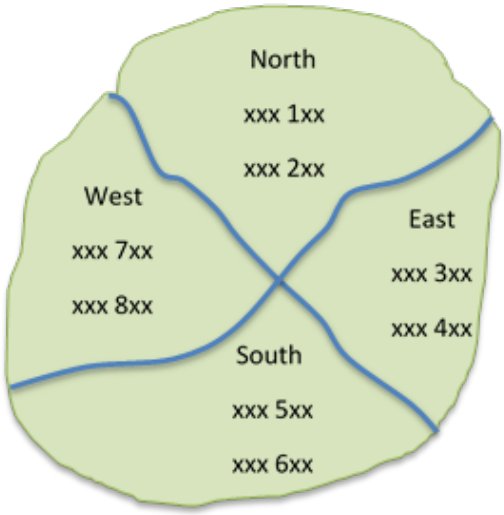
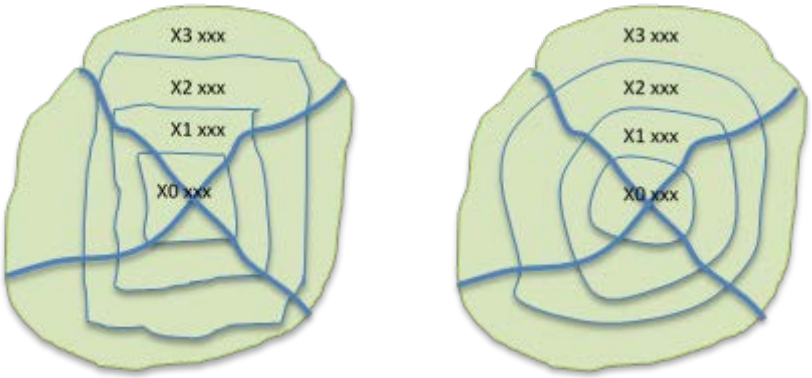


Figure 3-2 Select Characters for each Sector

Step Three: At the beginning of any design using the SR_LBI technique for any given area, the designer should decide either to divide the area into 10 zones using the outward formats LN, LLN, LNL and/or to divide the area up to 100 zones using one of these formats LNN, LLNN.

3.3.1 Using LNN/LLNN outward format

To satisfy the aim of the distance from the city centre, the outward format is used. The first, or the first and the second outward characters of the chosen SR_LBI formats represent a symbol for a city, such as the letter E representing the city of Erbil. The numbers of the outward section can be set to show distance from the city centre, as illustrated in Figure 3-3.



-a- -b-

Figure 3-3 Area Zones

As shown in Figure (3-3 a), in cities and towns with straight streets, the divisions can be made as consecutive squares, however, in cities with circular or oval streets, the divisions will need to be in consecutive circles, as shown in Figure (3-3 b). In addition, the technique is flexible in its application to cities with irregular streets. The designer can either use more than one irregular street to separate the zones or use any other available choices.

By applying this method on any outward format, we can provide up to 3,200 inward formats in the four main sections. The digit N for the inward formats of NLL could be 1 or 2, 3 or 4, 5 or 6, 7 or 8 that represent the direction. LL could be used for any of the selected 20

letters. Hence the maximum number of generated codes per zone in each directionC_D can be calculated as follows:

$C_D = 2 * (20 * 20)$

$C_D = 800\ codes$ (3.1)

Thus, the number of addresses that could be generated in each zoneC_Z in the 4 directions can be calculated as below:

$C_Z = 4 * C_D$

$C_Z = 4 * 800$

$C_Z = 3200\ codes$ (3.2)

The method provides 100 outward formats as the maximum limit for zones for any city symbol. The outward formats of LNN or LLNN could provide 100 different outward formats from 0-99 for the particular city or town symbol. As a result, the addresses that could generate for a specific city$C$ is:

$C = 100C_Z$

$\mathrm{C} = 100 * 3200$

$\mathrm{C} = 320{,}000\ codes$ (3.3)

The above generated code represents a block of flats, a building that receives a quantity and a significant number of posts and parcels, such as banks, government office military, or a small area. As a result, each single code (by using the SR_LBI technique), will be unique in the whole country or the region.

Assuming that each LBI code represents, for example, 15 properties or buildings, the maximum covered addresses AD for each city can be calculated as below:

$AD = 15\ C$

$\mathrm{AD} = 15 * 32{,}000$

$\mathrm{AD} = 4{,}800{,}000\ addresses$ (3.4)

3.3.2 Using LNL/LLNL outward format

If the city is not fully addressed by 320,000 codes as shown in equation 3.4, the LNL/LLNL format will be used (plan A). The character N divides the area into 10 consecutive zones, using LN or LLN format. Adding a character L at the end of the outward form (LNL/LLNL) splits the zones into 20 subsections by using one of the chosen 20 alphabet letters. Figure 3-4 below shows how zone 1 can be divided into 20 sections. For example, the first part is X1A XXX then X1B XXX, etc. Hence the addresses that could be generated for a specific city C are:

$C = 200C_Z$

$\mathrm{C} = 200 * 3200$

$\mathrm{C} = 640{,}000\ codes$ (3.5)

For example, if each LBI code represents an average of 15 properties or buildings. The maximum covered addresses, AD, for each city (by using this method) can be calculated as below:

$AD = 15\ C$

$\mathrm{AD} = 15 * 640{,}000$

$\mathrm{AD} = 9{,}600{,}000\ addresses$ (3.6)

3.3.3 Using compound of LNN/LLNN and LNL/LLNL outward formats

To design SR_LBI for large cities, the compound of LNN/LLNN and LNL/LLNL formats may be needed, if the whole city is not covered by 640,000 of LNL/LLNL codes. In this case, Plan B will be used for N, from 0 to 9, with 20 alphabet characters to obtain 200 outward formats. Then, for N from 11 to 99, plan A will used to obtain an extra 90 outward formats.

$$C = (200 + 90)C_Z$$

$$\mathrm{C} = 290 * 3200$$

$$\mathrm{C} = 928{,}000\ codes \qquad (3.7)$$

Assuming that each represents an average of 15 properties or buildings, then:

$$AD = 15\ C$$

$$\mathrm{AD} = 15 * 928{,}000$$

$$\mathrm{AD} = 13{,}920{,}000\ \ addresses \qquad (3.6)$$

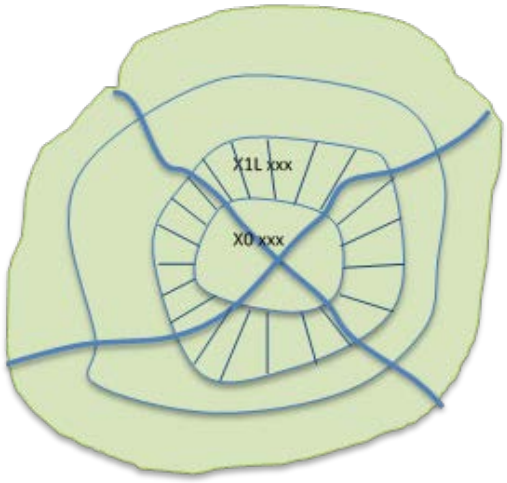


Figure 3-4 Zone Division

3.4 Applying the Proposed SR_LBI technique

3.4.1 Applying SR_LBI for Iraq

Iraq consists of 19 governorates, also known as "provinces". The 19th governorate is Halabja, which was established in 2014, making it the fourth governorate in the Kurdistan region, with Erbil as the capital of the KRI, Sulaimaniyah and Duhok. Administratively, the Kerkuk governorate is the fifth governorate under KRI control, and is part of a disputed territory between KRG and the main Iraqi government. Figure 3-5 shows the Iraqi governorates. Each governorate consists of a number of districts and sub-districts.

As discussed in Chapter 2, the ministry of communication of the Iraqi government defined 2-numeric digits as a governorate code and an extra 3-numeric digits to define districts and sub-district. By using the SR_LBI technique, 1-2 alphabet character(s) have been proposed to identify the districts and sub-districts of the country instead of the current 5-digits.

Table 3-1 illustrates the proposed LBI symbols for Iraqi districts and sub-districts, based on the SR_LBI technique. Using the first character of a city's name within SR_LBI could produce an error, because more than one city may begin with the same letter. Hence, the first letters of the KRI's main cities and Baghdad city (the capital of Iraq) have been selected as a first character of the proposed LBI system. However, two letters have been selected for other districts and sub-districts as an area definition. The proposed area codes for KRI districts and sub-districts have been presented in Table 3-2.

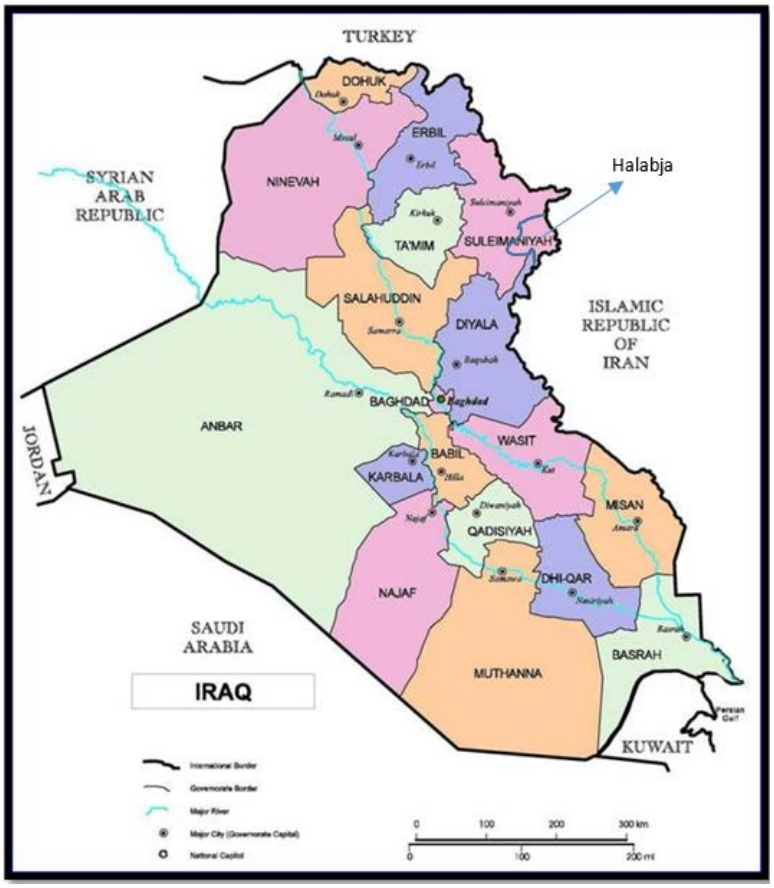


Figure 3-5 Iraqi Governorates

City name	Proposed area codes
Al Anbar	AN
Al Quadisiya	QY
Babil	BL
Baghdad	B
Basra	BS
Dhi Qar	DQ
Diyala	DY
Dohuk	D
Erbil	E
Halabja	H
Karbala	KR
Kirkuk	K
Maysan	MY
Muthanna	MN
Najaf	NJ
Nineveh	NH
Saladin	SD
Sulaymaniyah	S
Wasit	WT

Table 3-1 Iraq's cites area codes

3.4.2 Applying SR_LBI in Erbil

Erbil, the capital of the Kurdistan region of Iraq, has been selected as a case study to justify SR_LBI technique. The ancient citadel of Erbil is located at the heart of the city. The citadel is oval in shape, with dimensions of approximately 430 by 340 meters, or 102,000 square meters in area. The mound rises between 25 and 32 metres from the surrounding plain (McDowall, 2003; McGahey, 2006; Pavelka et al., 2007).

Erbil has expanded around the oval citadel over hundreds years of development. Several circular ring roads had been built around the citadel, which has clearly divided the city into zones around the city centre. Thus, each zone is bounded by two ring roads.

Erbil has a citadel at its centre, which is symbolised by the number zero in the outward section of SR_LBI. As such, E0 represents the Erbil citadel, E1 is Erbil zone one, out to the first ring road, etc.

The main design point of the LBI system for Erbil is the circular layout of the city, which can be used as an existing resource to implement the system. Erbil, as with many other cities, has several main roads connecting it to neighbouring cities. Four main roads have been selected to partition the city in to four sections: North, South, East and West. The four selected roads are Pirmam road in the North West, Malafandy road in the North East, Maxmur Road in the South East and Airport road in the South West, as shown in Figure 3-6. These roads are ideal for splitting the city into the required directional indicators (North, South, East and West), and are well-known by the Erbil population. In addition, these roads extend to the city centre. Furthermore, the five existing main ring roads are selected to divide the city into five zones. The citadel is located in the centre of the city (zone 0) and no division is applied, as its area is relatively small.

Erbil Governorate	Proposed area codes
Erbil	E
Ain Kawa	AK
Maseef Salahaddeen	MS
Shaqlawa	SH
Hareer	HR
Khaleefan	KH
Soran	SO
Rawendooz	RZ
Joman	CH
Galala	GL
Haj Umran	HU
Merga Sur	MR
Seerwan	SW
Debca	DG
Qushtapa	QP
Kalak	KK
Diana	DN
Mekhmour	MK
Quwair	GW
Altun Copri	AC

Halabja Governorate	SR_LBI code
Halabja	H
Sirwan	SA
Khurmal	KM
Byara	BY

Duhok Governorate	Proposed area codes
Duhok	D
Zawita	ZA
Kucher	KU
Amadiya	AM
Sarsink	SS
Barwari Bala	BR
Nerwa Rekan	NR
Simele	SL
Batel	BT
Fayda	FD
Zakho	ZK
Shirnakhi	SN
Rekani	RN
Sindi	ND
Rizgari	RG
Guli	GU
Ain Sifni	AS
Dashqotan	DT
Qasrok	QK
Baadra	BA
Ain Al-Ghazal	AG
Chiri	CR
Gohbal	GB
Hayali	HY
Khazuga	KG
Sayer	SY
Sinjar	SJ
Sinone	SE
Shamal	SM
Sibaya	SB

Sulaymaniya Governorate	Proposed area codes
Sulaymanya	S
Bazyan	BZ
Tanjora	TR
Bakrajo	BK
Chamchamal	CL
Shwan	WN
Aghjalar	AJ
Takiya	TK
Sangaw	SG
Qadir-karam	QM
Qaradagh	QG
Dukan	DK
Surdash	SU
Chinaran	CN
Bingrd	BD
Khidran	KN
Piramagrun	PG
Ranya	RY
Chwarqurna	CQ
Betwata	BW
Haji-Awa	HA
Sarkapkan	SK
Pishdar	PD
Hero	HE
Nawdasht	ND
Halsho	HS
Zharawa	ZW
Esewa	EW
Sharbazher	SR
Zalan	ZN
Zhazhla	ZH
Siwail	WL
Sytak	ST
Gapilon	GP
Pinjwin	PW
Garmik	GK
Nalparez	NP
Sharazur	SZ
Warmawa (Zarayan)	WM
Saidsadiq	SQ

Table 3-2 KRI governorates: area codes for districts and sub-districts of KRI

As shown in Figure 3-6, the Google Maps API is used to visually represent the design. The city is divided into sixteen sectors, excluding the citadel in the centre of the city.

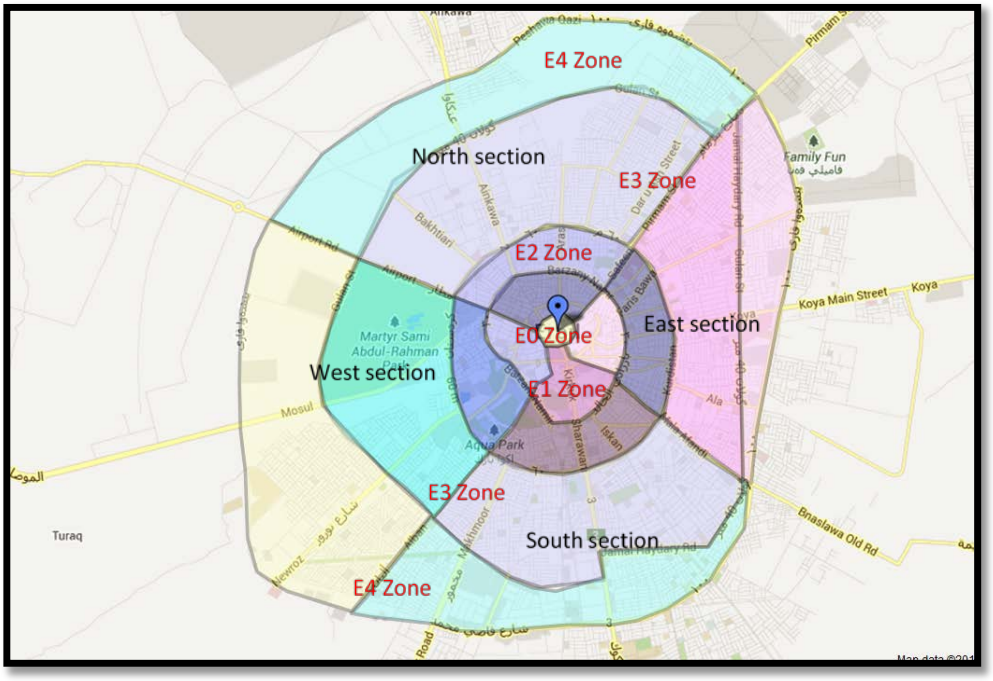


Figure 3-6 Erbil Sectors and Zones (the original image from ("Google Maps," 2014)).

3.5 Conclusion

Most of the designed LBI systems around the world do not provide a sense of direction and distance from a central area. In this research, a new intelligent LBI technique (SR_LBI) has been proposed and explained. The main feature of this technique is the perception of the approximate position of a specific point from the centre of an area. SR_LBI technique divides the city or town into a number of consecutive zones and divides it diagonally into a number of sectors and four main directions (North, South, East and West). Each zone and sector has a set of alphanumeric characters, which appears clearly in each individual SR_LBI

code. Thus, each SR_LBI code shows its approximate position from the centre of the city and the relevant direction.

4 Chapter Four: Technology Theories

4.1 Introduction

Technology theories have evolved through rigorous evaluation over many years. There are a number of models that are widely used for testing system acceptance based on a user's psychology. These theories, in general, are known as technology theory or Information Technology theory. In this chapter, a number of information theories are presented and discussed. A convenient model among these theories has been selected for the present study (acceptance of SR_LBI in KRI), based on extensive analysis.

Within this chapter, a number of determinants that the models are based on are defined, such as Behaviour, Behaviour Intention, Attitude, Subjective Norms, etc. These definitions will provide an understanding about each determinant before using it, within the proposed model.

The Theory of Reasoned Action (TRA), proposed by Fishbein and Ajzen (1975), provides the backbone for many other models. Based on an extensive study of the weak points and gaps in TRA, the Theory of Planned Behaviour (TPB) and Technology Acceptance Model (TAM) were proposed by Ajzen (1985) and Davis (1986) respectively. These models and others, such as the Decomposed Theory of Planned Behaviour (DTPB), (TAM2), (TAM3), etc., are also discussed within this chapter. Finally, a general comparison of the models is presented.

4.2 Major Research Model

The effectiveness, or the efficiency, of any technology model in dealing with a problem is not necessarily the key factor of successful modelling. The user Interaction patterns and the relation between the user and the technology are, as Davis states, "*essential in the prediction of technology uptake; a connection that has been labelled technology*

acceptance" (Fred D. Davis, 1989). Some of common technology components have been defined below.

Actual Behaviour (Behaviour B) - This is a noticeable response in a specific situation according to a specific objective (Ajzen, 2004).

Behaviour Intention (BI) – This construct is defined as the intention of an individual to undertake a given behaviour (Fishbein & Ajzen, 1975).

Attitude Toward Behaviour (ATB) – (personal factor): This refers to the individual's belief toward an outcome of a certain action. The belief might either be favourable or unfavourable. (Ajzen, 1985).

Subjective Norm (SN) – This refers to the perceived social pressure on the individual to undertake or not undertake a given behaviour (Ajzen, 1985).

Perceived Behaviour Control (PBC) – This refers to the perceived control a person has over non-motivational factors, such as the availability of necessary opportunities and resources (Ajzen & Madden, 1986).

Normative Subject (NS) Normative Beliefs– This refers to the person's understanding about the opinion of individuals or groups toward him/her to undertake or not undertake a certain behaviour.

Perceived Usefulness (PU) – "The degree to which an individual believes that using a particular system would enhance his or her job performance" (Davis Jr, 1986).

Perceived Ease of Use (PEU) – "The degree to which an individual believes that using a particular system would be free of physical and mental effort"(Davis Jr, 1986).

4.2.1 The Theory of Reasoned Action (TRA)

The Theory of Reasoned Action (TRA) is a behavioural intention model that has been proposed by Fishbein and Ajzen (1975). TRA is the first model in the context of the technology acceptance field and is considered an effective and fundamental theory of human behaviour (Venkatesh, Morris, Davis, & Davis, 2003). TRA has been used in different studies to explain a wide range of human behaviour types and information technology (IT) innovation usage behaviour (Sheppard, Hartwick, & Warshaw, 1988). In addition, TRA has also been used in many technology acceptance studies.

TRA consists of the following constructs, as shown in Figure 4-1:

- Actual Behaviour (Behaviour): how the individual behaves.
- Behavioural Intention: an indication of an individual's desire to behave.
- Attitude toward behaviour (Attitude): the strength of evaluating people, ideas and things that lead towards a positive outcome.
- Subjective norm: an action of the individual relating to normative behaviour.

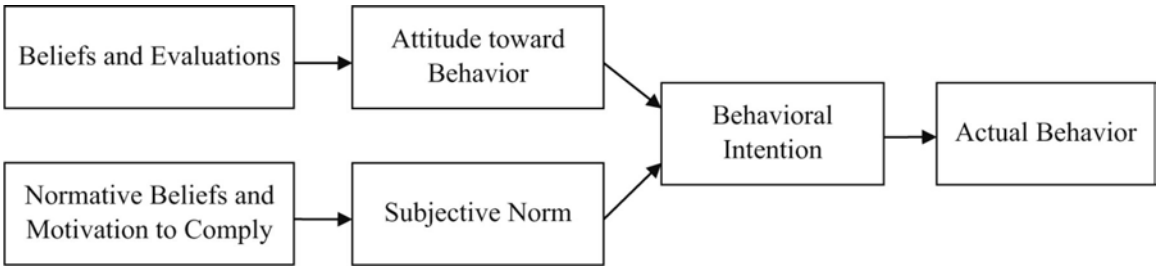


Figure 4-1 Theory of Reasonable Action (Ajzen & Fishbein, 1980)

TRA aims to have a good ability to predict and understand behaviours and attitudes. Unlike traditional approaches, TRA uses behavioural intentions as the main predictors, rather than focusing on attitudes (Ajzen & Fishbein, 1980).

TRA assumes that actual behaviour results from behavioural intention (BI). BI is based on two determinants, attitude toward behaviour (A) and subjective norm (SN). The effects of these determinants on BI vary according to the subject field of study and the individual's behaviour, as related in Equation 4.1 (Ajzen, 1985; Ajzen & Fishbein, 1977).

$$B \sim BI \cong w_1 A_B + w_2 SN \quad (4.1)$$

B is the behaviour of interest; BI is the person's intention to perform behaviour B, A is the person's attitude toward performing behaviour B, and w_1 and w_2 are the empirically determined factors that indicate the relative importance of A and SN respectively. The tilde symbol (~) is used above the ''='' symbol to indicate they are approximately equal, as the intention is expected to predict behaviour only if the case intention remains unchanged prior to behaviour performance (Terry, Gallois, & McCamish, 1993). Furthermore, it is clear that the intention is directly proportional to the weighted sum of attitude towards the behaviour and subjective norm.

TRA provides a clear picture about how effort in performing a certain behaviour increases through stronger intentions. In addition, the model indicates the prospect and the circumstances behind undertaking or not undertaking a specific behaviour.

Among the model elements, BI is considered a significant element that results from attitudes towards behaviour and subjective norms (Colman, 2015). The model assumes that the salient beliefs towards the behaviour produces A. These beliefs are the value of the individual's mind, since each one of them is linked to a specific behaviour with featured outcomes. In order to understand an individual's certain attitude toward a subject, it is necessary to have a clear assessment of these beliefs by having a free-response description of that particular belief from the person himself (Ajzen & Fishbein, 1980).

A can be determined as a result of the individual's evaluation of outcomes related to behaviour. An estimation technique can be applied to measure A, which is approximately

equal to the summation of the multiplication results of belief strength and outcome evaluation, as shown in equation 4.2 (Ajzen, 1985; Edwards, 1954).

$$A = \sum_{i=1}^{n} b_i e_i \quad (4.2)$$

$b_i$is the beliefs of performing behaviour B, whilst e_i is the evaluation of the outcome of B. Therefore, the positive attitude towards an object or in performing a certain behaviour will result when the person believes that undertaking this behaviour will generally produce a positive output or vice versa.

Subjective Norm (SN) is the other determinant which is assumed to be a function of normative beliefs without including the motivation to comply, which is further located within the broader construct of social norms (Ajzen & Fishbein, 1980). The decision maker might be under social pressure when he/she believed that the referents, who have direct influences over an individual, think that the individual should perform or not perform a certain behaviour. A referent could be a person, family member, friends and colleagues, superior, subordinate, etc., based on the subject area. The social pressure has a vital role. Equation (4.3) symbolically shows the relation between normative beliefs and subjective norm (Ajzen, 1985).

$$SN = \sum_{j=1}^{n} b_j m_j \quad (4.3)$$

Where SN is the subjective norm, bj represents the normative belief with regards to referent j, mj is the motivation of the decision maker to comply with referent j, and n is the number of salient normative beliefs.

Limited factors have been used in the Theory of Reasoned Action model, but the model has the capability to demonstrate and predict volitional behaviours. In the next step, intentions are explained in the form of attitudes toward behaviour A and subjective norm SN. A and

SN are interpreted in terms of beliefs about undertaking behaviour consequences and normative expectations.

The major weakness of TRA is that the model focuses only on voluntary behaviour. However, behaviour may not be controlled completely by the person (Sheppard et al., 1988). Behaviour can be predicted by intention, if the intention measured by the investigator reflects the intentions of the respondent, prior to undertaking the behaviour and when the behaviour is performed under volitional control (Ajzen, 1985). This disadvantage of the TRA model is addressed in the Theory of Planned Behaviour TPB, which takes the boundary condition of voluntariness into consideration (Madden, Ellen, & Ajzen, 1992).

4.2.2 Theory of Planned Behaviour (TPB)

The Theory of Planned Behaviour TPB is considered to be an extension of the TRA model introduced and theoretically tested by Ajzen (1985), Ajzen and Madden (1986). In this model, unlike TRA, an individual's perception on undertaking a specific behaviour, due to external and/or internal factors, is taken into consideration (Ajzen, 1991). This perception is linked to Perceived Behavioural Control PBC, which provides information regarding the possible constraints on acting, as perceived by the decision maker. Furthermore, perception is an indicator to explain the reasons that the intention does not always predict the behaviour (Ajzen & Madden, 1986).

An introduction to TPB was necessary due to the inability of TRA "to deal with behaviours over which individuals have incomplete volitional control" (George, 2004) p.199. Volitional control can be described as a decision to undertake a certain task that has an influence on the decision maker's behaviour and intention.

In addition to taking PBC into account, the model has been tested against TRA and granted an explanatory power within the model (Armitage & Conner, 2001; Madden et al., 1992).

The Theory of Planned Behaviour considers the overall concept of PBC as within a more generalised framework of links amongst attitude, behaviours, beliefs, and intentions.

TPB consists of the following structure elements, as depicted in Figure 4-2:

- Behaviour: This is defined as a direct action of Behaviour Intention and PBC, which is significantly influenced by the motivational factors.
- Behavioural Intention: This depends on attitude, subjective norm and PBC.
- Attitudes: This element relates to a positive or negative evaluation of a person towards performing a certain behaviour.
- Subjective Norm: This element depends on the positive or negative evaluations, or belief, about a certain behaviour by the significant referents.
- Perceived Behavioural Control PBC: This factor shows the perceptions of internal and external constraints on behaviour.

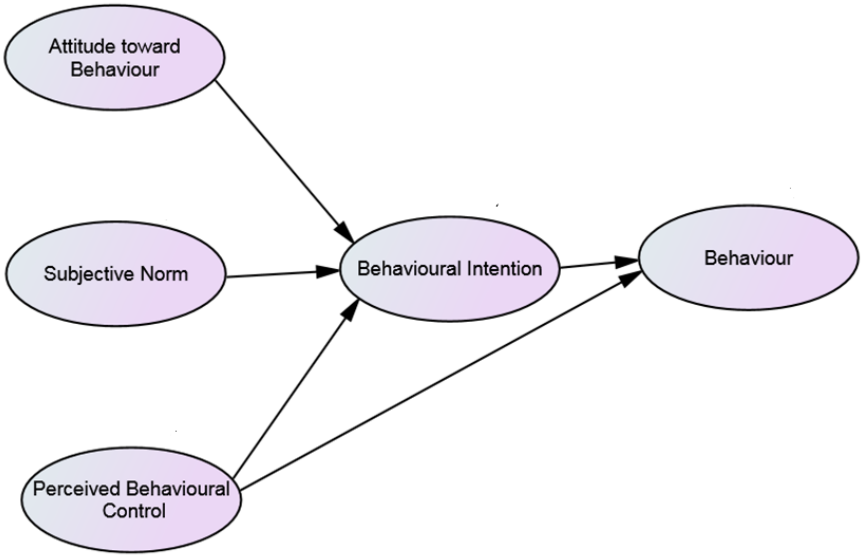


Figure 4-2 Theory of Planned Behaviour (Ajzen, 1991)

According to TPB, a mathematical relationship can be presented to relate the behaviour as a function of behaviour intention (BI) and perceived behaviour control (PBC), as below:

$$B = w_1 BI + w_2 PBC \quad (4.4)$$

Which w_1 and w_2 are the empirically determined factors that indicate the importance of BI and PBC, which indicates to what extend the individual intend to behave and the value of internal and external factors to support the action.

Behaviour intention (BI) is directly influenced by attitudes toward behaviour A, subjective norm (SN) and perceived behaviour control (PBC), as shown below in Equation 4.5:

$$BI = w_3 ATB + w_4 SN + w_5 PBC \quad (4.5)$$

The model assumes that human behaviour is directed by three essential elements (Ajzen, 2004):

1-Behaviour beliefs: Confidence about the positive consequences of behaviour.

2-Normative beliefs: Confidence about the normative expectations of others.

3-Control beliefs: Confidence about the existence of factors that may facilitate or impede behaviour performance.

Based on the above belief structure, attitude can be determined by the total set of accessible attitudinal beliefs, where the expected outcomes will be favourable or unfavourable towards behaviour. Similarly, subject norm is referred to as a normative belief, where its likely outcomes are control beliefs in the form of perceived social pressure and perceived behaviour control (Ajzen, 1991, 2004; S. Taylor & P. A. Todd, 1995).

As shown in Equation 4.6, Attitude A is determined by the attitudinal beliefs whereby performing a behaviour results in a certain outcome (b), which is based on an evaluation of the rate of outcome desirability (e) (S. Taylor & P. A. Todd, 1995). An example of this is the degree to which an individual believes that using an LBI system will lead to a highly desirable outcome regarding facilitating his/her daily life by saving time and money

$$ATB = \sum_{i=1}^{n} b_i e_i \quad (4.6)$$

SN is produced in the form of a person's normative belief regarding a referent or effective person as the decision maker, weighted by the rate of effectiveness and compliance (S. Taylor & P. A. Todd, 1995). The normal surrounding influences on a person could be from family, friends, classmates and/or colleges, peer-influence and superiors. A person's behaviour intention might be affected by their views, based on the level of their importance and effectiveness for the decision maker. For example a person may believe that his/her family think he/she should use the LBI system (nb_j) to simplify their daily life. In this regard, he/she may yield to their (mc_j) wishes, as shown in Equation 4.7.

$$SN = \sum_{j=1}^{n} nb_j mc_j \quad (4.7)$$

In the study of information technology fields, the role of the determinant SN is unclear. Davis et al. (1989) and Mathieson (1991) studied the relationship between SN and BI, but none of them concluded a clear relationship between these two determinants. This might be due to the fact that to carry out a certain behaviour, there are no direct and clear consequences related with the effect of the studied behaviour and insignificant external pressure (Fred D Davis, Bagozzi, & Warshaw, 1989; Hartwick & Barki, 1994). However, according to some studies about organisational settings, SN is an important determinant of BI, or self-reported usage of IT (Hartwick & Barki, 1994; Moore & Benbasat, 1991).

Perceived Behaviour Control (PBC) acts as a reflector for beliefs regarding approaching necessary resources and opportunities to perform a certain behaviour, or the internal and external obstacles that may have negative effects on behaviour performance (Ajzen, 1985, 1991; Ajzen & Madden, 1986; George, 2004).

Two components have been introduced to support this concept: facilitating condition and self-efficacy. Facilitating condition gives a sense of availability of required resources to be included in behaviour, such as time, money or any other applicable resources needed to

carry out a certain behaviour (Bandura, 1977; Triandis, 1980). Self-efficacy is the second component, first introduced by Bandura (1977), which reflects the self-confidence of the decision maker to carry out a certain behaviour.

According to research conducted by Bandura's systematic research programme, an individual's self-confidence to perform a certain behaviour has a great influence on the behaviour outcome. Therefore, self-efficacy beliefs are able to influence activity selections, efforts, thought patterns and emotional reactions. As shown in Equation 4.8, PBC can be calculated by the sum of control beliefs relating to the existence of some factors that may facilitate behaviour performance (cb_k), weighted by perceived facilitation (pf_k)

$$PBC = \sum_{k=1}^{n} cb_k pf_k \tag{4.8}$$

To apply an example using Equation 5.8, an individual may feel that he/she has the sufficient skills to use an LBI system (cb_k), and believe that skill level is important in determining usage (pf_k). Generally, the attitude and subjective norm of favourability and the level of perceived control are based on the strength of the individual's intention to carry out certain behaviour. Therefore, based on the control degree of the decision maker over a specific behaviour, it is expected that the person may perform his/her intention when the opportunity arises. However the intention is assumed to be the immediate antecedent of behaviour. However, some behaviours face achievement difficulties, which may influence volitional control. Therefore, to produce accurate behaviour analysis, in addition to intention, it is useful to consider PBC (Ajzen, 2004).

The Theory of Planned Behaviour (TPB) is a common model for the prediction of human social behaviour, and is often cited as a model in research projects. Much research has been carried out using TPB based on whether the intentions of the decision maker can be matched with the moral standards, or to illustrate the reasons behind unethical behaviours (Godin, Conner, & Sheeran, 2005). A meta-analysis of 185 different published studies up to

the end of 1997 was conducted by (Armitage & Conner 2001), and the effectiveness of TPB in predicting intentions and behaviour has been determined.

In addition, the TPB has also been applied successfully to other types of behaviour. For example, TPB has been used to explain the concept of behavioural intention, and explain complex economic behaviour, such as entrepreneurship (Kautonen, Van Gelderen, & Tornikoski, 2013). The model has also been widely used to understand specific environmental behaviour, such as the studies that have been conducted on the use of public transport (Heath & Gifford, 2002) and involvement in environmental activities (Fielding, McDonald, & Louis, 2008).

Both models of TPB and TRA have been compared to explain to what extent they have appropriate explanatory power, assumptions dependency, whether or not they need additional predictors and a consideration for bias and emotion. According to these studies and an unethical behaviour study by Chang (1998), TPB provided a better predictive framework than TRA (Chang, 1998; Madden et al., 1992).

TPB is only applied when some behaviour aspects are out of volitional control. Also, TPB does not explain variability in behaviour. The theory is based on the assumption that human beings are rational. Therefore, a decision will be made depending on available data, and unconscious motives will be neglected. Other limitations include neglecting factors such as personality and demographics. Also, the model assumes that PBC predicts actual behavioural control (Mathieson, 1991).

To summarise, according to Ajzen (1991), there is no clear evidence to fully understand the relationship between belief structures and the determinants of intention (A, SN and PBC), due to one-dimensional constructs that are produced due to the combination of the belief structures (i.e, $\sum b_i e_i$, $\sum nb_j mc_j$, $\sum cb_k pf_k$). Therefore, the determinants of intention (A, SN and PBC) may not relate to some monolithic belief sets (S. Taylor & P. A. Todd, 1995). To

achieve the aim of developing a reliable model to predict actual use of any particular technology, based on TRA and TPB, the Technology Acceptance Model TAM was proposed by Fred Davis in 1989.

4.2.3 The Technology Acceptance Model (TAM)

The Technology Acceptance Model (TAM) is one of the most influential extensions of TRA. TAM is considered an information systems theory that measures and predicts the acceptance and usage of technology by users. The model assumes that when any product has been presented to the customer, several factors play a role on their decision regarding how and when they are going to use it. TAM concentrates on two theoretical constructs - perceived usefulness (PU) and perceived ease of use (PEU). PU and PEU have been set as essential determinants of system use, to predict user adoption and IT usage (Fred D Davis et al., 1989; S. Taylor & P. A. Todd, 1995). In many studies over the last two decades, TAM has been used as a main study model and has been empirically validated (Holden & Karsh, 2010; King & He, 2006; Marangunić & Granić, 2015; Mathieson, 1991; S. Taylor & P. Todd, 1995; S. Taylor & P. A. Todd, 1995; Venkatesh & Davis, 2000).

As shown in Figure 4-3, TAM possesses the following constructs:

- Actual System Use (Behavioural): As explained in TRA, the model assumes that computer usage is determined by Behavioural Intentions (BI), as shown in Equation 4.9.
- Behavioural Intentions (BI): This construct depends on the user's attitude towards using the system (A) and Perceived Usefulness (PU), as shown in Equation 4.9.
- Attitude Toward Behaviour (Attitudes A): This construct, which is symbolised by A, refers to the extent to which a user has positive or negative evaluation of undertaking a behaviour. As shown in Equation 4.10, Attitude depends on both perceived usefulness and perceived ease of use.
- Perceived Usefulness (PU): This construct was defined by Fred Davis as "the degree to which a person believes that using a particular system would enhance his or her

job performance". As shown in shown in Equation 4.11, PU has been evaluated empirically by adding weight of PEU and EV.

- Perceived Ease-of-Use (PEU): Davis defines this as "the degree to which a person believes that using a particular system would be free from effort" (Fred D. Davis, 1989). As shown in Equation 4.12, PU has been evaluated empirically by adding weights of PEU and EV.
- External Variables (EV): EV has an indirect effect on attitudes toward the use and actual usage of behaviour, by having significant influence on PU and PEU (Fred D Davis et al., 1989; Marangunić & Granić, 2015).

$$B \cong BI = w_1 A + w_2 PU \quad (4.9)$$

$$A = w_3 PU + w_4 PEU \quad (4.10)$$

$$PU = w_5 PEU + w_6 EV \quad (4.11)$$

$$PEU = w_7 EV \quad (4.12)$$

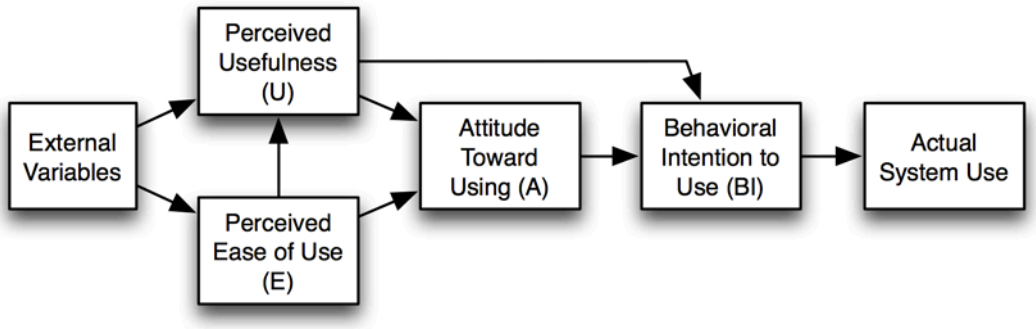


Figure 4-3 TAM (Fred D Davis et al., 1989)

Prior to introducing TAM, Davis (1986) proposed two main changes to the TRA and TPB. The first change is taking only the person's attitude toward behaviour for predicting an actual behaviour B while neglecting the effect of subject norm SN. The second change was

identifying perceived usefulness (PU) and perceived ease of use (PEU) as two distinct beliefs to predict the person's attitude towards the use a certain system (Davis Jr, 1986).

According to this model, attitude is the outcome of a user's evaluation towards certain behaviour, such as good/bad, harmful/beneficial, pleasant/unpleasant (Holden & Karsh, 2010). The model's hypothesis is that the overall attitude of a user toward using a target system is an essential determinant of whether or not the user uses or refuses the system. Several studies have been conducted and a variety of measurement methodologies have been used for measuring attitude. These studies have observed a considerable link between attitude and usage and also PU and other similar variables, such as perception of performance impacts. Relevance and importance have also been linked to usage. Usage, in parallel with usefulness, is considered influenced by PEU. Overall, perceived usefulness is the major determinant of the intention to use a certain system (Fred D. Davis, 1989; Fred D Davis et al., 1989; Davis Jr, 1986).

Among many influential variables, there are two variables which have a significant influence on system use. The first variable refers to perceived usefulness, which is people's tendency to either use or reject an application by the way they believe it will facilitate their jobs (Davis Jr, 1986). A system is considered to have a high perceived usefulness value when users trust its performance. Second, regardless of the usefulness of any given application, a user might expect that using a given application is hard and the usage benefits are little with respect to the effort needed for using the application. PEU, as explained in Equation 5.12, is a causal effect on EV. Furthermore, in any organisational framework, PU is considered the main driver of technology adoption (Egea & González, 2011). For example in health information systems, PU has been introduced as a major determinant of physicians' acceptance of health technology (Egea & González, 2011).

In addition to usefulness, usage is also introduced as a dependent on ease of use. Davis et al. (1989) reported that PEU is a basic determinant in technology adoption, since it depends on the potential user's perspective to begin accepting certain technology (Fred D Davis et al., 1989). Venkatesh (2000) concluded that PEU shows two main distinct influences on the BI for technology adoption, in which one of them is a direct influence and the other an indirect influence through PU. There are some effective external variables that should be considered when designing a system. The most well-known variables are ''system quality, training, compatibility, computer anxiety, self-efficacy, enjoyment, computing support, and experience'' (Venkatesh, 2000). Furthermore, the specification of the system design, which is represented by external variables, has a significant and direct impact on PEU. Therefore, the external variables' evaluation will be the determinant of PEU, as shown in Equation 4.12.

Lee et al. (2003) proposed a historical and analytical study of TAM. The study is linked between the history of the theory, from 1986 to 2003, and the prediction of its future trajectory through extensive analysis. The study focused on answering some crucial questions of TAM during the time period and propose future direction advice, which contains the need for incorporating more variables and defining boundary conditions (Lee, Kozar, & Larsen, 2003). Another study conducted by Chuttur (2009) considered TAM a highly cited model, and wrote that TAM ''lacks sufficient and rigorous research''. Instead of PU and PEU, there are additional factors that have an influence on system acceptance, which are not taken into account by TAM (Chuttur, 2009). A statistical meta-analysis of TAM has been conducted by King and He (2006), in various fields. The results concluded the validity and robustness of TAM as an applicable model in a wide range of fields (King & He, 2006). Recently, a comprehensive concept-centric literature review of the TAM, from 1986 onwards, has been presented by Marangunić & Granić, 2015. The study clarified the model's popularity in the technology acceptance field, which originated from the psychological

concepts of TRA and TPB (Marangunić & Granić, 2015). TAM has been developed and has become a significant model for understanding human behaviour predictors toward either the acceptance or rejection of a given technological system. Many studies have confirmed the strength and broad applicability of TAM towards various technological systems (Marangunić & Granić, 2015).

Many suggestions have been proposed to discover new effectiveness factors on the core variables of TAM. It is understood that there are some gaps in the TAM model's potential application and it needs to be updated in order to improve the predictive validity of TAM. Thus, some critical proposals have been identified for future research and the improvement of TAM. A modified version of TAM has been proposed by Venkatesh and Davis (2000), named TAM2, in order to identify the factors that have an effect on PU. The identified variables include SN, image, job relevance, output quality and result probability. In addition, two moderate factors have been included in the model, which are experience and voluntariness (Marangunić & Granić, 2015; Venkatesh & Davis, 2000).

4.2.4 Decomposed Theory of Planned Behaviour (DTPB)

DTPB is an improved version of TPB, with decomposed belief structures. The model was introduced by Taylor & Todd in 1995 (S. Taylor & P. Todd, 1995; S. Taylor & P. A. Todd, 1995). The belief structures of TPB, which are Attitude (A), subjective norm (SN) and perceived behaviour control (PBC), have been decomposed in DTPB and a multidimensional belief structure has been produced. Several advantages were added by DTPB. The idea behind decomposing these beliefs is to clearly demonstrate the relationship betweem them. Furthermore, a stable set of beliefs can be provided by this model and then can be applied across different settings. Another advantage of DTPB is the model's focus on particular factors that may have an effect on usage and adoption (S. Taylor & P. A. Todd, 1995).

As shown in Figure 4-4, DTPB possesses the following constructs:

- Usage Behaviour (Behaviour): Discussed in TRA, TPB and TAM.
- Behaviour Intention: Discussed in TRA, TPB and TAM.
- Attitude: Discussed in TRA, TPB and TAM.
- Subjective Norm SN: Discussed in TRA and TPB.
- Perceived Behaviour Control (PBC): Discussed in TPB.
- Perceived Usefulness (Relative advantage): This construct specifies the extent that the benefits will be provided by an innovation that replaces its precursor. In addition, some factors, ''such as economic benefits, image enhancement, convenience and satisfaction'', might be incorporated (Rogers, 2010).
- Perceived Ease of Use (Complexity): This is the extent to which an innovation is perceived as complicated and comparatively difficult to understand and utilise (Rogers, 2010).
- Compatibility: This is the extent to which an innovation is ''perceived as consistent with the existing values, past experiences, and needs of potential adopters'' (Rogers, 2010).
- Peer influence (Peer pressure or social pressure): This represents the influence of a peer group, controller, or a person's effort to encourage other people in order to change their attitudes, values, or behaviour of an individual to adapt to the influencing person or group (Rogers, 2010).
- Superior's Influence: This is the influence of an organisation's referent group (manager, supervisor or teacher) on a person's decisions (Rogers, 2010).
- Self-Efficacy: This relates to the perceived ability of the decision maker. The ''higher levels of self-efficacy will lead to a higher level of behavioural intention and technology usage''. (Rogers, 2010).
- Resource Facilitating Condition: RF is considered a control belief relating to resource factors such as time and money (Rogers, 2010).
- Technology Facilitating Condition: TF is considered a control belief, which relates to technology compatibility issues that may affect usage (Rogers, 2010).

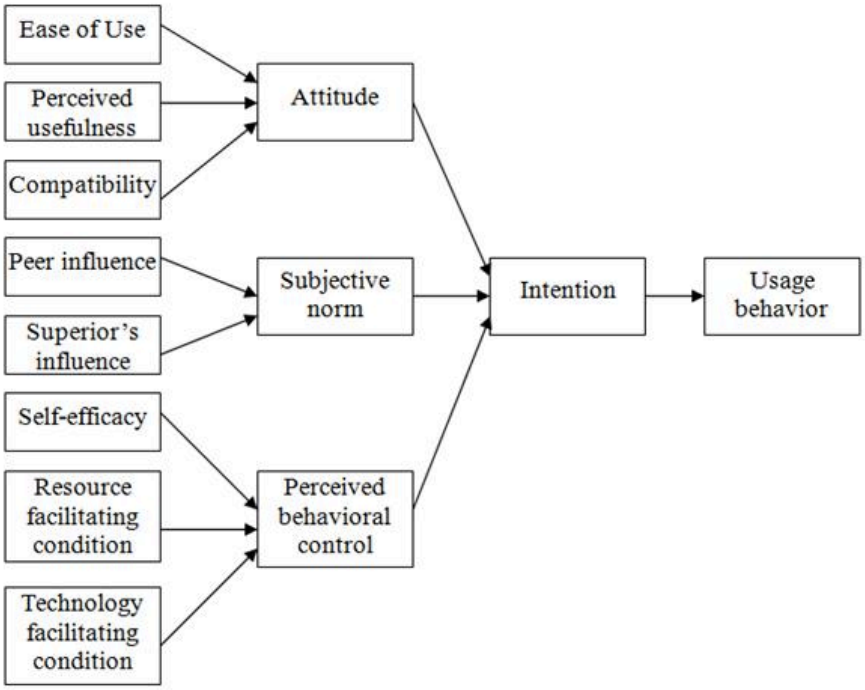


Figure 4-4 Decomposed theory of planned behaviour (S. Taylor & P. A. Todd, 1995)

DTPB suggests that behavioural intention is the major direct determinant of behaviour (S. Taylor & P. A. Todd, 1995). The other core constructs of behaviour, as illustrated in TPB and Equation 4.13, are attitude toward behaviour (A), subjective norm (SN), and perceived behaviour control (PBC).

$$B \cong BI = w_1 A + w_2 SN + w_3 PBC \tag{4.13}$$

Cognitive belief structures cannot be considered a singular concept or cognitive component. Based on the observations of Shiue (2007), direct assessments of attitude, subjective norm and perceived behavioural control are utilised by TPB by taking individual and external constraints into account to predict the behavioural intention of the person (Shiue, 2007).

Attitude, as it has been previously defined, is based on the feeling toward a certain behaviour, which encourages the decision maker to perform that behaviour. As Taylor and Todd (1995) suggested, attitudinal belief has been decomposed into three different factors, which are ''perceived usefulness (PU), perceived ease of use (PEU), and compatibility''. These factors have been discovered and defined as IT usage related factors (S. Taylor & P. A. Todd, 1995). The decomposition of attitude is shown in Equation 4.14.

$$A = w_4 PU + w_5 PEU + w_6 COM \quad (4.14)$$

PU has a positive direct relationship with the innovation's rate of adoption, and Complexity can be derived from PEU. In addition, potential users are likely to adopt less complex IT in terms of use, than complex IT. Complexity can be considered a major factor in the process of technology adoption (Fred D. Davis, 1989). According to (Fred D. Davis, 1989; Moore & Benbasat, 1991), the determinants of PU and PEU are considered a positive determinant of attitudinal belief. Compatibility is likely to act as an ''antecedent of perceived usefulness and ease of use'' (Fred D. Davis, 1989; S. Taylor & P. A. Todd, 1995; Venkatesh & Davis, 2000). (Fred D Davis et al., 1989) argued that an innovation is more likely to be adopted by users when it is compatible with the work and lifestyle of that potential user. The decomposition of attitudinal beliefs will positively influence an individual's attitude towards using new technology, based on the ease of use and compatibility of the technology.

Based on various views on IT usage, DTPB is derived from normative belief (NB) according to peer influence and a superior's influence. As an example, peers of the user may be against using a particular system, such as LBI, by arguing it requires too much change in their life's routines. A user's superior may look at the outcome of the system's use and as a result may encourage the use of the system. In some particular cases, as a result of opposite influences of the referent groups, a monolithic normative structure may show no influence on SN or Intention. Therefore, a suggestion of decomposing normative belief into

two referent groups (peers and superiors) has been made (S. Taylor & P. Todd, 1995; S. Taylor & P. A. Todd, 1995). As such, SN is a combination of both peer influence and superior influence, as shown in Equation 4.15.

$$SN = w_7 PI + w_8 SI \tag{4.15}$$

In the DTPB, PBC expands to include both components of self-efficacy and facilitating conditions. The facilitating conditions consist of resource facilitating conditions, and technology facilitating conditions. Efficacy has been defined by Bandura (1977) as the perceived capabilities of a person to arrange and manage a certain action or a situation (Bandura, 1977). Basically, in DTPB the person's skills and confidence have been taken into account. Shih and Fang (2004) argue that confident users possess self-skills in using information technology (Shih & Fang, 2004). Self-efficacy is linked to perceived ability and it is expected that higher levels of behavioural intention and IT usage will be gained as a result of higher levels of self-efficacy (Bandura, 1977; S. Taylor & P. Todd, 1995).

The function of the facilitating conditions construct is to provide two dimensions for control beliefs. The first relates to resource facilitating conditions, such as time and money. The second dimension relates to technology facilitating conditions, such as issues that constrain usage. According to Triandis (1979), facilitating conditions relate to the availability of necessary resources, in order to undertake certain behaviour. Facilitating resources may urge the formation of intention. However, the absence of facilitating resources represents barriers to usage, but “the presence of facilitating resources may not encourage usage’’ (Taylor & Todd 1995 b). DTPB has been presented as a model which possess the capability of explaining usage behaviour. The function of PBC has been shown in Equation 4.16, which is the sum of SE, RF and TF.

$$PBC = w_9 SE + w_{10} RF + w_{11} TF \tag{4.16}$$

The government's role might be a significant factor in promoting the diffusion of innovation (Cheng, Yu, Huang, Yu, & Yu, 2011; Shin, 2013; Wang & Kim, 2007; Zhang, Guo, Chen, & Chau, 2009). Furthermore, new strategies can be implemented in order to guarantee the adoption of innovation at a nation level. Innovation operators also play an important role in facilitating diffusion, as a result of increasing awareness through extensive advertising and promotion.

Since the introduction of DTPB by Taylor and Todd in 1995, the model has played a great role in many subject areas (Hsu & Chiu, 2004; Ndubisi, 2004; Sadaf, Newby, & Ertmer, 2012; Shiue, 2007; Tsai, Cheng, Hung, He, & Wang, 2015). In some studies, DTPB has been expanded upon by adding extra factors to the original model. Moons and De Pelsmacker (2015) used DTPB in their study of electric car usage and added some extra factors that may influence electric car usage intention. The factors have been defined as an emotion towards car driving as well as car driving habits. The study presented emotions as the most significant electric car usage intention, followed by attitude (Moons & De Pelsmacker, 2015). In addition, an institutional trust factor has been added to DTPB by Lai (2013) to study the physician's acceptance behaviour of the electronic medical record (EMR) exchange. The study specified four factors, ''attitude, subjective norm, perceived behaviour control, and institutional trust'', which have a significant influence on usage intention of physicians (Lai, 2013).

DTPB has a feature that distinguishes it from other theories. It characterises a number of dimensions of attitude, subjective norm and perceived behaviour control. The main role of these dimensions is to provide a better understanding of the antecedents of behaviour intention. Unlike the monolithic belief structure, as explained in TPB, the set of beliefs of DTPB is stable and more detailed (S. Taylor & P. Todd, 1995). DTPB can be considered a less complex and more easily made operation when compared with other models. This simplicity is shown in belief structures, which are applied to a wide variety of settings.

Furthermore, DTPB provides greater understanding of behaviour and intentions than TAM. Therefore, management can be guided more effectively by DTPB as a result of identifying the issues that affect usage and technology adoption (Mathieson, 1991).

4.2.5 Innovations Diffusion Theory (IDT)

Innovations Diffusion Theory (IDT) was used in the 1950s at the University of Chicago to estimate and measure the efficiency of broadcast advertisements (Radford & Bloch, 2011). A well-known version of IDT has been published by Rogers (1962) in the first edition of his book (Diffusion of innovations) (Rogers, 2010). The concept of this theory is based on describing the innovation-decision process. The model investigates how, why and at what rate the culture accepts new technology and innovations. According to this model, an individual needs to pass five steps in order to accept a piece of new technology, idea or any new innovation, as below:

1- The knowledge of its existence and functionality is an essential requirement. Advertisements, publications and product catalogues are useful in this regard.
2- The individual's attitude toward the system in terms of ''favourable'' and 'unfavourable''.
3- Making decisions is the next step, based on the previous steps.
4- Implementation of the system occurs when the individual decides to use it.
5- Confirming the individual's decision is the final stage. This can be done by expressing the idea and impressions regarding the system.

The details about each stage of the model are illustrated in Figure 4-5.

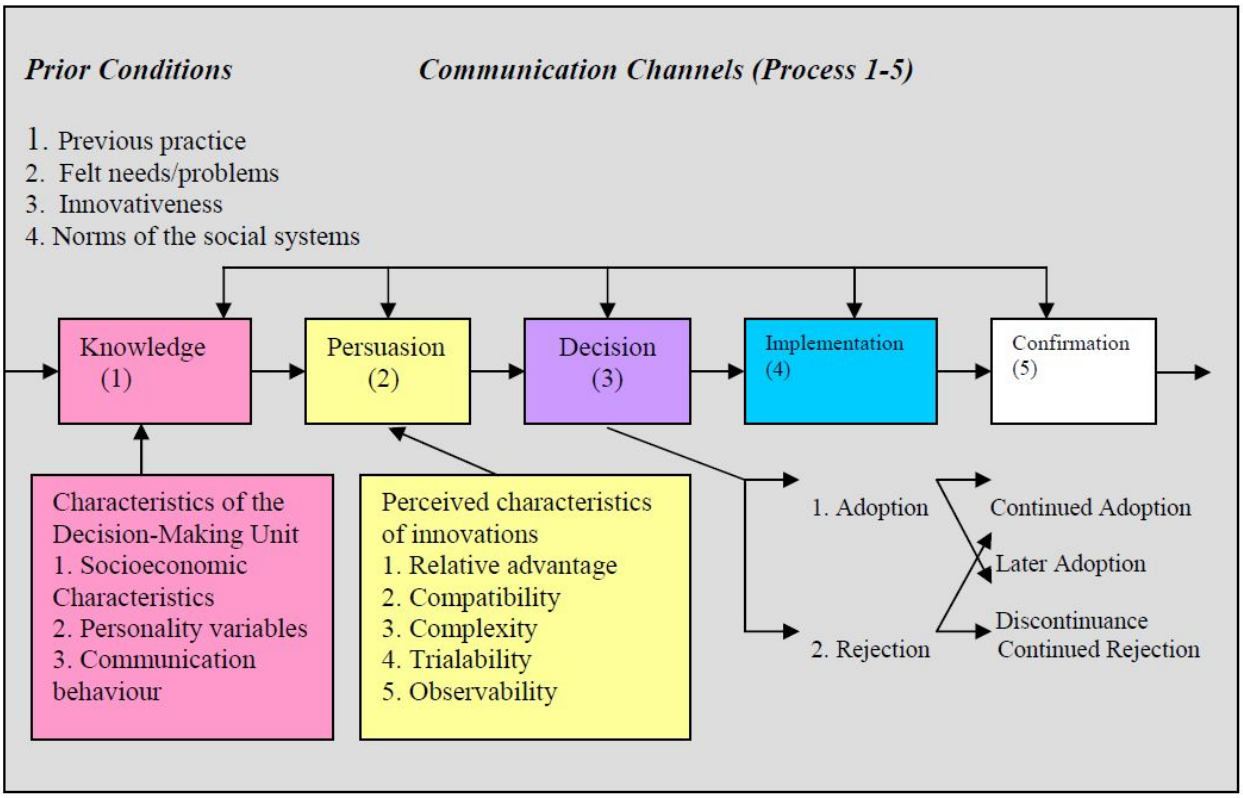


Figure 4-5 The five stages of Innovation-Decision Process (Rogers, 2010)

4.2.6 Other models

After explaining models TRA, TPB, TAM and DTPB in the previous sections, other models have been proposed with regards to system acceptance. TRA is considered a base model for proposing all other models. As mentioned in section 4.2.3, TAM has been extended to TAM2 by Venkatesh & Davis (2000). In TAM2, many details have been added to the original model to move it closer to other effective models, such as TPB and TRA. The added elements of TAM2 can be classified into two main categories. First is the process of social influence, which depends on social interactions, group behaviour (subjective norm, voluntariness, and image). Second is the processes of cognition, which depends on technology performance and its impact on work (job relevance, output quality, demonstration of results and perceived ease of use) (Venkatesh & Davis, 2000). TAM2 has been presented in Figure 4-6.

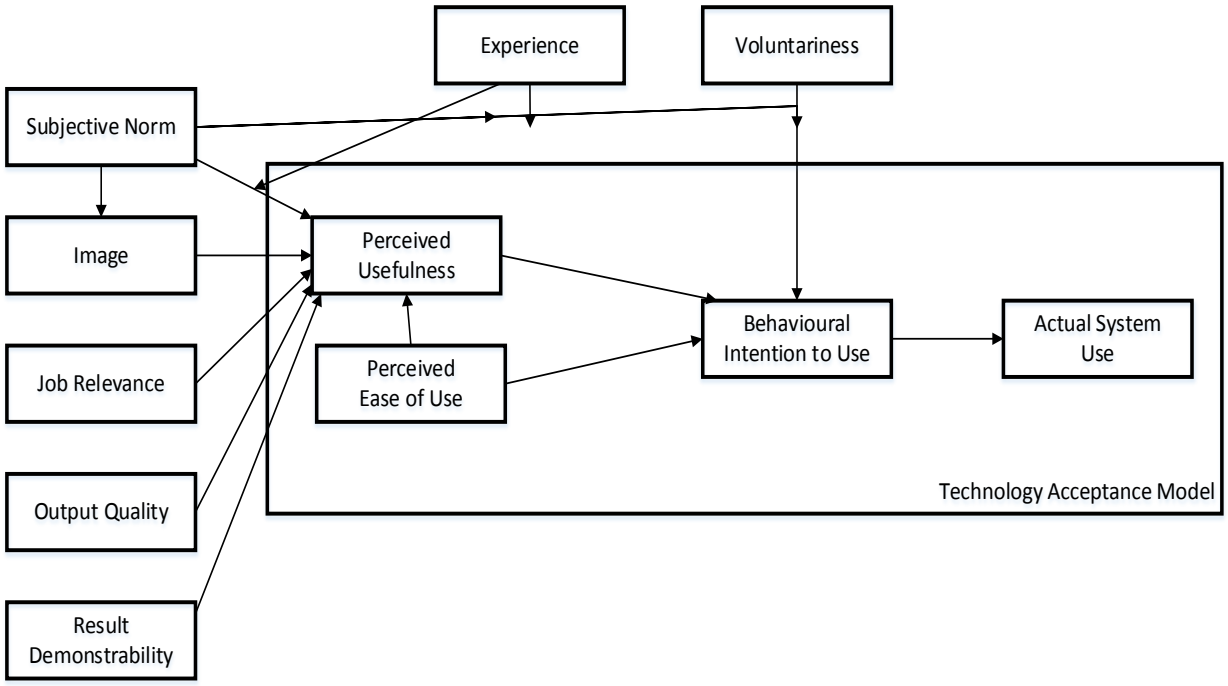


Figure 4-6 TAM2 (Venkatesh & Davis, 2000)

A number of additional variables have been explored by Venkatesh & Davis (2000), which act as antecedents to Perceived Usefulness (PU). These variables are considered as the impact of predominantly subjective norms on behavioural intention, which act to explain why a system was perceived to be useful. In addition, the model assumes that Perceived Ease of Use (PEU) and the related results have a positive impact on perceived usefulness. Perceived usefulness is positively influenced by job relevance and output quality (Venkatesh & Davis, 2000). Much research has been carried out based on TAM2 (Chismar & Wiley-Patton, 2002; OGUNDEJI, Oluwakayode, & Tijani, 2014; Singletary, Akbulut, & Houston, 2002; Wu, Chou, Weng, & Huang, 2008). These studies show the model's acceptance within the academic community, who consider the model as a positive step toward justifying technology acceptance in an organisational framework. None of the seven new added constructs hypothesised perceived ease of use as a core construct.

Venkatesh (2000) developed a model of perceived ease of use determinants based on the framing of decisions. The model assumed that decision makers will produce pre-perceptions of the perceived ease of use of a system. The pre-conception is dependent on several anchors relating to the general beliefs of the person relating to computers and computer use. These anchors consist of ''computer self-efficacy, computer anxiety, computer playfulness, and perceptions of external control''. Different individual beliefs that are associated with computer use are represented by the first three anchors. The model suggests that judgements of any new system will be adjusted by the user based on the anchors that drive initial ease of use. System characteristics of perceived enjoyment and objective usability have been suggested as determining perceived ease of use. These characteristics are analysed as users gain experience with a new system (Venkatesh, 2000). The model theoretically explains the direct proportional relationship between user's experience and the role of computer self-efficacy and perceptions of external control. However, the role of computer playfulness and computer anxiety diminish over time (Venkatesh, 2000).

The TAM2 model (Venkatesh & Davis, 2000) and the model of the determinants of perceived ease of use (Venkatesh, 2000) have been combined into a single integrated model called TAM3 by (Venkatesh & Bala, 2008). TAM3 consists of the determinants of individuals' IT adoption and use. The model suggests that perceived ease of use will not be affected by the determinants of perceived usefulness and perceived usefulness will not be affected by the determinants of perceived ease of use. Therefore, the model does not assume any cross-over effects, as shown in Figure 4-7 (Venkatesh & Bala, 2008). The model postulates three new empirical relationships, which are not justified by Venkatesh (2000) and Venkatesh and Davis (2000). The suggested relationships exist between computer anxiety and PEU; PEU and PU; and PEU and behavioural intention BI respectively.

The suggested relationship between PEU and PU represents the case of increasing experience, where the users will be able to conduct an assessment of their likelihood of attaining high-level goals. In that case, PEU, as a low level identity, will significantly influence PU as a high level identity (Venkatesh & Bala, 2008). The relationship between computer anxiety and PEU has been suggested based on the experience gained by the user. For highly experienced users, the effect of computer anxiety on PEU will diminish and can be neglected, since system specific beliefs become the main determinants of PEU. In addition, accurate perceptions of the experienced users regarding the effort needed to use a system is another reason for the suggested relationship between computer anxiety and PEU (Venkatesh & Bala, 2008). The final suggested relationship between PEU and BI is moderated by experience. This relationship will be weaker with highly experienced users and vice versa (Venkatesh & Bala 2008). When users become familiar with a particular system, the effect of PEU on BI will recede to the user's background,given thast more procedural knowledge on how to use the system has been gained. As a result, users will consider PEU as being less important than BI when using a system.

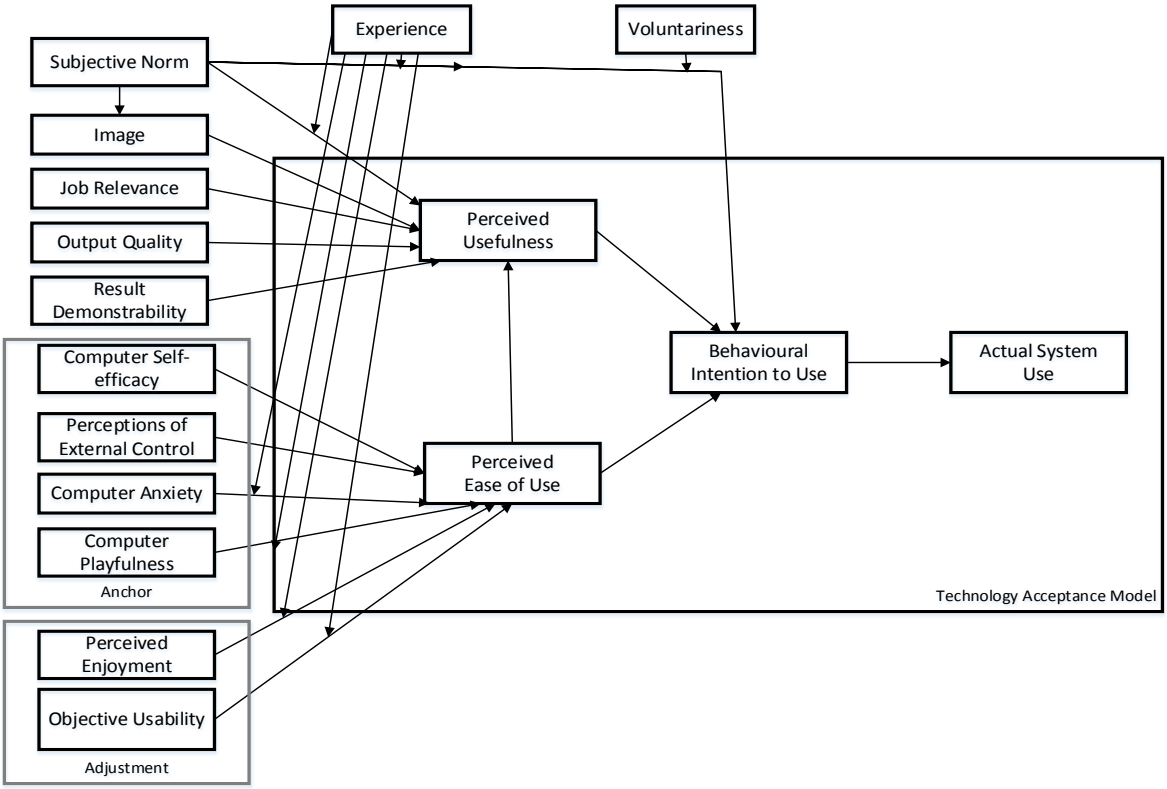


Figure 4-7 TAM3 (Venkatesh & Bala, 2008)

Venkatesh, Morris, Davis, & Davis, (2003) aimed to propose an empirical comparison between eight models and their extensions, in order to formulate an integrated model based on the compared model elements. The compared models are TRA, TAM, motivational model, TPB, a model combining TAM and TPB, PC utilization the innovation diffusion theory, and social cognitive theory. Thus, the Unified Theory of Acceptance and Use of Technology (UTAUT) has been formulated, as shown in Figure 4-8 (Venkatesh et al., 2003). Four constructs (performance expectancy, effort expectancy, social influence and facilitating conditions) have been suggested, theoretically, as a direct determinant of user acceptance and usage behaviour. In spite of this, attitudes toward using technology, self-efficacy, and anxiety have been considered as indirect intention determinants. Since about 70% of the variance in intention has been explained by UTAUT, it is possible to explain a person's acceptance and usage decisions in organizations (Venkatesh et al., 2003).

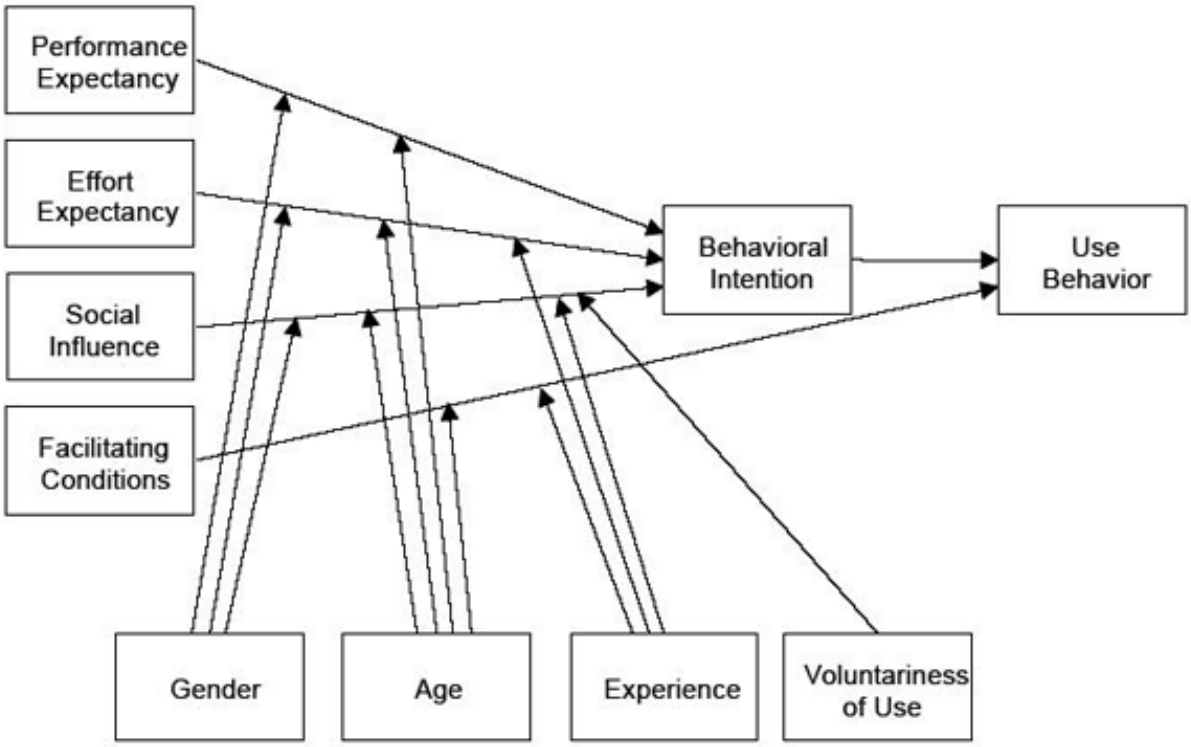


Figure 4-8 Unified Theory of Acceptance and Use of Technology (UTAUT) (Venkatesh et al., 2003)

Both models of TAM and TPB can be used as a combined model, which is called C-TAM-TPB (S. Taylor & P. Todd, 1995). This combined model can provide the effects of social and control factors on IT system usage behaviour, which TAM enables the provision of (S. Taylor & P. Todd, 1995; Venkatesh et al., 2003). (Venkatesh et al., 2003) conducted a comparison study between eight different models, based on "core constructs, beliefs, moderators and percentage of explained variance''. The selected models are "TRA, TAM, a motivational model (MM), TPB, C-TAM-TPB, a model of PC utilization (MPCU), IDT, and SCT''. The study investigated how the power of the selected model in explaining user intention varies from 17% to 53%. TAM2 scored 53% and TAM includes gender at 52%. The details of the scoring of the models are shown in Figure 4-9. As a result of this comparison, The Unified Theory of Acceptance and Use of Technology (UTAUT) has been formulated. The study concluded that

UTAUT has highest power to explain behaviour intention (BI) when compared with other eight models model, by 69%.

Theory/ Model	Belief	Core Construct	Moderator	Predicting Intention (R^2)*
1. IDT	No	1. Characteristics of Decision-Making Unit (3 variables) 2. Perceived characteristics of Innovations (5 variables)		T1=0.38, T2= 0.37, T3= 0.39
2. SCT	No	1.Personal Factors 2. Environmental F.		T1=0.37, T2=0.36, T3=0.36
3. TRA	1. Beliefs & evaluations 2. Normative beliefs & Motivation to comply	1.Attitude toward behaviour (ATB) 2. Subjective norm (SN)	Base on Voluntary	T1= 0.30, T2=0.26, T3=0.19
4. TPB	1. Behaviour beliefs 2. Normative beliefs 3. Control beliefs	1. ATB 2. SN 3. PBC	No	T1= 0.37, T2= 0.25, T3= 0.21
5.DTPB	1. PU, PEOU, and Compatibility 2. Peer & superior's influence 3. Self efficacy, Resource & Technology Facilitating Condition.	1. ATB 2. SN 3. PBC (Perceived Behaviour Control)	No	T1= 0.37, T2= 0.25, T3= 0.21
6.TAM	1.PU 2.PEOU	1. ATB	No, but based on voluntary	T1=0.38, T2= 0.36, T3=0.37
7.TAM2	1. Subjective norm 2. Image 3. Job relevance 4. Output quality 5.Result demonstrability (All determine PU)	1. PU 2. PEOU	Two: Experience (exp.) & voluntary (vol.)	T1=0.38, T2=0.36, T3=0.37
8.C-TAM-TPB	1. PU 2. PEOU (determine attitude)	1. ATB 2. SN 3. PBC	Experience & inexperience	T1=0.39, T2=0.36, T3=0.39
9.UTAUT	No	1. Performance expectancy 2. Effort expectancy 3. Social Influence 4. Facilitating conditions	Four: gender, age, exp., and vol.	T1=0.35, T2= 0.38, T3=0.36 , Pooled = 0.69

Figure 4-9 Model Comparisons (Venkatesh et al., 2003)

4.3 Summary of technology models

Attitude is considered the main predictor of behaviour intention in TRA. The model can be the perfect choice for the small business domain (Southey, 2011; K. E. Thompson & Panayiotopoulos, 1999). As explained in section 4.2.1, the TRA model assumes that attitude and subjective norms affect an individual's behavioural intention to do or not to do a particular action. In addition, attitude and subjective norm are proposed as a function of silent beliefs and normative subjects. Ajzen (1985) proposed other factors of individual control that have influence on behaviour intention. Perceived behaviour control (PBC) has been added as an additional determinant of BI in the TPB model. TPB has been explained in detail in section 4.2.2. According to Chang (1998), TPB offers better results than TRA because TPB has a better predictor (perceived behaviour control) of behaviour intention than TRA, which is a predictor of attitude (Chang, 1998).

Davis (1989) proposed an explanation for silent beliefs, which were first introduced by Fushbin and Ajzen (1975) as a function of PU and PEU. The new modified model, known as TAM is explained in detail in section 5.2.3. Although SN and PBC determinants have been ignored in TAM, the model is considered one of the most popular models for examining system usage over the last few decades. The determinants of TPB have been decomposed to produce DTPB by (S. Taylor & P. Todd, 1995), as explained in detail in section 5.2.4. In addition to PU and PEU, proposed by (Fred D. Davis, 1989), compatibility has been added as an additional factor of attitude toward behaviour in the DTPB model. In addition, SN has been decomposed into peer influence and a superior's influence factors. Finally, PBC has been decomposed into three main factors of self-efficacy, resource facilitating conditions and technology facilitating conditions. Despite that, DTPB provides a detailed explanation of the factors behind system usage. The model is generally described as a complex model to test system acceptance.

There is one single aim behind proposing these various models, and that is to explain an individual's attitude and behaviour intentions, and then their actual behaviour. The Theory of Planned Behaviour TPB has been described as an extended model of TRA and it became the basis of the Technology Acceptance Model TAM. In TAM, the determinants of PBC and SN have been neglected (S. Taylor & P. A. Todd, 1995). Since the beginning of 21st century, many studies have been conducted and additional factors have been proposed, such as Anchor and Adjustment, to modify the original version of TAM. The modified TAM models include TAM2, TAM3 and UTAUT, as explained in section 5.2.5. In TAM2 and TAM3, PBC, which is an important determinant in system acceptance, has not been taken into consideration. SN has been described as an influential determinant of a person's decisions in relation to technology acceptance (Venkatesh & Davis, 2000). Studies by Taylor and Todd (1995a and 1995b) clearly demonstrated that the decomposition of the belief structures (A, SN and PBC) into multi-dimensional constructs will lead to a better understanding of the latent variables.

Most of the models include the same factors, but with different names, such as the five constructs from the different models that relate to performance expectancy. These are perceived usefulness (TAM/TAM2 and C-TAM-TPB), extrinsic motivation (MM), job-fit (MPCU), relative advantage (IDT), and outcome expectations (SCT) (Venkatesh et al., 2003). The concept of effort expectancy has been captured by three constructs of the existing models, which are perceived ease of use (TAM/TAM2), complexity (MPCU), and ease of use (IDT) (Fred D Davis et al., 1989; Moore & Benbasat, 1991; R. L. Thompson, Higgins, & Howell, 1991). Social influence is represented as SN in TRA, TAM, TAM2, TPB/DTPB and C-TAM-TPB, social factors in MPCU, and image in IDT. The captured concepts of the facilitating conditions are "embodied by three different constructs: perceived behavioural control (TPB/ DTPB, C-TAM-TPB), facilitating conditions (MPCU), and compatibility (IDT)'' (Mohsin Manzari 2016). In order to remove barriers to use any

particular system, the aforementioned constructs are operationalised to include technological and/or organisational environment aspects. Taylor and Todd (1995) argue that there is a theoretical overlap as a result of modelling facilitating conditions, which is the core element of PBC in both models of TPB and DTPB. Attitude toward using technology has been defined as the sum of a person's affective reaction to use a particular system. This definition may apply to four constructs from the existing models, which are ''attitude toward behaviour (TRA, TPB/DTPB, and C-TAM-TPB), intrinsic motivation (MM), affect toward use (MPCU), and affect (SCT)'' (Venkatesh et al., 2003). Based on logical explanations, Venkatesh et al. (2003) suggested that attitude toward using technology will not have a direct or interactive impact on intention (Venkatesh et al., 2003).

4.4 Conclusion

In this chapter, a review of a number of technology models has been explained. The aim of using these models is to review the core technology acceptance models. These models have been reviewed in order to provide a clear view of the existing effective factors that should be taken into account while designing a conceptual framework. In the next chapter, DTPB will be used as a conceptual framework to test LBI system acceptance.

5 Chapter Five: Conceptual Model

After the extensive review of the literature in the previous chapters, this chapter outlines the study's framework and the aspects of the LBI system that have been covered in this research. To propose and suggest any technological system or toolkit, and put it into practice, three important questions should be answered by the researcher, which are as as follows (Bwalya, 2013; Tanner, 1992).

Q1- What is the necessity of having this system in real life?

Q2- What are the impacts of this system in real life?

Q3- What are the positive utilities of this system in real life?

The answers to the above questions lead us to the logical assessment of the suggested system. Any successful design should have the following features (Michalko, 2010).

It should:

- Meet the required objective(s).
- Work as a solver for specified problem(s).
- Have technical feasibility.
- Be capable of development and operate within constraints.
- Have the ability to be implemented.
- Be convenient for at least medium term business growth.
- Be accepted by the users.

As shown in Figure (5-1), the three aspects explained above have been taken into account in the current study separately in three different studies. The first aspect has been covered by undertaking a quantitative study. The individual objectives of the study have been presented. The key determinants of the theoretical framework that are expected to influence the usage behaviour of the KRI population regarding the use of an LBI system has been proposed and discussed. The study is based on a Likert scale questionnaire. The aim

of this survey is to validate either the objectives of the suggested system being met, or not, and to address the problems in the research field. The second and third aspects have been covered by undertaking quantitative studies based on an open-ended questionnaire and personal interviews for the second and third studies respectively. The aim of the second survey is to discover solutions for the addressed problems. However, the goal of the interview is to assess the capability and the applicability of the system, with a view to make it functional in today's working environment.

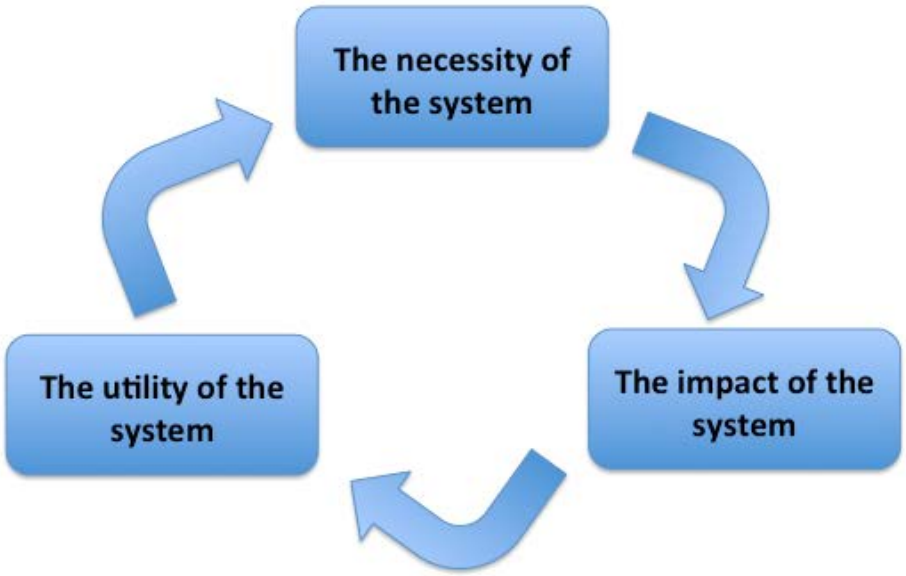


Figure 5-1 The research aspects

5.1 The acceptance of LBI system

Some well-known technology theories and models have been explained in the previous chapter. Amongst these models, the Decomposed Theory of Planned Behaviour (DTPB) and Technology Acceptance Model (TAM), as part of DTPB has been chosen and used as a conceptual framework for the current research to test the necessity and acceptance of LBI

systems. The reasons behind choosing DTPD and TAM to test the necessity and acceptance of the proposed LBI system has been explained in the previous chapter. The model DTPB has been built on multi-dimensional belief structures, rather than using a single dimensional structure, as in TPB. Moreover, TAM can be taken as a part of DTPB, in which attitude is decomposed into PU and PEU. Finally, the decomposition of perceived behavioural control into self-efficacy and government support is another important feature of DTPB, which is a factor within this research.

5.1.1 Evaluation

The SR_LBI technique has been proposed as an appropriate and useful LBI system for KRI. The purpose behind evaluating any system by its users is to predict acceptability, to specify the reasons resulting in lack of acceptance, and to suggest proper actions in order to improve user acceptance Davis (1989).

The individual evaluation of the current research can be listed as below:

- To develop a conceptual framework for testing the necessity of having LBI system.
- To generate and validate a conceptual model, based on DTPB model and TAM as part of DTPB in order to test the LBI system acceptance by KRI citizens. This has been achieved in this chapter by proposing a number of hypotheses based on the conceptual model.

5.1.2 The Conceptual Model

The conceptual framework (or theoretical framework) is the set of theories and models which support a positivistic philosophy research study (Collis & Hussey, 2014). In other words, it is a conceptual model that theoretically and logically organises relationships between the several identified factors in order to address a specific problem. The development of a specific conceptual framework helps to provide appropriate assumptions and hypotheses, as well as test certain interrelationships between different variables considered in the study. Thus, a clear picture of the dynamics of the situation will be drawn, which leads to improving our understanding in this regard. Knowledge regarding the

meaning and types of variables is essential to build an appropriate conceptual framework. The next step, after formulating the theoretical framework, is developing testable hypotheses to examine the validity of the formulated theory, using a survey strategy (Sekaran, 2006).

The current study model has been designed based on the integration of TAM and DTPB, as shown in Figure 5-1. The designed model includes a demonstration of the constructs, which either have positive or negative influences on a user's attitude toward using an LBI system in general and the SR_LBI technique in specific. The proposed research model involves two important categories of variables (see Figure 5-2).

- The six core constructs (independent variables) are perceived usefulness (PU), perceived ease of use (PEU), compatibility (COM), family and friends (FF), self-efficacy (SE) and government support (GS). These core constructs are expected to influence LBI and SR_LBI usage behaviour.
- The four dependent variables are attitude (A), subjective norm (SN), perceived behaviour control (PBC) and behaviour intention (BI).

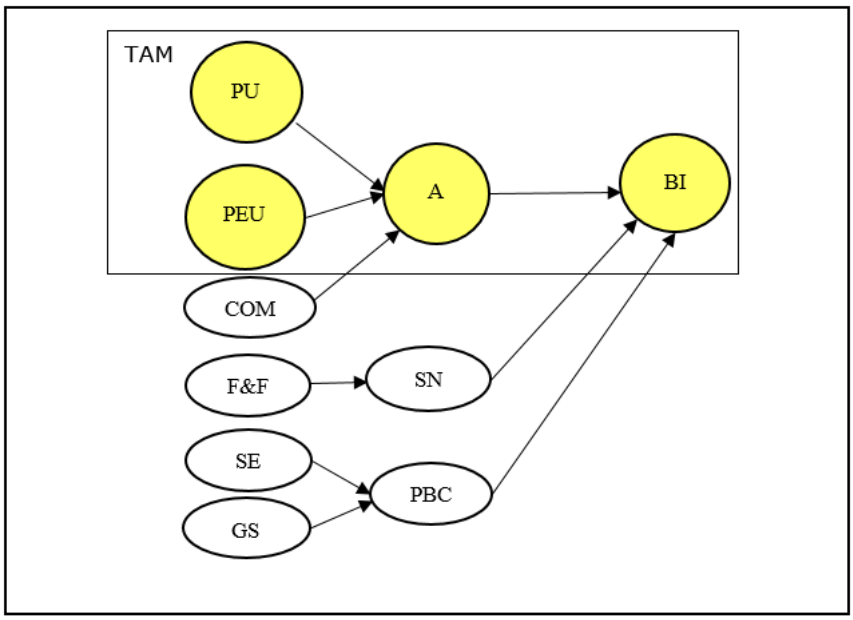


Figure 5-2 The proposed research model

Figure 5-2 represents the proposed model, including both TAM (highlighted in yellow) and DTPB (the whole model). In addition to dependent variables of attitude towards behaviour A and behaviour intention BI, TAM includes independent variables, which are perceived usefulness PU and perceived ease of use PEU. Based on these latent variables of TAM, the proposed model can be tested to specify the extent of the acceptance and usefulness of SR_LBI by the residents of KRI. While, DTPB consists of ten construct variables, including the four latent variables of TAM as shown in Figure 5-1. The other six variables of DTPB are compatibility, family and friends, self-efficacy, government support (COM, FF, SE and GS as independent variables), subjective norm, and perceived behaviour control (SN and PBC as dependent variables). LBI acceptance will be investigated based on these variables.

5.1.3 Research Hypotheses

Based on the proposed model, which is built up on both TAM and DTPB, nine different hypotheses have been formulated. The first three hypotheses are proposed based on both TAM and DTPB, whilst hypotheses 4 to 9 are based on DTPB only. The strength of the hypothesised relationships has been tested based on the conceptual framework. In addition, the robustness of the model in predicting users' intention to adopt LBI in KRI has been confirmed in Chapter 7 Results.

H1. Positive attitudes towards SR_LBI will increase the intention to use LBI system.

H2. The usefulness of SR_LBI has a positive effect on citizens' attitudes toward using LBI system.

H3. The ease of using the LBI system has a positive effect on attitudes toward using it.

H4. LBI compatibility has a positive effect on citizens' attitudes toward using LBI system.

PU, PEU and A are considered as the main factors for system usage (Fred D. Davis, 1989).

H5. Subjective norms positively affect a citizen's behavioural intention to use LBI system.

H6. Family and friends positively affect subjective norm to use LBI system.

H7. Perceived behaviour control has a positive effect on a citizen's behavioural intention to use LBI systems.

H8. Self-efficacy has a positive effect on perceived behaviour control towards using an LBI system.

H9. Government support has a positive effect on perceived behaviour control.

5.2 The impact of LBI system

The impacts of LBI systems in the community need to be explored in order to choose a best design for any particular country. In the current research, a qualitative approach has been followed to discover the required features of LBI systems in the following areas:

(1) In particular, what is the impact of being able to identify postcodes through an alphanumeric system, when compared with a numeric system?

(2) What is the impact of postcode systems on location based services and technology?

(3) What are the benefits of a location based system of postcodes, when detailed information is already available for the use of both numeric and alphanumeric systems, which do not indicate location?

(4) What is the impact on the economy of poor postal distribution?

(5) What is the impact of policy on postal distribution and vice versa?

5.3 The utility of the proposed LBI system

The utility of any designed system should be justified based on the decisions gathered from the review of experienced and qualified people, practitioners, and the decision makers of the same field. A decision should be made on the best postcode system to use in a given context, which supports researchers and analysts who wish to study the potential implementation of new systems. Indeed, a key finding of the current study could indicate the need of a new technique to design a postcode system, but this needs a much stronger justification. In order to achieve this aim, a further qualitative research study has been made to assess the issues already raised and discussed in this research and the key findings from the quantitative study regarding policy. This quantitative study has been undertaken in the form of a set of direct interviews and Skype interviews with professional people and policy makers in the field of postcode systems in different counties.

The study focused on the following points:

1- The necessity of having a technique as a standard to design a new postcode system. This technique might be useful for countries that do not yet have their own postcode system. The novelties of the proposed technique will be focused on in the discussion with the interviewees.
2- The assessment of the proposed technique also includes the applicability of the technique. Therefore, experienced people in the business sector, such as insurance, advertisement, and public service companies, are important to be included in this study.
3- The scalability of the proposed technique needs to be assessed as an important feature of any applicable system.
4- The flexibility of the proposed technique also needs to be assessed. In this regard, a discussion will be held about how the technique is flexible to be used in different countries and in different cities. The key point of this section will be the compatibility of the technique with different cultures, nations and development plans of the cities.

Seven different interviewees have participated in this study from countries of Iraq, the United Kingdom, Spain, Syria and India. The names of the interviewees have been kept anonymous to ensure confidentiality and anonymity in research.

No.	Name	Country	Specialist
1	Prof. Dr J. A.	The United Kingdom	Academic
2	A. J.	Iraq	Engineer/ GIS centre / Erbil
3	N. G.	Iraq	Engineer/ GIS centre/ Sulaymaniyah
4	M. J.	Syria	Insurance company
5	M. T.	Spain	International Humanitarian organisation
6	M. R.	India	Postal service specialist
7	D. H.	Iraq	Postal service specialist

Table 5-1 Interviewees' details

5.4 Conclusion

In this chapter, a conceptual framework has been designed based on three primary steps, which test the acceptability, impacts and the utility of the accepted LBI system. DTPB and TAM, as part of DTPB model, will be used to examine the acceptance of an LBI system based on the proposed technique (SR_LBI) by the citizens of the Kurdistan region of Iraq. The acceptance of the system is based on TAM. A number of hypotheses have been presented based on PU and PEU. These hypotheses will be expected to have a positive effect on an individual's attitude towards using an LBI system. Moreover, based on DTPB,

additional hypotheses have been designed to examine subjective norms and perceived behaviour control and the effects of these factors on an individual's intention to use an LBI system. These factors have been decomposed into compatibility, family and friends, self-efficacy and government support, in order to present a clear view of the weak points that could explain the reason an LBI system is not active in the region. Based on the above hypotheses, a number of questions have been prepared to be used in the study questionnaire, as presented in Appendix 1 - the study questionnaire. Based on these hypotheses and the question's results, the adoption of LBI systems in the Kurdistan region of Iraq can be investigated.

To discover the impacts of an acceptable LBI system, a qualitative study will be conducted. Five open-ended questions have been formalised, based on five different factors, as explained in section 5.2. In the next step, the utility of the proposed system will be studied. Towards this purpose, a qualitative study has been planned. The study consists of some interviews with decision makers and experts from different countries. The results of these interviews will be presented as an assessment of the outcomes of this research.

6 Chapter Six: Methodology

6.1 Introduction

All research methods and techniques have a philosophy that may vary considerably from one science to another (Kothari, 2004). Research can be classified as ''exploratory, descriptive, analytical, predictive, quantitative, qualitative, deductive, inductive, applied, and basic research'' (Hussey & Hussey 1997). In any type of research, the researcher needs to concentrate their efforts on two main points; the methods that the researcher intends to use, and second, a justification for choosing the methods. The justification of the research choice needs to reach into the assumptions about the reality that the researcher brings to their studies (Crotty 1998).

In this chapter, the steps towards research development and the techniques that have been used in the current study are presented. The research questionnaire is presented and the methods used and steps to test data validity and reliability are explained.

6.2 Research methodology steps

The steps of the current research method are designed based on the research onion method, proposed by Saunders, Lewis, & Thornhill (2008). This method contains six consecutive layers, from the outside research method followed by the research approach, methodological choice, strategies, time horizon and in the final layer, techniques and procedures, as depicted in Figure 6-1.

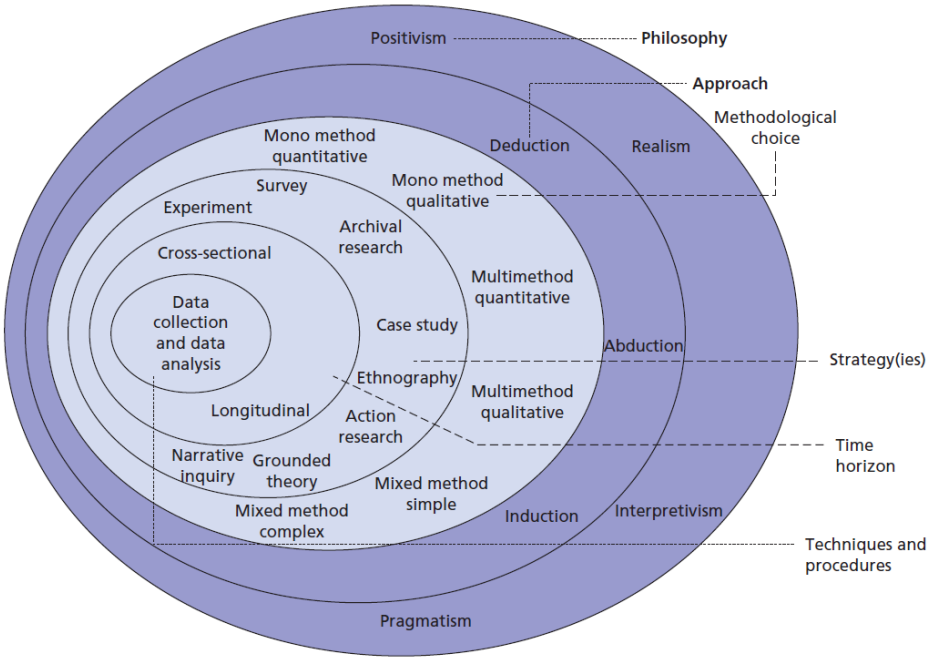


Figure 6-1 the research 'onion' (Saunders, Lewis, & Thornhill, 2012)

6.2.1 Research philosophy

The research philosophy can be defined as the belief and understanding of the philosophical assumptions that support the methodology in use and the approach towards research. According to the research onion, research philosophy comes in the first layer, which contains important assumptions about planning and carrying out the research. These assumptions are the backbone of the research strategy and the methods that have been chosen. There are three major ways of thinking about research philosophy: epistemology, ontology and axiology. Each contains important differences that influence the way of thinking about the research process (Kothari, 2004).

Epistemology concerns acceptable knowledge in the field of a particular study. This depends on asking questions to discover what information is known to be true in the relevant field of research. Acceptable knowledge is treated as fact. This philosophy is commonly used in

scientific researches for information that can be proven, rather than opinions and changeable situations. Ontology is concerned with the nature of being, becoming, existence or reality. Epistemology is concerned with the theory of knowledge in a given field of study. According to Collis and Hussey (2014), the philosophy of assumption can be classified into positivism and interpretivism (Collis & Hussey, 2014). According to Lewis, & Thornhill (2008), any research will come under one of the main philosophies of Positivism, Realism, Interpretivism and Pragmatism (Saunders et al., 2012). Axiology, or theory of value focuses on the value of the study based on ethics and aesthetics. The term ethics refers to the decisions of the individual toward a specific thing, subject or idea by it being good or right. On the other hand, aesthetics refers to the concept of beauty and harmony (von Hartmann, 1908).

According to (Saunders et al., 2012), if research philosophy reflects the principle of positivism, then the researcher ''will probably adopt the philosophical stance of the natural scientist'' (Mark, Philip, & Adrian, 2009). Based on this philosophy, the researcher will prefer “working with an observable social reality and that the end product of such research can be law-like generalisations similar to those produced by the physical and natural scientists” (Remenyi & Williams, 1998). Credible data can be produced as a result of observing a specific phenomenon. By using an existing theory to develop a hypotheses, a research strategy is generated to collect data. The generated hypothesis can be partially tested, or in full, and is either confirmed or refuted. The results will lead to further development of the theory, which may then be subjected to other tests through further research (Saunders et al., 2012).

Realism is considered an epistemological position that relates to scientific enquiry, and is based on the sense that presents reality as a truth. These senses are independent of the human mind. According to the theory of realism, reality is quite independent of the mind. Thus, realism is opposed to idealism, which depends only on the mind and its contents.

Similar to positivism, realism is an element of epistemology, which leans towards the development of knowledge by assuming a scientific approach. This assumption supports the collection, analysis and understanding of the data (Crotty, 1998). There are two contrasting forms of realism, direct realism and critical realism. Based on direct realism, we get exactly what we see and our experience through our senses reflects the real world. Critical realists often focus on how the senses deceive the individual (Saunders et al., 2012).

Interpretivism, also known as the interpretivist approach, involves researcher interpreting the differences between human interests and integrating interpretivism into a study. Accordingly, “interpretive researcher assumes that access to reality (given or socially constructed) is only through social constructions such as language, consciousness, shared meanings, and instruments” (Myers, 2013) page,39.

On the other hand, Pragmatism assumes that a proposition or ideology is true and only relevant where it supports satisfactory action (Kelemen & Rumens, 2008). This means that impractical ideas are to be rejected, and for pragmatists, the practical consequences are the most important part of an idea or a research finding. Different ways of interpreting the world and undertaking research have been recognised by pragmatists. Based on this philosophy, there is no single point of view that can give the entire picture of reality. According to (Kelemen & Rumens, 2008; Saunders et al., 2012), pragmatists always use single or multi-method to advance research based on credibility, reliability, reasonability and the relevance of the data to be collected. The current study is based on multi-method. The quantitative part of the research adopts the positivism philosophy, while the research is based on a number of hypotheses to be tested throughout the study. However, the qualitative part of the study adopts the interpretist philosophy in collecting in-depth descriptions and insights from the open-ended questionnaire and the interview.

6.2.2 Research Approach

A research strategy could be based on one of the following approaches:

1- Deductive approach: Deductive can be defined as “a set of techniques for applying theories in the real world in order to test and assess their validity” (Lancaster, 2007). Based on this approach, a theory and hypothesis (or hypotheses) is developed and a research strategy is designed to test the hypothesis. Furthermore, based on the empirical observations of quantitative research, the developed theories and hypotheses can be either accepted or rejected (Lancaster, 2007).

2- Inductive approach: Inductive can be defined as “a process where we observe certain phenomena and on this basis arrive at conclusions” (Sekaran, 2006). Based on this approach, data is collected and a theory will be developed as a result of extensive data analysis. The research investigation begins by observing a particular phenomenon to understand the nature of the problem, then explain the observed phenomenon through the development of a theory or a hypothesis (Saunders et al., 2012). Based on (Crowther & Lancaster, 2012; Teddlie & Tashakkori, 2003), an inductive approach is best suited to use and interpret qualitative data.

3- Abductive approach: Based on this approach, research begins by collecting data to explore a phenomenon, identify themes and explain patterns, in order to build a new theory or modify an existing one. Consequently, the collected data will be tested based on the developed theory (Saunders et al., 2012).

In the current multi-method research, both deductive and inductive approaches have been followed. In the first survey, the factors that influence LBI acceptance, based on SR_LBI technique, have been identified based on deductive approach. Then the theoretical framework of the study has been designed by using two different technology theories. In the second survey, the inductive approach is clear in exploring the impacts of using LBI

system by identifying themes from the collected data In addition, the final interview study is also based on the inductive approach in assessing the findings and the proposed techniques of the current research.

6.2.3 Methodological choice

The design of a research method can be defined as a plan to prove a research hypothesis by answering the study questions. The design should clearly demonstrate the objectives, the data collection sources, data analysis plan, and the probable constraints that may face the researcher in completing the research. The research method can be classified into mono method and multi-method. Mono research follows either a single qualitative or quantitative approach. The method selection must be done based on the requirements and the objectives of the research.

Qualitative research can be defined as “a process of inquiry that seeks to understand phenomena in a real-world setting where the researcher does not attempt to manipulate the phenomenon of interest” (Armour & MacDonald, 2012). Qualitative research follows an interpretive philosophy in expressing the subjective and in explaining a particular phenomenon that the research is focused on (Denzin & Lincoln, 2011). An inductive approach is the base of qualitative study. The detail about the study will be presented utilising expressive language by the researcher and the respondents. (Armour & MacDonald, 2012) state that the main difficulty of conducting qualitative research is in data collection, since the owner of the study plays the main role in data collection.

Quantitative research can be defined as “attempts to gather data by objective methods in order to provide information about relations, comparison and predictions, without ‘contamination’ by the investigator” (Armour & MacDonald, 2012). The philosophy of positivism and the deductive approach are the basis of this research type. Approaches can be tested by quantitative research based on the quantity of data being collected. The

research deals with the theory being tested, based on a study of the relationships between the measured variables. These variables are measured numerically and analysed based on different statistical approaches. The experiment and survey strategies are the base of this type of research, where the survey is conducted through questionnaires, observations or interviews. Unlike qualitative research, the role of the researcher in the process of data collection is insignificant (Saunders et al., 2012).

The research design based on a multi-method of qualitative and quantitative, with either inductive and/or deductive approaches. In some cases, the research splits into two or more sequential stages. The research may start with a quantitative or qualitative approach to test the study hypothesis and is followed by further quantitative and/or qualitative stages to develop the theoretical approaches of such study (Tashakkori & Teddlie, 2010).

The present study is based on a multi-method approach. Using multi-method has some disadvantages such as: (CRESWELL & Clark, 2011; Venkatesh, Brown, & Bala, 2013).

- The research design might become very complex.
- Needs more time and resources for research planning and implementation.
- The integration of the quantitative and qualitative data need to be done very carefully.

Next to the disadvantages referred to in the above, there are significant advantages of multi-method worth mentioning as follows:

- The method provides strengths to the research that compensate the weaknesses of the quantitative and qualitative research.
- The method provides deep understanding of the topic that cannot be provided by using the other methods.
- The method is better than the other methods for providing developing approaches.
- It is easier than the other methods to explain the findings and detail about work process.

The quantitative part of the research (the first survey) is based on a number of hypotheses and explanation of the relationships between variables according to the positivistic philosophy. The reasons behind using the quantitative approach in the first survey are as follows:

1- To create correlations between dependent and independent variables within the research framework (Muijs, 2010).
2- To control the data collection environment and draw clear borders for the study, through summarising a wide range of data.
3- The necessity of having an addressing system can be justified by people who have (at least) superficial knowledge about the system. Therefore, employing prescribed procedures by using quantitative method will be useful (Muijs, 2010).
4- Nowadays, the functionality of an addressing system is well developed and in this case, the quantitative method is appropriate (Riccucci, 2010).

Furthermore, the qualitative approach has been used in the second survey in order to collect further information to explore the impacts of LBI systems in daily life, based on the respondents answers to the open-ended questionnaire. This type of survey has been chosen due to the following reasons:

1- The survey can be considered a discovery and explanatory study and the quantitative method is appropriate for this kind of study (Yin, 2002).

2- Using qualitative research can lead to a comprehensive understanding of the case study and can become complementary strengths for the research (Starman, 2013).

3- The data from the open-ended questions may create ideas that have not been taken into consideration by the researcher (Ozuru, Briner, Kurby, & McNamara, 2013).

The aim of the third study is to assess the proposed ideas of the research. Hence, only experienced people and decision makers in this field have the capability to assess a piece of academic work. Therefore, qualitative research is the only way to achieve this goal. An

interview method has been chosen in this study in order to give the assessors the freedom to talk about any aspects of the current research (Brinkmann, 2014).

6.2.4 Research strategy

The research strategy can be defined as a plan to perform actions in order to fulfil certain criteria. The strategy of the researcher is often the methodological relationships between the research philosophy and the existing choices that lead to achieve logical answers for the research questions (Denzin & Lincoln, 2011). These strategies consist of an ''experiment, survey, archival research, case study, ethnography, action research, grounded theory and narrative inquiry'' (Saunders et al., 2012). Research can consist of field experiments, laboratory experiments, and/or surveys. The aim of experiments is to gain a clear picture of the causes and effects of the case study. In addition, surveys conducted either through questionnaires or interviews provide standardised and reliable data from a selected population. Furthermore, a survey strategy is considered an authoritative strategy by people who have a direct concerns in the case being studied (Saunders et al., 2012).

A survey strategy gives the researcher good control over the process of the study by generating data from a selected sample of the population, and further considers them representative of the whole population. The strategy should validate the representation of the respondents by having an acceptable response rate from individuals. Furthermore, time management is another factor that should be taken into consideration by the researcher. In addition to the time taken in data collection, the majority of the study period is taken up by data analysis and by making conclusions on the findings. The questionnaire is a popular form of data collection and has been used in this study to reach a wide sample size of the first and second surveys respectively. In the present research, 236 and 153 participants are used as the sample size for both questionnaires. Another reason for choosing a questionnaire is to ensure that the collection of data from participants' is done anonymously and without interference. In this regard, the online Google Forms tool has been used to

design the questionnaire, with the generated links published through emails and social media websites. The processing of responses and data collection was made automatically by using Google Sheets to ensure a high number of responses in a short period of time. In addition, the third study has been made with 7 interviewees. The responses have been analysed and different themes have been found from the data.

6.2.5 Choosing a time horizon

Research can be classified according to a time horizon of cross-sectional and longitudinal research. Cross-sectional research is based on a 'snapshot' time horizon, while cross-sectional research is based on a 'diary' perspective. Many strategies often utilise Cross-sectional research. These strategies may aim to explain a phenomenon occurrence or a relationship between factors in different methods. In addition, a study might be based on qualitative or multiple strategies, such as interview based research during a short time period. In the present study, a survey and questionnaire have been used as a research strategy and method respectively. In addition, based on a time horizon strategy, the study is a cross-sectional strategy.

After designing the first questionnaire through the relevant design tool (Google Forms), the questionnaire was published for three months from 15th December 2014 to 15th February 2015. However, the second questionnaire was published for 70 days from 5th November 2016 to 15th January 2017. Moreover, the interview meetings were conducted in March and April 2017, based on the availability of the interviewees.

6.2.6 Research techniques and procedures

This section focuses on the study population and sampling process. Sampling is defined as *"the process of selecting a sufficient number of elements from the population"* (Forza, 2002). The technique of sampling is necessary when the participation of whole research

population in the survey is difficult. or impossible. due to various reasons. such as “geographical boundaries, survey expenses, or time limits’’ (Saunders et al., 2012).

In the present research, to ensure the reliability of the study preliminary questionnaires were conducted in 21st July 2014 and 15th October 2016, as shown in Appendix 6 & 7. The surveys have been conducted as a group meeting, by explaining the meanings of LBI systems and the SR_LBI technique, since most participants were not familiar with LBI systems. The results of the preliminary questionnaires show that the majority of KRI citizens do not have enough information about LBI systems. To collect reliable data for the study, the participants must have at least superficial knowledge about LBI systems in general. As a result, a group of KRI citizens who are familiar with the LBI system have been selected to participate in the studies. The majority of the research population for the first and second surveys are students who are studying in developed countries where the LBI system is active. In addition, preliminary interviews were conducted with research students in the University of Huddersfield.

Sampling can be classified into two main approaches, which are: probability sampling and non-probability sampling. In a probability sampling approach, each individual from the entire research population has an equal participation chance in the study (Forza, 2002). The most important feature of this approach is providing a list containing the population that need to be sampled, known as the “sampling frame’’ (Forza, 2002). This approach is not applicable when the sampling frame is unavailable. The approach of non-probability enables the researcher to sample the research population, without the need for a sampling frame (Saunders et al., 2012).

Non-probability sampling has been used in the first and second surveys studies due to the unavailability of the sampling frame. This approach includes many different techniques. Among these techniques, self-selection within a volunteer group has been followed.

According to this sampling technique, the researcher publishes a questionnaire via the appropriate media and the participants voluntarily participate in the research. The online link to the questionnaires was published in social media, using scholarship program groups, the Human Capacity Development Program (HCDP) of the ministry of higher education, KRI. The majority of the participants were undergraduate and postgraduate KRI students that are/were studding in developed countries such as the United Kingdom, the United States, Canada, and Australia. The survey links have also been shared by the students via emails and other student social media groups, in order to reach a high number of participants.

For the quantitative study, Hair et al., (2010) state that structural equation modelling, which includes multiple regression analysis and confirmatory factor analysis, requires a minimum sample size ratio 20:1 (20 respondents per independent variable). However, a sample size of 50:1 is recommended for better results (Joseph F Hair, 2010). The developed model for the first quantitative study consists of 6 independent variables, which are perceived usefulness, perceived ease of use, compatibility, family and friends, self-efficacy and government support. Therefore, 120 responses are required as a minimum sample size. The total number of completed responses collected by online Google Sheets was 236. Finally, the data encoded into the SPSS program and analysed using Amos Graphic program is based on Structural Equation Modelling (SEM).

For the open-ended questionnaire, the sample size is based on the principle of data saturation. The decision of stopping the collection of the data is based on the experience and knowledge of the researcher. According to Trana et al. (2016), data saturation can be predicted based on the ratio of created themes to the sample size. Based on this study, for 5 open-ended questions, at least 78 participants are needed to consider 26 themes. In the current study, 26 themes have been found for the 5 open-ended questions in a sample size of 153 respondents, which is nearly double the required sample size (Tran, Porcher, Tran, & Ravaud, 2017).

6.3 The proposed questionnaires

6.3.1 The first questionnaire

The proposed research model includes ten latent variables. These latent variables can be represented using one or more observed variables, which are also called measured variables or indicators. These observed variables represent specific items or questions (Joseph F. Hair, 2010). The latent variables include six independent constructs and four dependent constructs. An independent construct is a latent variable, which is not influenced by the other model variables (Joseph F. Hair, 2010; Sharma). In the present study, each latent variable consists of two to three observed variables such as perceived usefulness (PU). PU consists of 3 observed variables: PU1, PU2 and PU3. In addition, the latent variable of subjective norm (SN) consists of 2 observed variables of SN1 and SN2 as shown in Table 6-1.

As shown in Table 6-1, in the present research, 16 items have been used to measure independent variables and 8 items for dependent constructs. The data has been analysed based on a two-step approach outlined by (R. Kline, 1998). The reliability and validity of the constructs will be discussed in the subsequent sections, prior to an SEM analysis, as recommended by (R. B. Kline, 2015). It is essential to test the data against both reliability and validity, because the measure may be consistent, but not accurate, and vice versa (Joseph F. Hair, 2010).

Construct	Number of Items	Items	Name of Constructs	Definition of the Constructs
1*	3	PU1-PU3	PU	Perceived Usefulness
2*	3	EOU1-EOU3	EOU	Perceived Ease Of Use
3*	3	COM1-COM3	COM	Compatibility
4*	2	FF1, FF2	NS	Normative Subject
5*	3	EF1-EF3	EF	Self-Efficacy
6*	2	GS1-GS2	GS	Government Support
7**	2	A1, A2	A	Attitude Towards Behaviour
8**	2	SN1-SN2	SN	Subjective Norm
9**	2	PBC1-PBC2	PBC	Perceived Behaviour Control
10**	2	BI1, BI2	BI	Behaviour Intention

Table 6-1 Eleven Constructs in the Research Model

* = Independent Latent Construct

** = Dependent Latent Construct

The constructs of the first questionnaire are based on the Decomposed Theory of Planned Behaviour (DTPB) and the Technology Acceptance Model (TAM). A number of hypotheses based on the DTPB and TAM models have been formulated (see Chapter 5, Conceptual Model and Hypotheses). These hypotheses are the focus of a number of latent variables (unobserved variables), which are defined in Table 6-1. These latent variables, also called

unobserved variables, are difficult to express in a direct way. For example, depression cannot be explained or defined directly, however some features, if they exist in a person (such as staying alone without communication with others and rarely smiling), can be interpreted as a sign of depression.

In the next step, a number of questions or indicators, measurement variables, or observed variables, have been suggested for each latent variable. The formulated questions are as follows:

Perceived Usefulness

PU1: Using the addressing system would enable me to accomplish my tasks more quickly.

PU2: Using the addressing system would make it easier for me to carry out my tasks.

PU3: Using the addressing system increases my productivity.

Compatibility Relative advantage

COM1: Using the addressing system will save time.

COM2: Using the addressing system allows me to manage my work more effectively.

COM3: Using the addressing system gives me greater control over my work.

Ease of Use

EOU1: The addressing system is easy to learn.

EOU2: The addressing system is easy to operate.

EOU3: Interaction with the addressing system does not require a lot of mental effort.

Family and Friends

FF1: My family would think that I should use the addressing system.

FF2: Most people would think that I should use the addressing system

Efficacy

E1: I would feel comfortable using the addressing system on my own.

E2: I am confident in using the addressing system, even if I have never used such a system before

E3: I am confident in using the addressing system if I have just seen someone using it before.

Government Support

GS1: The government supports using an addressing system in the Kurdistan Regional Government.

GS2: Kurdistan government is active in setting up the facilities to activate an addressing system.

Attitude

A_1: Using the addressing system is a good idea.

A_2: Using the addressing system is a wise idea.

Subjective Norm

SN_1: People who influence my behaviour would think that I should use the addressing system.

SN_2: People who are important to me would think that using the addressing system is a wise idea.

Perceived Behavioural Control

PBC_1: I would be able to use the addressing system.

PBC_2: Using the addressing system is entirely with my control.

Behavioural Intention

BI_1: I plan to use the addressing system, if available.

BI_2: I intend to use the addressing system to send, receive post (among other applications) within the next 3 months, if available.

6.3.2 The second questionnaire

This questionnaire has been designed to explore the impact of using different LBI systems. The proposed questionnaire was divided into two parts. The first part consisted of 5 questions of a personal information. The second part consisted of five open-ended questions. This qualitative survey aims to gather themes from the responses in order to encourage full, meaningful answers, using the participants' own knowledge and feelings. The survey focused on the effectiveness of LBI codes based on its style (format) and the impact of the LBI system on technology, addressing, economy development and the govermental policies.

The questionnaire has been designed as follows:

Q1/ In particular, what is the impact of being able to identify postcodes through an alphanumeric system, compared with the numeric system?

Q2/ What is the impact of a postcode system on location based services and technology?

Q3/ What are the benefits of a location based system of postcodes, when detailed information is already available for the use of both numeric and alphanumeric system, which do not indicate location?

Q4/ What is the impact on the economy of poor postal distribution?

Q5/ What is the impact of policy on postal distribution and vice versa?

6.4 Validity of the Questionnaires

The questionnaire design is an influential factor that affects the quality of the process of data collection, in terms of response rate, validity and reliability (Saunders et al., 2012). According to (Foddy, 1994), the question must be understood by the respondent in the way it is intended by the researcher, and the answers given by the respondent must be understood by the researcher in the way intended by the respondent. For this reason, the questionnaires of the present study are developed through various stages to guarantee the validity of the questions.

6.4.1 Validity of the first questionnaire

In the first stage, the measured variables have been identified. Hair (2010) states that a minimum of two measurement items are required for every model variable (Joseph F Hair, 2010). In the present study, 2-3 measurement items have been modified for each variable to fit the context of the research. Hence, twenty-four variables have been suggested for the measurement of model variables, as presented in the previous section. As the current study is associated with technology acceptance research, a direct question style using the Likert-scale has been used (Johns, 2010). According to this style, "the respondent is asked how strongly he/she agrees or disagrees with a statement or series of statements, usually on a four, five, six or seven-point rating scale" (Saunders et al., 2012). A five-point Likert-scale has been used, where the lowest scale 1 represents "strongly disagree'' and the highest

scale 5 represents “strongly agree’’. The purpose and the importance of the study have been explained in the cover page of the survey. To test the questionnaire validity, a pre-testing method has been followed, as below:

- The supervisor of this study, five PhD researchers and two senior lecturers have reviewed the first draft of the questionnaire. The aim of this stage is to benefit from the experience and knowledge of the reviewers. All the feedback and suggestions have been studied and discussed with the study’s supervisor. Some modifications have been made in regard to the structure of some of the questions and the layout design is based on the reviewer comments.
- A pilot study has been conducted to test the modified version of the questionnaire. This stage aimed to test the acceptance of the questionnaire design, based on the responses and mistakes in the collected data. 42 responses were collected and a test has been applied based on Cronbach’s alpha (Saunders et al., 2012). Based on the results of measurement items, the test showed the applicability and acceptability of the designed questionnaire.

6.4.2 Trustworthiness of the second questionnaire

To test the trustworthiness of the open-ended questionnaire, a pre-testing method has been followed as below:

- The supervisor of this study, three PhD researchers and one senior lecturers have reviewed the first draft of the questionnaire. This step aimed to strengthen the questionnaire from the experience and knowledge of the reviewers. All feedback and suggestions have been taken into account and discussed with the study’s supervisor.
- A pilot study has been conducted to test the acceptance of the questionnaire design based on the responses of the collected data. 25 responses were collected and themes were clearly found from the data. Based on the results, the test showed the applicability and acceptability of the designed questionnaire.

6.4.3 Validity of the interview

The aim of the interview is to assess the techniques that are proposed in the current research. Therefore, the candidate selection for the interview is the key to the validity of the study. In addition, the method of data collection and evaluation has a significant impact on

the validity of the interview [Campion, M. A., Palmer, D. K., & Campion, J. E. (1997). A review of structure in the selection interview. *Personnel Psychology*, *50*(3), 655-702]. In the current research, the following steps have been followed to obtain a high degree of validity.

1- The candidates are either experienced individuals or decision makers in the field of LBI system. In this regard, rating scales have been used to choose the interviewees based on their work positions, past experience, technical skills and knowledge.
2- The answers of the candidates have been analysed separately by the author of this study and another PhD student in the University of Huddersfield. Both data analyses have been compared, and the analysis validity has been justified.

6.5 Reliability of the questionnaire

The fact is there is no perfect study and bias can not be completely eliminated. However, by following planned procedures, the sources of bias can be minimised. Reliability is "the extent to which it is without bias and hence ensures consistent measurement across time and across various items in the instrument," (Sekaran, 2006). A reliability test is essential, especially when each study construct includes interrelated multiple measurement items (Bryman & Cramer, 2011).

6.5.1 Minimising bias in the first quantitative survey:

To minimise the bias in the first quantitative survey, the following points have been taken into consideration.

1- Designing the questionnaire based on well-known and trusted models.
2- Making responses anonymous.
3- The considered responses are for the participants who have used addressing systems in their daily life and they have at least superficial knowledge about the topic.
4- Testing the questionnaire for reliability by using the method of Cronbach's coefficient alpha.
5- Using SPSS and Amos graphic software for data analysis.

The present study followed the most popular inter-item consistency reliability test, known as Cronbach's coefficient alpha (Saunders et al., 2012; Sekaran, 2006). According to this test method, a decision will be made based on measuring a construct with interrelated items. (Johns, 2010) states that using Likert-scales is the most appropriate way to apply a reliability test. Cronbach alpha values for the current study have been measured using SPSS. Table 6-2 shows Cronbach's coefficient alpha for the pilot study of 42 participants. Based on (Saunders et al., 2012), results less than 0.6 represent poor reliabilities, results between 0.6 and 0.7 represent acceptable reliabilities and over 0.8 represent good reliabilities. The reliability results of this study are presented in the next chapter.

Measurement Items	Items	Cronbach'Alpha
PU	3	0.88
PEU	3	0.823
COM	3	0.923
FF	2	0.843
EF	3	0.863
GS	2	0.858
ATB	2	0.761
SN	2	0.921
PBC	2	0.891
BI	2	0.996

Table 6-2 Reliability result for the pilot study

6.5.2 Minimising bias in the second (open-ended) questionnaire

For the second qualitative questionnaire, the following procedures have been taken into account, in order to minimise the sources of bias.

1- Using an open-ended questionnaire is a well-known way to prevent bias.

2- Making responses anonymous.
3- The considered responses are for the participants who have used addressing systems in their daily life and they have at least superficial knowledge about the topic.
4- Using the inter-rater method for the reliability test.

The inter-rater method for reliability tests is a common method for checking the reliability of an open-ended questionnaire. The method can be defined as the solidity of the procedure being used in data collection and in data analysis (Keyton et al., 2004; Stoyanov et al., 2015). A minimum required sample size for inter-rater reliability check is 15% of total sample size (Zou, 2012). Therefore, a minimum of sample size of 24 participants is required for this study. 25 samples have been collected and analysed by the second rater (a Phd student in the university of Huddersfield). Based on (McHugh, 2012), 0.8 is the minimum inter-rater agreement. The results of the inter-rater samples have been compared with the study results and 84% of inter-rater agreement has been found.

6.5.3 Minimising bias in the qualitative survey (Interview)

The third qualitative survey was done by conducting interviews to assess the proposed methods and ideas in the current study. In this stage, minimising bias is essential. For this purpose, the following points have been considered.

1- The interviewees have been chosen based on their experience and knowledge. All the interviewees are either decision makers or experienced people in the field of addressing systems (Martell & Guzzo, 1991).
2- The interviewees have been chosen from different countries.
3- The novel techniques and findings in this study have been shown to the interviewees and their questions about the study have been answered.
4- The interviewees have asked to assess the work without preparing any questionnaires.
5- The interviewees have given plenty of time to read the questions, think and take notes (Blair & Banaji, 1996).
6- The role of the interviewer has been restricted in managing the interview only.

6.6 Quantitative Data Analysis procedure

A set of questions have been formalised based on the present study's hypotheses presented in the previous chapter. After the data has been collected, two steps for analysing the data have been followed. The preliminary analysis of the data was conducted using Statistical Package for Social Sciences (SPSS). Then, based on Analysis Moment of Structures Software (Amos), Structure Equation Modelling (SEM) has been used.

6.6.1 Preliminary data analysis

Prior to any statistical analysis, examining the collected data is essential (Joseph F Hair, 2010; Hair, Anderson, Tatham, & William, 1998). Kline (2015) advised of two main reasons for the necessity of data preparation before proceeding to SEM analyses. First, find the inabilities of the software to obtain acceptable and logical results when random and disorganised data is used. Second, ensure that multivariate analysis using SEM deals with data that is error free. Any errors may lead to an enormous difference in the results (R. B. Kline, 2015). Therefore, this stage includes data assessment, checking for missing data, reliability and normality of collected tests.

6.6.2 Structure Equation Modelling (SEM)

SEM is a set of several computer algorithms, multivariate processes and mathematical models, such as multiple regression, path analysis, multivariate analysis of variance (etc). It is used "to simultaneously examine a series of interrelated dependence relationships among the measured variables and latent constructs (variants) as well as between several latent constructs" (Joseph F Hair, 2010). A concise definition for SEM suggested by (Byrne, 2010) is a statistical method to test hypotheses about the associations between observed variables and unobserved variables. The hypotheses of the present study, discussed in Chapter 5, evaluate the unobserved variables (latent variables) PU, PEU, COM, FF, SE, GS, A, SN, PBC

and BI. To measure each latent variable, a number of observed indicators (measurement variables) are used in the questions of the survey.

According to (Joseph F Hair, 2010), the foundation of SEM is based on “Confirmatory Factor Analysis’’ (CFA) and “Multiple Regression Analysis’’ (MRA) techniques. To enable SEM and to conduct CFA and MRA, the software package Analysis of Moment Structures (Amos) has been used. Based on this software, the variables and regression paths between the variables, either independent or dependent variables, are presented graphically.

(Anderson & Gerbing, 1988) state that a two-step method is recommended for using SEM, instead of a single-step method in localising the source of a poor model fit. The single-step approach “involves assessing measurement and structural models simultaneously’’ (Singh & Smith, 2004). The first step of a two-step method includes evaluating the measurement models to ensure the sufficiency of the utilised latent variables to measure the constructs using CFA. In the second step, the relationships between the constructs will be presented by the structural model assessment using MRA (Byrne, 2010; R. Kline, 1998).

6.7 Qualitative data analysis procedure

Several computer-based software packages have been developed since the last decade that are used to analyse qualitative data, such as Nvivo, QDA, MAXQDA and ATLAS. These programs work according to similar concepts, which aim to reduce the consuming time of data analysis. However, the use of computer-based analysis has been avoided in this study due to two main reasons. First, the questions have been answered in three different languages, English, Kurdish and Arabic. Second, according to (Beidas, Mychailyszyn, Podell, & Kendall, 2013), computer-based qualitative data analysis is more appropriate when the data is solid and does not include different meanings and understandings. Most of the questions have been answered in short and brief sentences. Therefore, the answers have been sorted based on a general understanding based on the answer’s context.

6.7.1 Thematic analysis

Thematic analysis is considered the most common form of qualitative study analysis. The important feature of this analysis is flexibility. The analysis is based on highlighting, examining and recording themes in the data. The themes are the raw materials for the description of the subject associated with the questions being asked. Thematic analysis can be explained as a process of coding the detected themes into patterns that have clear meanings (G Guest, MacQueen, & Namey, 2012; Greg Guest, MacQueen, & Namey, 2011). This process is performed through the following stages (Braun & Clarke, 2006):

1- Understanding the data.
2- Creating the initial codes.
3- Selecting themes among codes.
4- Combining the similar themes.
5- Reviewing the detected themes.
6- Defining the themes.
7- Preparing the final analysis report and presenting the data statistically.

6.8 Conclusions

The methodology and design of the present research has been explained in detail based on the approach of the research onion, proposed by Saunders, Lewis, & Thornhill (2008). The study depends on a multi-method, which uses quantitative and qualitative methods in separate surveys and an interview study. However, the decision regarding these selections have been justified.

Different hypotheses have been built in the quantitative survey according to the DTPB and TAM models discussed in Chapter 5 - Conceptual Model. In addition, to develop these hypotheses within the present research model, this research follows a deductive approach. The acceptance of the proposed research model will be decided based on model testing. The direct question strategy (survey) has been applied in the data collection stage and the adequacy of this method has also been justified. In addition, the steps of using the collected

data to either accept or reject the hypotheses have been explained. Non-probability sampling (self-selection strategy) has been applied to the questionnaire, so it can interact with the respondents. Based on the cross-sectional method, a period of three months (time horizon) has been set, from 15th December 2014 to 15th February 2015, for data the collection. The second survey consisted of open-ended questions in order to discover the impact of a good LBI system in the daily life. The trustworthiness of the questionnaire has been explained and the inter-rater reliability has been depended on to prove the reliability of the questionnaire. The procedure of creating themes from the collected data has been explained in detail.

7 Chapter Seven: Results

7.1 Introduction

In this chapter, the results of the data analysis are presented, based on the steps explained in Chapter 6 - Methodology. At the beginning of this chapter, the preliminary data analysis is explained, which includes ways of avoiding errors caused by missing data, data normality and the reliability of the study. Next, the demographic question results are discussed. Then the analysis of the three studies are discussed respectively. Finally the overall outcomes of this chapter are discussed.

7.2 Preliminary data analysis

After the process of data collection, a number of steps are followed in the preliminary data analysis to ensure the collected data is reliable and appropriate. This process includes finding missing data, normality and reliability.

7.2.1 Missing Data

Missing data occurs when one or more respondents fail to answer one or more questions in the questionnaire (Joseph F Hair, 2010). During the analysis stage, missing data may result in problems and incorrect results. For instance, using SEM to test the hypothesis of the first survey with missing values in the data may require extensive recalculations and make it difficult to achieve a model fit. According to Hair (2010), if one respondent fails to answer 50% of the questions, then the response should be deleted. As such, the design of the questionnaire can have a significant impact in reducing the missing value rate. In Chapter 6 - Methodology, the process of the design for the study questionnaire was discussed. In thje present study, the length of the questionnaires were considered very carefully. Effort was made to keep the questionnaire short and easy to complete. All related questions were grouped together. The average time to complete any survey during the pilot stage was 9 to

12 minutes. As a result of the above, the process of sorting the collected data showed that from the 254 collected responses of the first questionnaire, there were 18 uncompleted responses. That is, 18 participants failed to answer half or more of the questions. Therefore, the 18 incomplete responses were deleted to avoid creating any artificial relationships between the model variables. In the second survey and the interviews, all the participants completed at least 60% of the questions. Hence, 100% of the responses have been taken into consideration.

7.2.2 Normality

The most fundamental assumption in a multivariate analysis is assuming multivariate normality. Normality can be defined as the "degree to which the distribution of the sample data corresponds to a normal distribution" (Joseph F Hair, 2010). In the current study, different normality methods have been used. The normality of the quantitative study has been measured by calculating the measures of Skewness (SI) and Kurtosis (KI).

The measures of Skewness (SI) and Kurtosis (KI) are used to show either the normality or non-normality of the collected data in two different distribution statuses (Tabachnick & Fidell, 2007). The results can be presented either by two different variables (SI and KI) or both as a single variable.

SI results show the distribution of the data regarding its mean value (Tabachnick & Fidell, 2007). The result zero shows an ideal (normal) and symmetric distribution. The data distribution considers as positive skew when having a tail to the right side and when the bulk values lies to the left side. On the other hand, data distribution is considered as a negative skew when having a tail to the left side and when the bulk values lies to the right side. Positive skew shows that the majority of the respondents selected a score below the average result and vice versa for negative skew.

KI results show the distribution shape of the data curve regarding the mean of the collected data. Leptokurtic and Platykurtic are the terms to describe data distribution with positive kurtosis and negative kurtosis respectively (Joseph F Hair, 2010). The effect of non-normality can be reduced by increasing the sample size (Joseph F Hair, 2010). In addition, the SI and KI values for each measured variables were calculated using SPSS. The results show(see Table 7-1) that every measured variable has an acceptable distribution, if (SI < 3) and (KI < 10) as reported by Kline (2011). The histograms of the normal distribution of the present study data have been presented in Appendix 3. In addition, Normality and Q-Q Plots are presented in Appendix 4.

Latent Variables	Measurement variables	Skewness	Kurtosis
Perceived Usefulness	(PU1)	-1.487	1.489
	(PU2)	-.892	-.253
	(PU3)	-.757	-.444
perceived Ease of Use	(EOU1)	-1.190	.752
	(EOU2)	-1.145	.567
	(EOU3)	-1.019	.480
Compatibility	(COM1)	-1.873	2.883
	(COM2)	-1.198	.832
	(COM3)	-1.345	1.313
Family and Friends	(NS1)	-.314	-.724
	(NS2)	-.477	-.695
Self-efficacy	(E1)	-1.601	2.385
	(E2)	-1.573	2.020
	(E3)	-1.320	1.332
Government Support	(GS1)	-.570	-.755
	(GS2)	-.822	-.420
	(GS3)	-1.227	.895
Attitude towards behaviour	(A1)	-2.764	2.921
	(A2)	-1.223	.842
Subjective Norm	(SN1)	-.758	-.265
	(SN2)	-.801	-.125
Perceived Behaviour Control	(PBC1)	-1.368	1.479
	(PBC2)	-.908	.051
Behaviour Intention	(BI1)	-.978	-.282
	(BI2)	-.921	-.378

Table 7-1 Skewness and Kurtosis results

7.2.3 Reliability

As discussed in Chapter 6 - Methodology, Cronbach's Alpha has been used to test the measurement variables for reliability. Construct validity refers to "the extent to which a measure assesses the construct that it is intended or supposed to measure" (Cramer & Howitt, 2004). For any particular model, the assessment of the construct validity indicates the consistency of the measured variables, represented by Cronbach's Alpha. According to Hair (2010), the value of 0.7 or higher for Cronbach's Alpha represents good reliability. However, the value of Cronbach's Alpha between 0.6 and 0.7 still represent an acceptable reliability if the variable has passed the convergent and discriminant validity tests (Joseph F Hair, 2010). Cronbach's Alpha, for each measurement, is presented in Table 7-2, which shows good reliability for all measurement values. The values of Cronbach's alpha should exceed 0.6 as a minimum acceptable level of data reliability. Most of these values are greater than 0.8, except for Attitude Toward Behaviour (A) and Perceived Behavioural Control (PBC) which are 0.7 and 0.71 respectively.

Constructs	items	Cronbach alpha
Perceived usefulness	PU1 PU2 PU3	0.838
Perceived ease of use	EOU1 EOU2 EOU3	0.89
Compatibility	COM1 COM2 COM3	0.831
Family and friends	FF1 FF2	0.886
Self-efficacy	SE1 SE2 SE3	0.855
Government support	GS1 GS2	0.901
Attitude towards behaviour	A1 A2	0.70
Subjective norm	SN1 SN2	0.836
Perceived behavioural control	PBC1 PBC2	0.71
Behaviour intention	BI1 BI2	0.964

Table 7-2 Constructs' validity

7.3 Demographic results

In the first questionnaire, the rate of male participants was 80.5% and only 19.5% were female. According to age range, the majority of the participants (72.7%) were between 26 and 35 years old, followed by 15.3% between 36 and 45 and 10.6% between 18-25 years old. Only 1% of the participants were above 56 years of age. Most of the participants (74.2%) were Master/PhD degree students, while 22.9% of them were undergraduate degree holders and 2.5% of them were students with lesser qualifications.

In the second questionnaire, the rate of male participants was 73.2% and only 26.8% were female. According to age range, the majority of the participants (70.5%) were between 26 and 35 years old, followed by 18.5% between 36 and 45 and 9 % between 18-25 years old. Only 2% of participants were above 56 years of age. Most of the participants (62.5%) were Master/PhD degree students, while the rest were undergraduate degree holders.

7.4 The acceptance of LBI system

The aim of the questionnaire is to measure the acceptance of LBI as a system to be used in the KRI. During the questionnaire, the participants were asked to what extent they use the applied LBI system in the Kurdistan Region of Iraq. Approximately 64% of the total participants do not use LBI on a daily basis. Moreover, the rest (36%) use the LBI system either once a year or once every few years. This result proves that the LBI system in KRI is inactive. due to a lack of uptake in normal daily life. In order to achieve the aim of activating an LBI system, the participants should be asked about what type of system they would prefer to use. In the questionnaire, the participants have been asked to choose between two different provided samples of LBI codes. As explained in Chapter 2, KRI used different LBI code in different cities. The 13 numeric digit set has been applied in Erbil and Sulaymaniyah as an addressing code, whereas in this study, as discussed in Chapter 3 -

SR_LBI technique, an alphanumeric LBI format has been proposed. since KRI's LBI code has a length up to 7 characters. The participants have been asked to choose between these two LBI codes; first the current numeric LBI code of KRI, and also the proposed LBI code. The result shows that the majority of the participants (97%) prefer the proposed code, which is designed based on the SR_LBI technique, due to it having less characters than the current numeric LBI. The participants claimed that the proposed code, with a short alphanumeric code, is easier to use. The result of this questionnaire supports the notion that the absence of the factor, ease of use, is one of the reasons for the inactive use of the current numeric LBI. To analyse the responses in detail, Structural Equation Modelling (SEM) has been used.

7.4.1 Structural Equation Modelling (SEM)

Structural equation modelling is a "Multivariate technique combining aspects of factor analysis and multiple regressions that enables the researcher to simultaneously examine a series of interrelated dependence relationships among the measured variables and the latent constructs" (Joseph F Hair, 2010). A number of hypotheses have been presented in Chapter 5, based on a number of factors that exists in the Decomposed Theory of Planned Behaviour (DTPB) and Technology Acceptance Model (TAM). The factors that the research hypotheses are concentrated on are perceived usefulness (PU), perceived ease of use (PEU), compatibility (COM), family and friends (FF), self-efficacy (SE), government support (GS), attitude (A), subjective norm (SN), perceived behavioural control (PBC) and behaviour intention (BI). Figure 7-1 shows the research hypotheses, H1, H2, H3, H4, H5, H6, H7, H8 and H9 that have been tested using IBM Analysis of Moment Structures (Amos). Structural Equation Modelling SEM has been used to study and analyse the research framework and hypotheses. Structural equation modelling allows the examination of the developed model fit, and explains variance and the research hypotheses.

The conceptual framework of the current research is based on the DTPB and TAM models. As the technology acceptance model (TAM) is part of DTPB, the analysis has been made based on both TAM and DTPB models.

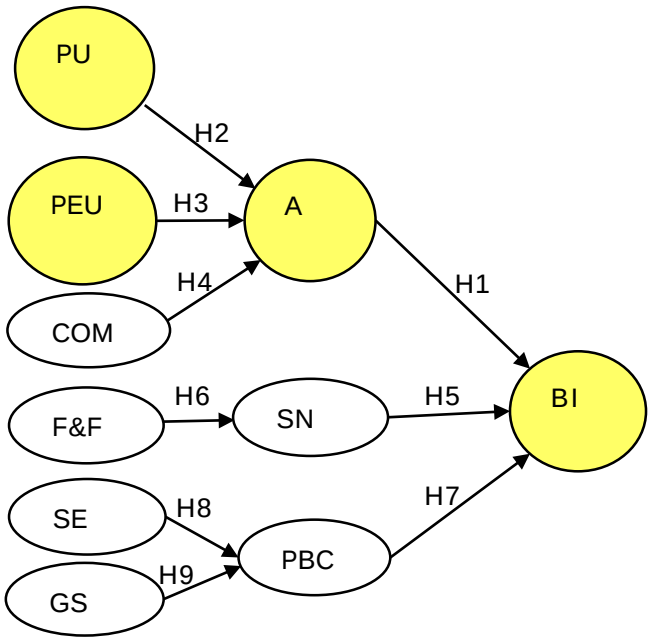


Figure 7-1 the research hypotheses

The conceptual framework mode has been presented using IBM Amos Graph in Figure 7-2. Amos uses circle and oval shapes to represent latent variables. The square and rectangle shapes represent the measurement variables. Finally, the small circle shape represents error measurements.

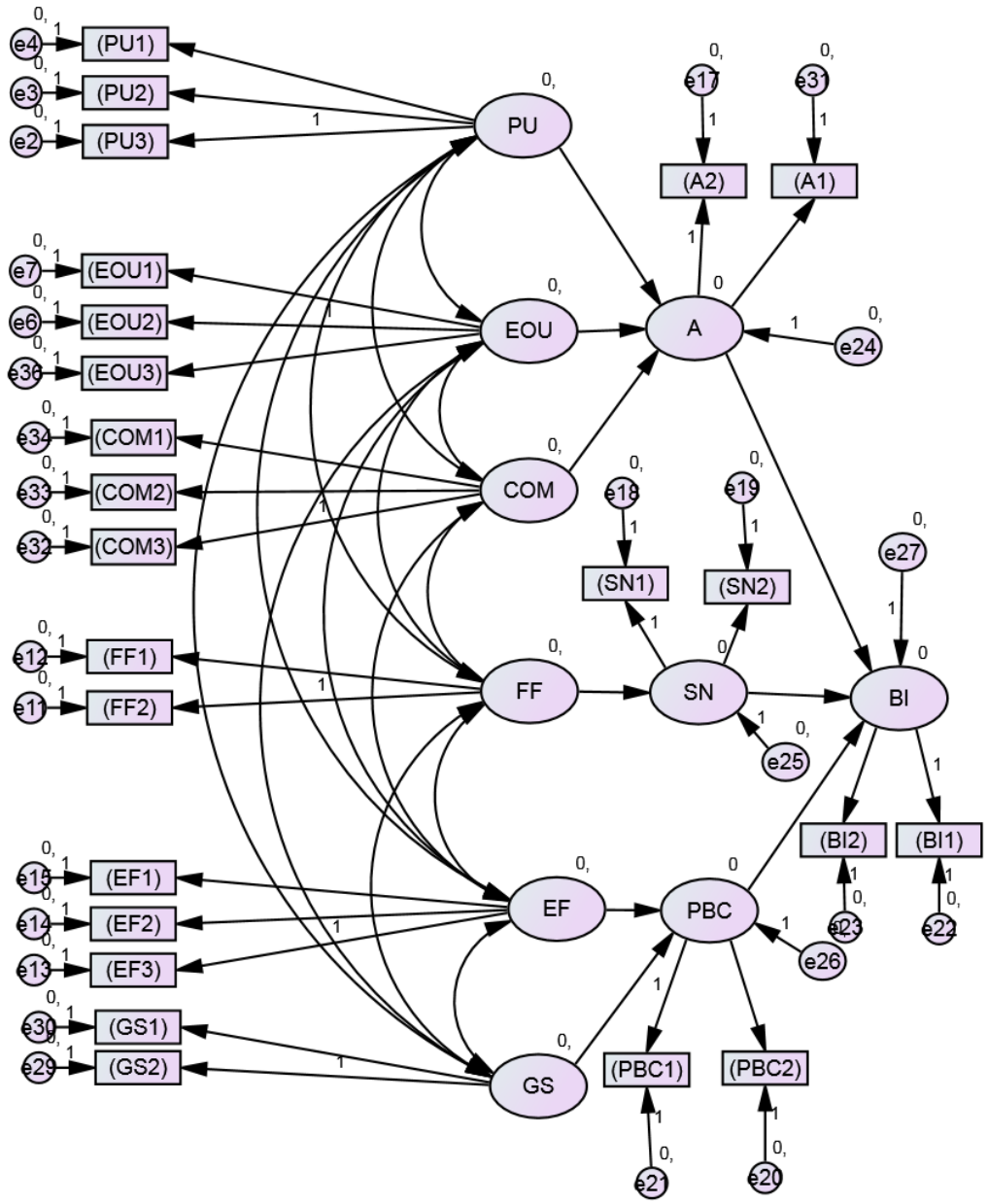


Figure 7-2 The framework model representation in IBM Amos.

7.5 Measurement Model Test

It is important to assess the quality of the adopted measures before testing the structural relationships between the latent constructs. For this purpose, the measurement model was tested using the Confirmatory Factor Analysis (CFA) technique. This technique is an appropriate technique to test the model and establish measurements (R. B. Kline, 2015).

Convergent validity is "the extent to which a measure is related to other measures which have been designed to assess the same construct" (Cramer & Howitt, 2004). In the present study, the factor of convergent validity has been used to check and evaluate the degree of correlations between the measurements in a given construct. This assessment can be done based on the Average Variance Extracted (AVE), which is the result of the total of all squared standardised factors divided by the number of measured variables. Using the two criteria proposed by Fornell and Larcker (Fornell & Larcker, 1981), the convergent validity assessment has been performed. These criteria recommend that the values of factor loading should exceed 0.7 and the value of AVE for each construct should be greater than 0.5 (the measurement error variance) (Joseph Jr, William, Barry, & Rolph, 2009).

As shown in Table 7-3, the factor loadings are higher than 0.7 and the AVE values are higher than 0.5 (between 0.557 and 0.932). Hence, both conditions (criteria) have been fulfilled, which is proof of the convergence validity for the study model.

Constructs	items	Factor loading DTPB	AVE
Perceived usefulness	PU1	0.767	0.646
	PU2	0.867	
	PU3	0.774	
Perceived ease of use	EOU1	0.882	0.733
	EOU2	0.886	
	EOU3	0.798	
Compatibility	COM1	0.739	0.623
	COM2	0.782	
	COM3	0.843	
Family and friends	FF1	0.873	0.792
	FF2	0.907	
Self-efficacy	SE1	0.841	0.665
	SE2	0.838	
	SE3	0.765	
Government support	GS1	0.918	0.819
	GS2	0.892	
Attitude towards behaviour	A1	0.74	0.557
	A2	0.752	
Subjective norm	SN1	0.798	0.724
	SN2	0.901	
Perceived behaviour control	PBC1	0.842	0.626
	PBC2	0.737	
Behaviour intention	BI1	0.98	0.932
	BI2	0.951	

Table 7-3 the measurement and AVE values

7.5.1 Structural Model Test

Goodness-of-Fit (GoF) is the process of testing how well the predicted data fits the observed data. GoF depends on a number of variables (indices) which are found by SEM. Five common variables have been used in the current research, which are "chi-square/degrees-of-freedom (χ2/df), comparative fit index (CFI), normed fit index (NFI), incremental fit index (IFI), and root mean square error of approximation (RMSEA)'' (Hair et al., 1998;

Hooper, Coughlan, & Mullen, 2008). TAM and DTPB have been compared according to these measurements as shown in Table 7-4. The results show that the outcomes of fit statistics "CFI, NFI and IFI'' for both TAM and DTPB are greater than or equal to 0.9. In addition, RMSEA values should be <0.08 that are ranged from 0.064 to 0.075. These results indicate an acceptable fit of predicted data by the model with the observed data (Bagozzi, Yi, & Phillips, 1991; Hair et al., 1998). Overall, the results of TAM show a better model fit than DTPB, using the same sample size. This difference is due to several reasons, such as a higher number of observed variables and the existence of government support in DTPB, which are the main sources of measurement error.

Furthermore, Akaike information criterion (AIC) is a measure of the relative quality of a statistical model for a given set of data. Based on a collection of models for the data, AIC estimates the quality of each model with respect to the other models. The result of Akaike's Information Criterion (AIC), 129.2 for TAM and 778.45 for DTPB, is further evidence that TAM has a better model fit than DTPB, since the lower value of AIC indicates a better model fit (Hair et al., 1998).

Fit indices	**Norm**	**Obtained value TAM**	**Obtained value DTPB**
Absolute indices Scaled CMIN (CMIN/DF)	>1 and <5	1.97	2.311
Root mean square error of approximation (RMSEA)	< 0.08	0.064	0.075
Incremental indices			
Comparative fit index (CFI)	>0.9	0.98	0.92
Normed fit index (NFI)	>0.9	0.96	0.9
Incremental fit index (IFI)	>0.9	0.98	0.92
Akaike information criterion AIC	The lower by comparison	129.2	778.45

Table 7-4 Measurement analysis results (Joseph Jr et al., 2009)

7.5.2 Structural Model Evaluation and Hypotheses Testing

After testing the data for normality, reliability, GoF (etc) in the previous sections, SEM has been used to test the study hypotheses presented in Figure 7-3. The acceptable p-value result for each research hypotheses should be less than 0.05, otherwise the hypothesis will be rejected.

As discussed previously, TAM has been used based on Ease of Use and Usefulness of the system, to prove the acceptance of the SR_LBI technique by the users (KRI citizens). By proving the three hypotheses H1, H2 and H3, the applicability of the proposed SR_LBI technique is shown. The results of H1 show that Attitude is a significant influence on behaviour intention to use the proposed LBI system (β=0.80, p=***), where *** means p-value<0.001, thus, H1 is supported. The second hypothesis H2 is supported, since the results show a positive and significant influence of the perceived usefulness on attitude toward SR_LBI (β=0.33, p=***). H3 is also supported, since the results (β=0.45, p=***) prove the significant and positive relation of the perceived ease of use, with an attitude to use the proposed LBI. Furthermore, H4 is supported as compatibility significantly and positively affects attitudes toward using LBI (β=0.88, p=***). H5 has been proven based on the significant and positive influence of subjective norms on behaviour intention to use LBI (β=0.23, p<0.05). The significant and positive influence of Family and friends on subjective norm to use LBI (β=0.99, p=***) has been proven, hence, H6 is supported. H7 is supported based on the result of significant and positive influence of perceived behavioural control on behaviour intention to use LBI (β=0.76, p=***).

Self-efficacy, H8, is supported, which has a significant and positive effect on perceived behavioural control to use LBI (β=0.69, p=***). The significant and negative influences of government support (H9) on perceived behavioural control to use LBI, as the final hypothesis, is also supported by the results of (β=-0.07, p<0.05).

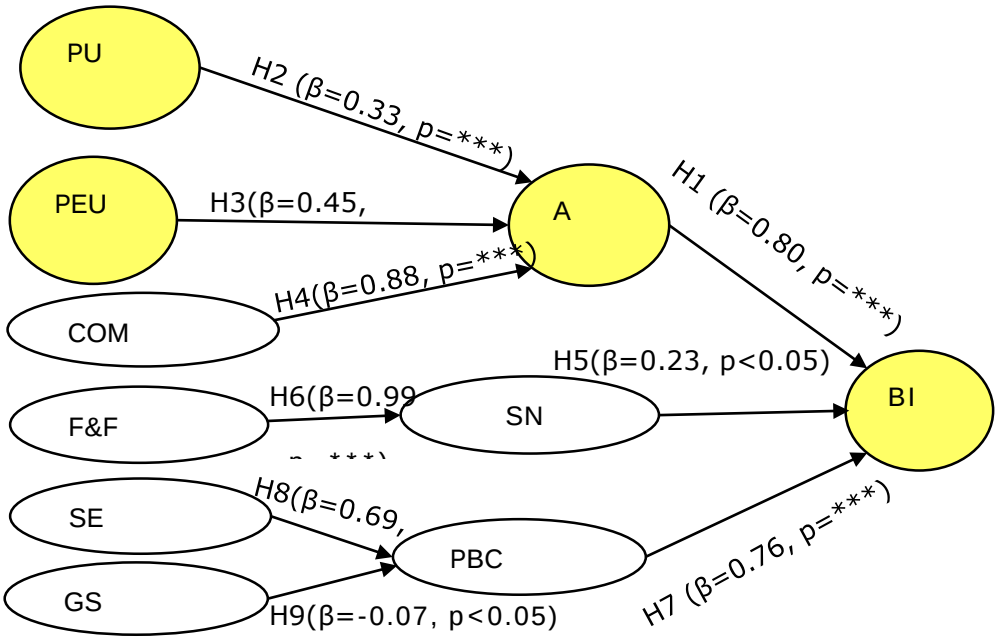


Figure 7-3 Research hypotheses result

*** mean P value <0.001

7.6 The analysis of the impact of LBI system

This questionnaire has been designed to explore the impact of using different LBI systems. The proposed questionnaire was divided into two parts. The first part consisted of 5 questions pertaining to personal information. The second part consisted of five open-ended questions.

- **LBI format**

This section shows the results of the first question, i.e. Q1/ In particular what is the impact of being able to identify postcodes through an alphanumeric system compared with the numeric system? The section also lists the positive and negative themes from the responses and illustrates the reasons behind these answers.

Positive themes:

T1.1 Easy to remember.

T1.2 Less mistakes.

T1.3 Shorter codes.

Negative Themes

T1.4 Hard for non-English speakers.

T1.5 No difference.

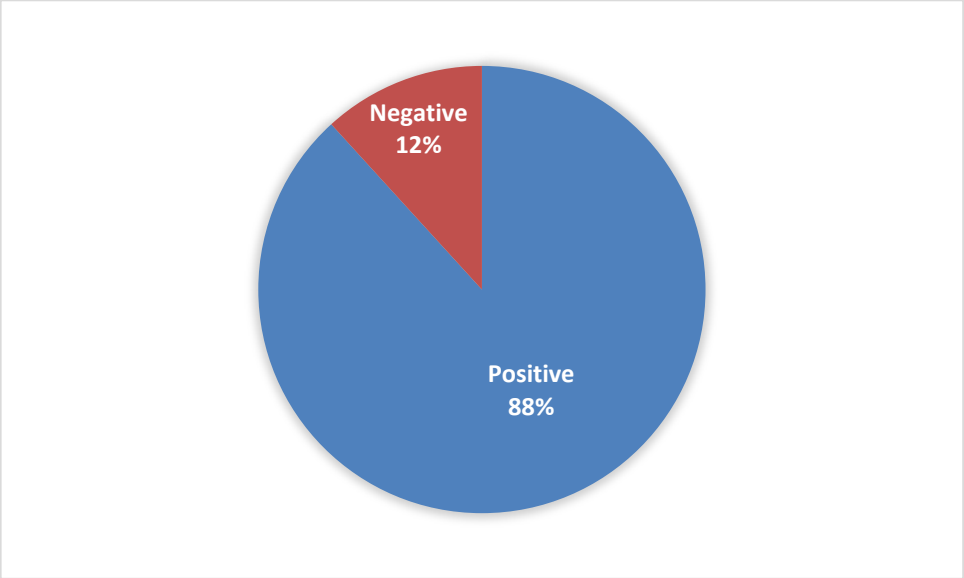


Figure 7-4 The positive and negative response rate of Q1

Three positive and two negative themes have been detected from the responses of the first question. As shown in Figure 7-4, 88% of the respondents answered positively, while 12% of them answered negatively. Figure 7-5 presents the results of each detected themes. The first theme represents the ease of use of the alphanumeric postcode. 46% of the respondents believe that using an alphanumeric postcode is easy to remember. As one of the respondents wrote, “Using the first letter of an area in the postcode simplifies the code

and can be easily memorised and remembered". Moreover, the majority of the participants believe that the combination of letters and numbers in a single code helps the user to memorise the code easier, "like a poem" as one of the respondent commented, rather than a long series of numbers. The second detected theme is that using a combination of numbers and letters will produce more codes, when compared with numeric codes. This technical theme has been detected from the answers of 34% of the participants. This respondent group may have a good background in coding techniques, since using limited alphanumeric characters can generate more codes than numeric codes, due to availability of more alphabet characters than numbers. The third detected theme is facing less mistakes by using alphanumeric codes than numeric codes. This theme has been detected in 31% of the answers. These three positive theme are strongly interconnected together. "Logically short codes are easy to memorise and remember and has less probability in making mistakes during daily use", one of the participants wrote.

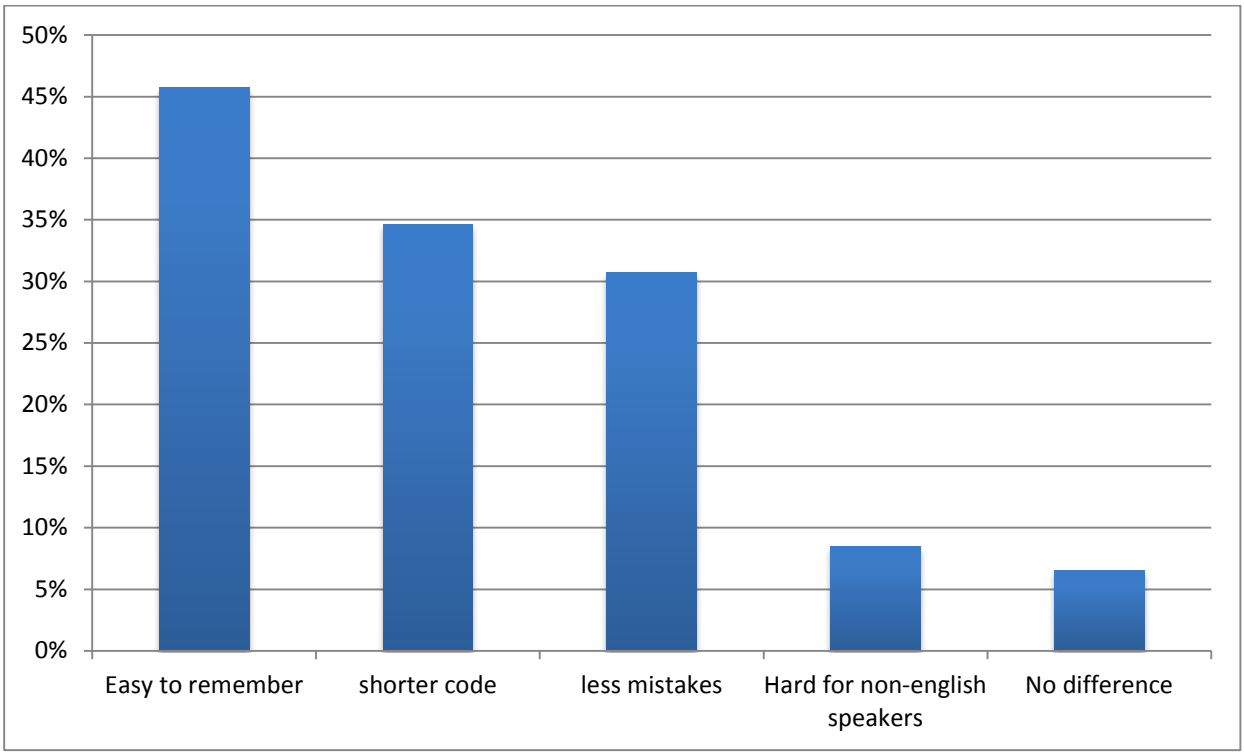


Figure 7-5 The detected themes from the data of Q1

The last two themes are considered negative themes. The first negative theme is the difficulties of using the English alphabet for non-English speakers, which is detected in the answers of 8% of the participants. One of the respondents believes that this negative point appears with any changes and will disappear when the people begin practising the issue in their daily life. Only about 6.5% of the respondents believe that there is no difference between using either numeric or alphanumeric codes. This answer was justified by one of the respondents, who wrote that "using LBI system, either numeric or alphanumeric, become a daily routine, therefore switching the system from one form to another is very difficult to be accepted by the users".

- **LBI and technology**

This section shows the results of the second question, i.e Q2/ What is the impact of postcode system on location based services and technology?

Positive themes:

T2.1 The improvement of navigation systems.

T2.2 The improvement of public services.

T2.3 Simplify the governmental services.

T2.4 The development of the private sectors.

Negative Themes:

T2.5 No effect.

Figure 7-6 shows that 98% of the participants answered positively regarding the effects of postcode system on various services and technology, while only 2% of the respondents think that there is no difference of having or not-having postcode system in peoples' daily lives. As discussed in section (6.2.6), the majority of the research population of the survey

are students who are studying in developed countries where the LBI system is active. Hence, the advantages of LBI system are clear and known for the majority of the participants.

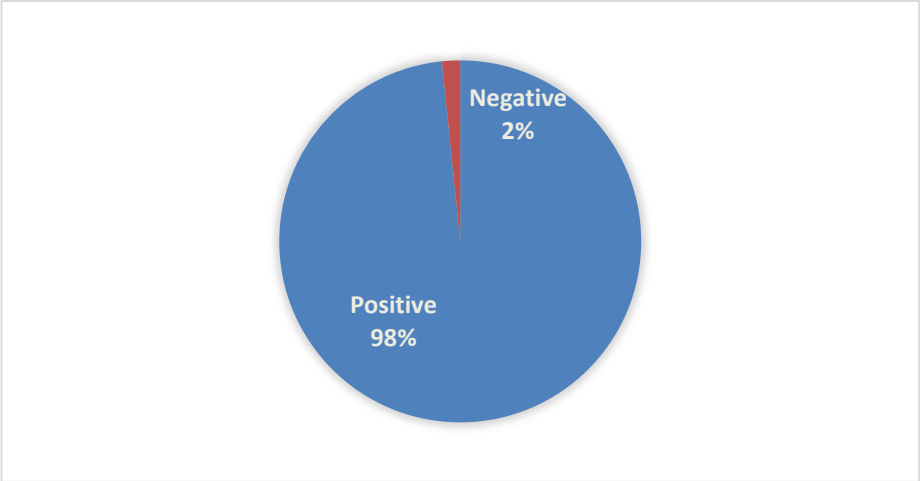


Figure 7-6 The positive and negative response rate of Q2

Five general topics have been detected from the answers of the second question. As shown in Figure 7-7, 34% of the participants focused on the effects of the LBI system in improving navigation systems. One of the respondents said, “In many developing countries, the citizens are not using navigation systems because of the unavailability of an active postcode system”. Another participant said, “In the Kurdistan region of Iraq, the use of navigation systems by Sygic application has increased due to entering the addressing system into the system”. However, “the Sygic navigation system, is based on the older version of the Kurdistan numeric LBI system” which was recently replaced by another numeric system.

The improvement of public services by using the LBI system was another theme that was mentioned in the responses. As shown in figure 7-7, this theme has been detected from the answers of 26% of the participants. Many examples are mentioned, such as using the LBI system in the sectors of health, education, agriculture. Another detected positive theme is the effect of an LBI system on simplifying governmental services. As shown in figure 7-7,

this theme has been detected from the answers of 27% of the participants. Developing LBI systems may lead to simplify the work routine and the structure of the governmental directories and departments.

The development of private sectors in general has been detected from the responses as a positive impact of using an LBI system. As shown in Figure 7-7, this theme has been detected from the answers of 33% of the participants. Many examples have been provided in the answers, such as online shopping and the delivery of goods. One of the participants commented that “in developed countries such as the UK, customers can receive their goods at home through online shopping as a result of having an active and known addressing system in the country. Unfortunately, in many countries that do not have active LBI system such as Iraq, delivery of post and the delivery of goods is so difficult”.

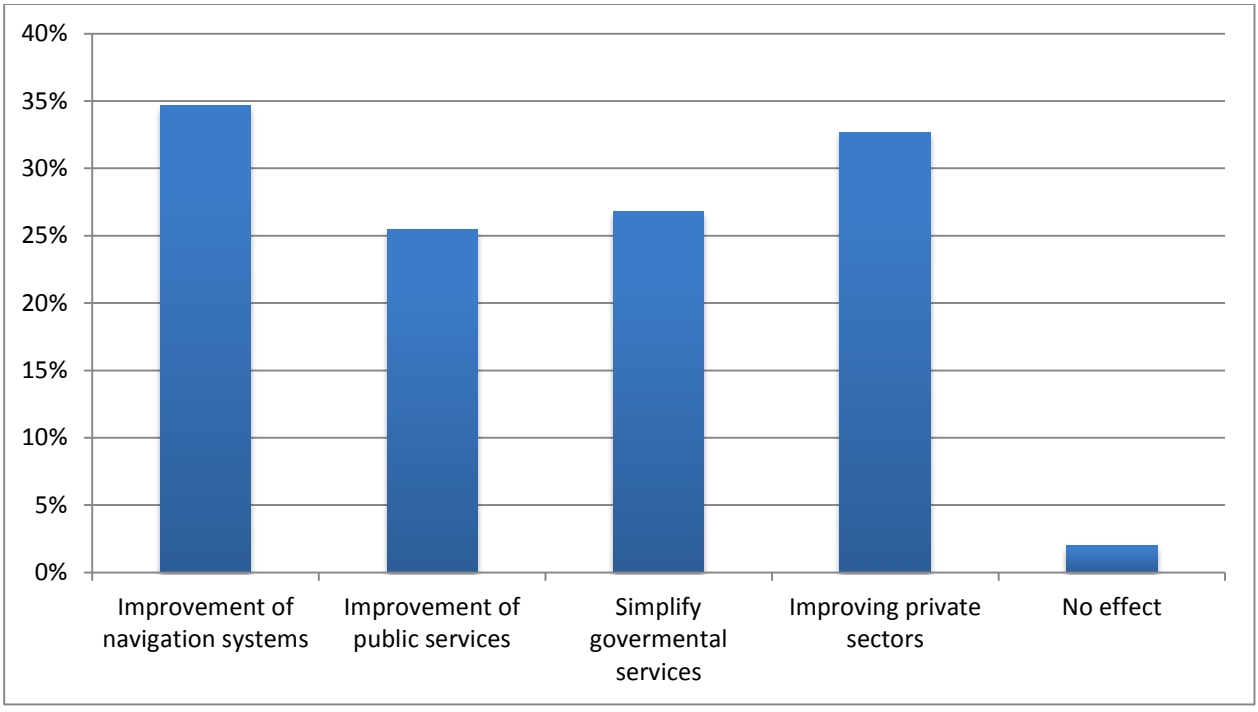


Figure 7-7 The detected themes from the data of Q2

- **LBI and locations:**

This section shows the results of the third question, i.e Q3/ What are the benefits of a location based system of postcodes, when detailed information is already available for the use of both numeric and alphanumeric system, which do not indicate location?

Positive Themes:

T3.1 Easier to use by tourists and visitors.
T3.2 Delivering post to any specific location.
T3.3 Facilitating mail delivery by using mail sorting machines based on a defined LBI system.
T3.4 Beneficial for calculating charges of delivery of goods and transportation.
T3.5 Beneficial for land subdivision.

Negative themes:

T3.6 No effect.

Figure 7-8 shows that 90% of the participants answered positively about the benefits of having a postcode system when detailed information about cities and towns are available, while only 7% of the respondents think that there is no benefit to having an LBI system in that case.

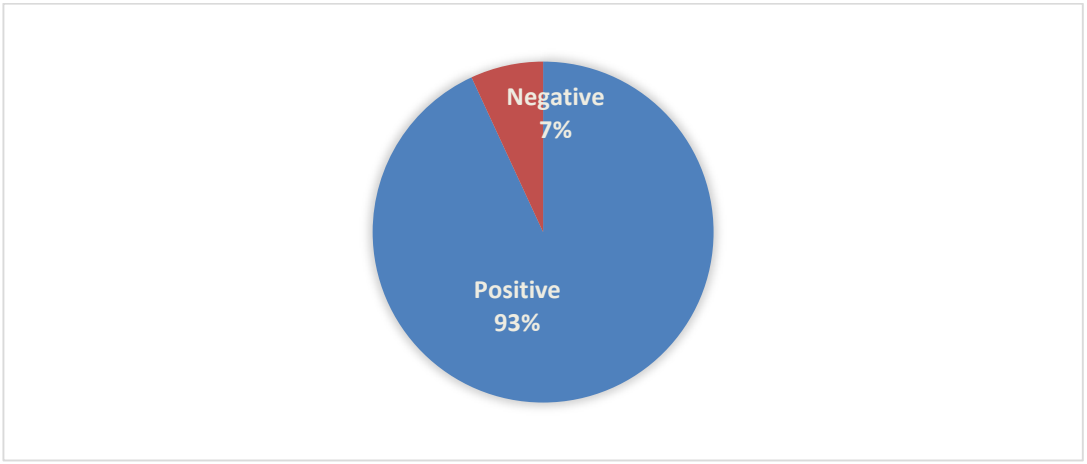


Figure 7-8 The positive and negative response rate of Q3

As shown in Figure 7-9, three positive themes have been detected in the responses of the questionnaire. More than 40% of the participants talked about using the system for shopping and calculating delivery charges. However, more than 37% of the participants talked about tourists and visitors using the system, who may not have enough information about the relevant places. In addition, using an LBI system for land division has been detected in the responses of 30% of the participants, as one of them said, “An LBI system can facilitate the old land sorting technique in the Kurdistan region of Iraq, which is based on special numeric codes used for this purpose only”. About 31% of the participants mentioned the benefit of LBI codes in delivering post. However, 21% of the respondents believe that the process of delivering post can also be done without LBI codes, while LBI codes only facilitate this process. On the other hand, the theme of no-benefit has been detected from the answers of only 12% of the participants.

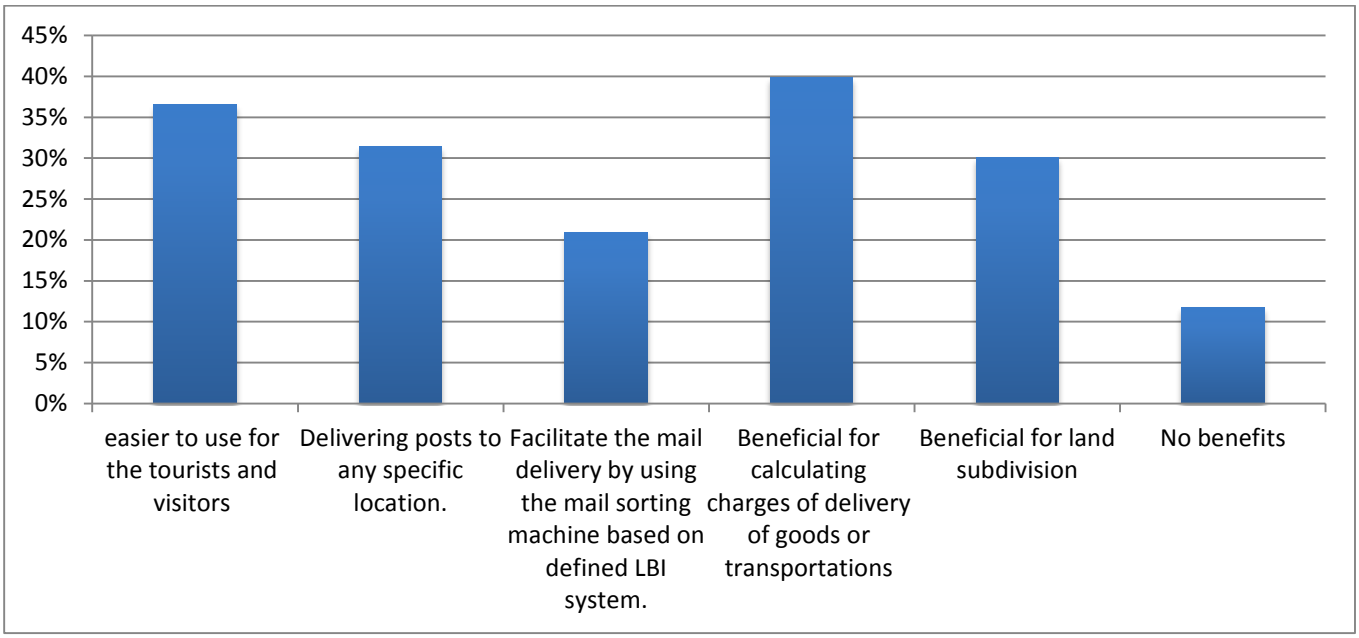


Figure 7-9 The detected themes from the data of Q3

- **LBI and economy**

This section shows the results of the forth question, i.e Q4/ What is the impact on the economy with regards to poor postal distribution?

Positive themes:

T4.1 Decreases trust between the customers and the sellers.
T4.2 Waste of time in delivering goods.
T4.3 Impedes the creative process of business advertisement.
T4.4 Impedes the work of the banks in taking adequate personal data of the customers.

Negative Themes:

T4.5 No effect

Figure 7-11 presents the most focused subjects that the participants concentrated on in question 4. 97% of the participants positively answered question 4, as shown in Figure 7-10. As time is an important factor in today's business, almost 44% of the answers mentioned that the poor postal distribution will cause a delay in delivery time, as shown in Figure. One of the participants commented that "in the Kurdistan region, delivering a parcel inside a city takes days as a result of an unclear addressing system".

The second detected theme, "the poor postal distribution decreases trust between the customers and the sellers" has been found in the answers of about 37% of the respondents. This theme also relates to the first theme, since the delay in the delivery of items negatively affects trust between customers and providers. In addition, as one of the participants mentioned, the poor postal distribution may lead to increases in lost items, and consequently may affect any specific business. Another respondent said, "trust is the key of any successful business, and a good addressing system will help the providers achieve their goals by building strong trust with their customers by offering high quality services".

Another detected theme was “poor postal distribution impedes the creative process of business advertisement”. This theme has been found in the answers of about 34% of the participants.

The final theme, which is found in the answers of less than 8% of the respondents, is that the poor postal distribution impedes the work of banks in taking adequate personal data of the customers and contacting them by post.

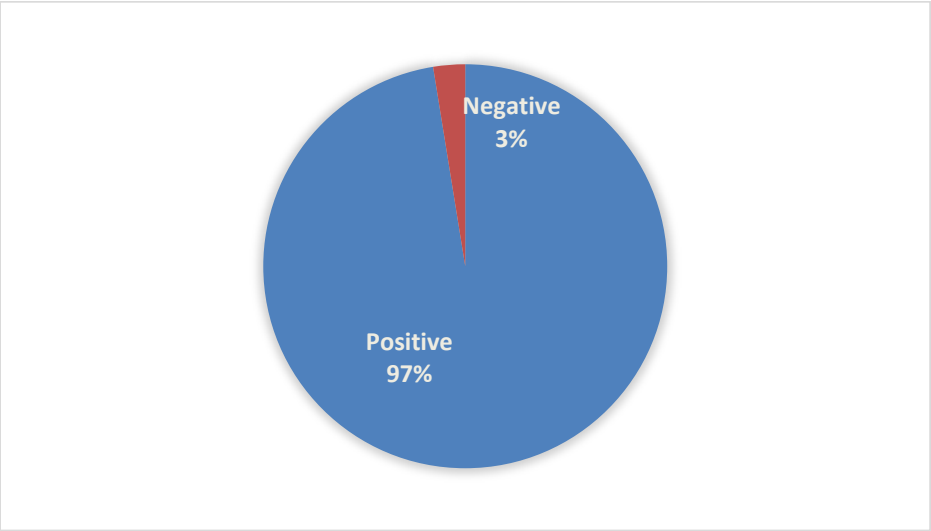


Figure 7-10 The positive and negative response rate of Q4

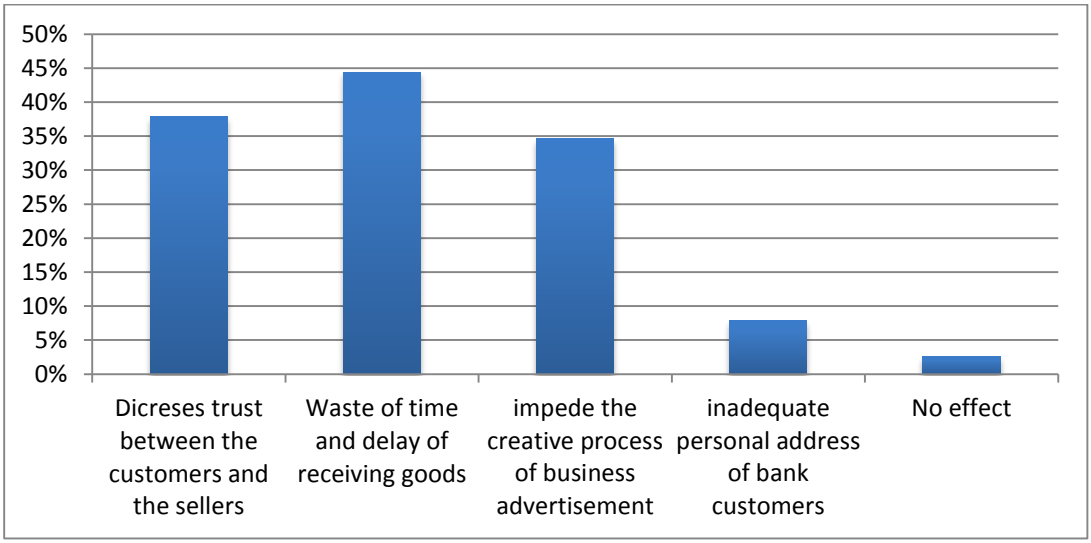


Figure 7-11 The detected themes from the data of Q4

- **LBI and the governmental policies**

This section shows the results of the fifth question, i.e. Q5/ What is the impact of policy on postal distribution and vice versa?

Positive themes:

T5.1 Security issues.
T5.2 Using English parameters in non-English countries.
T5.3 The acceptability by the policy of the country.
T5.4 A clear governmental rule about the entity who becomes in charge of operating the system.

Negative themes:

T5.5 No effect.

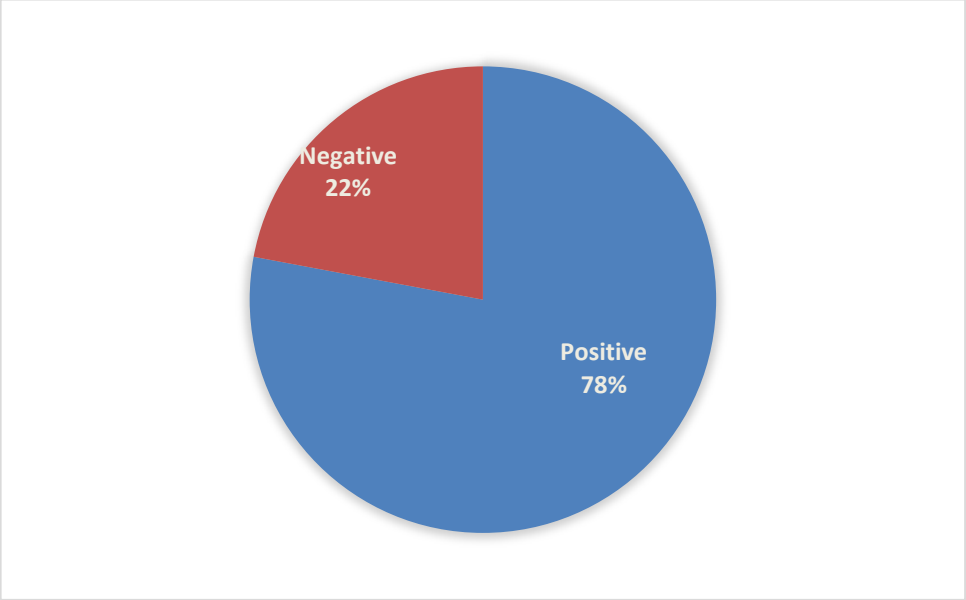


Figure 7-12 The positive and negative response rate of Q5

As shown in Figure 7-12, 78.5% of the participants positively answered the question “What is the impact of policy on postal distribution and vice versa?”, however, 20.5% negatively answered the question, as seen in Figure 7-12.

Figure 7-13 shows the percentage of positive themes that have been chosen as the most frequent subjects among the answers. In the beginning, the most focused subject was number three, “the acceptability by the policy of the country” in which about 50% of the participants’ answers have focused on this subject. The policy of the country affects postal distribution, and at the same time, postal distribution affects a country’s policy. One of the participants said that the country’s president or top decision maker should decide to apply a postal system among a number of proposed systems, otherwise the same problem or a similar variety of postcode systems will be generated. For example in the Kurdistan region of Iraq, more than one postal system has been applied within the main cities of the region. Another participant mentioned that using foreign letters in the Libyan government’s projects are banded. As a result, 20% of the answered questions mention that using English letters in many non-English language countries is not favoured by the governments and the public. However, some participants mention that using English letters in Kurdistan will not be a problem, since the region in general uses the English alphabet in education, and many levels are based on the English language. About 37% of the participants focused on the security of the system. Moreover, the level of security in the postal system affects the level of using the system. As one participant said, to use a postal system among the public, the government should increase user’s trust in the system. Moreover, some secure documents, and contraband, must be controlled within postal system. For example, some illegal items cannot be posted, and as a result, the postal policy should control this side during transmission and delivery. Finally, about 29% of respondents support the idea that the policy has no effect on postal distribution and vice versa.

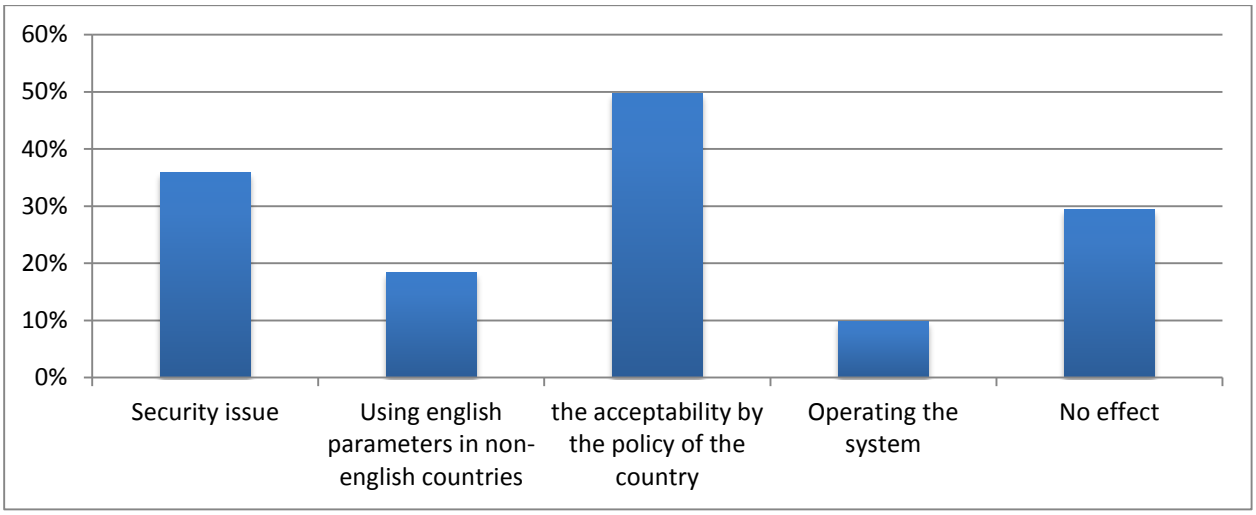


Figure 7-13 The detected themes from the data of Q5

7.7 The analysis of the utility of the proposed LBI system

The utility of the proposed system has been studied by conducting assessment interviews. The interviewees were decision makers and experienced people in the field of addressing systems, or other fields relating to it. Four different points have been focused on within the discussions, which are novelties, applicability, scalability and the flexibility of the proposed technique for the design of an LBI system. The interviewees were from different countries, and some of them held dual citizenship.

The comparison between the proposed technique and the currently used addressing system in the country of the interviewee was an element of the assessment for some of the interviewees. However, some of the interviewee, such as Prof. J. A. and Mr A. J., who are specialists in the field of LBI systems, presented a clear assessment based on what was available in many developed countries, and the salient risks of changing the current system.

The most important and required feature of any new system or technique is the capability to solve identified problems. Prof. J. A. believes that a standard technique for designing an LBI

system will be beneficial for countries who do not have a system in place. As he said, the cost of switching from one system to another is considerable and might be unacceptable for the citizens at the beginning of any change. However, Mr M. J. argued against this, pointing to a successful experience of introducing a new LBI system in Syria. The new system was not usable by the people at the beginning, but day after day, people discovered the importance of the system, and how it made life easier Mr A. J. said that one of the designers of the current Erbil postcode system mentioned that the technique tells the designer when to start and how to start, which simplifies the work at the early stages of the design.

The scalability of any proposed system is very important, especially for developing countries such as the KRI. Mr Manoj argues that using numeric codes are easier, both for the user and the operators. He believes that the numeric system is easy to code for any probable future expansion of the cities. However, the other interviewees believed that the alphanumeric codes are more scalable than numeric codes, and are more applicable to the designer and the operator of the system for any future updates or extension. As Prof J. A. said, having about 36 characters (26 numbers and 10 numbers) provides more choices, generates all the required codes, and even saves some characters for future use.

All the participants stated that they consider the ideas of the proposed technique as a novel work. The model of the London postcode has been discussed by some of the participants, especially Prof J. A. Unlike the postcode of London, the technique can be conveniently applied to all cities and towns within a country, with an additional feature of providing a view of the distance of any point from the centre of the area. In addition, direction has been defined numerically, whereas direction has been defined as an area code with letters in the London postcode. Mr M. J. emphasised that, regardless of what features the proposed technique has, proposing an idea as a standard tool for designing an LBI system for any

area is a novelty in itself. However, Mr M. R. believes that the technique should be developed more towards being applicable for countries who prefer to use numeric systems.

According to Prof J. A. and Mr A. J., who have deep experience in the field of addressing systems, the proposed technique can be utilised in different countries based on what the designer needs. Moreover, the technique can be adopted for different styles of city roads, land divisions and can take into account any future expansions. Miss M. T. stated that modern devices that utilise navigation systems accept alphanumeric codes, which is an important issue. However, the technique can be used for generating alphanumeric codes only, as argued by Mr. D. H. and endorsed by Mr. M. R. Unlike this point of view, Mr. A. J. and Mr. M. J. emphasised that applying the system as a complete design tool is not conditional. In addition, the ideas of the technique can be utilised to generate numeric codes too.

7.8 Discussion and Conclusions

The present research consists of three consecutive studies. The aim of the first study was to proof the importance and the acceptance of an LBI system in general. The study was based on a quantitative close-ended questionnaire in order to draw a clear border around the extent that the research will cover. In addition, the awareness of the KRI residents regarding the LBI system has been discovered and the reasons behind the inactivity of the current LBI system in KRI have been addressed. In order to activate the LBI system based on the proposed model, the impact of the system in daily life for the people and the government need to be ascertained. To do so, a second study has been designed based on open ended questions.

The generated themes of the study will be used as justifications of the results of the first study. The utility of the current research should be justified by practitioners that decide on the best postcode system to use in a given context. Hence, it will be a good support for

researchers and analysts who wish to study the potential implementation of new systems and techniques for system design. In order to achieve this, further research study has been conducted to explore and assess the findings of the current research by undertaking a qualitative interview study with experienced people and policy makers in different countries. In this study, the issues already raised and discussed in this thesis and the key finding from the previous surveys have been discussed and assessed.

The Technology Acceptance Model has been used in the present study to test the acceptance of a non-technology system (LBI). Both TAM and DTPB models have been used to examine the adoption of an LBI system in the KRI, based on the SR_LBI technique. The reasons behind using two different models are to concentrate on Perceived Behaviour Control PBC ,which is decomposed into government support (GS), to activate LBI system in KRI, using DTPB. The results of using DTPB have been used in conjunction with the TAM results. TAM focuses on PU and PEU factors. These factors have been proven to have positive effects on attitudes toward using the proposed LBI system. Therefore, the TAM model provides better results when compared with DTPB, based on GoF variables (indices), as explained in section 7.5.1 - Structural Model Test.

This result shows that the DTPB model has superior explanatory power than TAM and confirms its robustness to predict the intention of the citizens to accept and use the proposed LBI system. However, this system has been neglected so far, due to the absence of government support, which has led to a lack of community awareness towards using the LBI system within the government and in private sectors. The research hypotheses results show that the p-value of each model variable is less than 0.001. However, GS is <0.05 with a negative beta value. As mentioned previously, the minimum accepted P-value is <0.05 and the lower value represents the better value. This shows the weakness of government support is negatively affecting the activation of LBI in the KRI. This study clearly demonstrates that the perceived usefulness (PU) and perceived ease of use (PEU) have a

significant influence on attitudes toward using LBI. The results of DTPB show that compatibility, family and friends, self-efficacy, subjective norm and perceived behaviour control have a positive effect on individuals' behaviour intention towards using the LBI system.

The impacts of a good LBI system have been also studied in a qualitative open-ended questionnaire. Five different aspects have been focussed on in five open-ended questions. The first question was a comparative study to show the impact of identifying postcodes through an alphanumeric system, compared with the numeric system. Negative and positive points of each type have been discovered from the themes of the collected data. The impact of postcodes on technology has also been studied in the data analysis of the second question. Sectors that require a good postcode system to improve have been detected from the data. The third question focused on the importance of having an LBI system when the detailed information is already available and known by the residents. The majority of the respondents have mentioned one or more positive effects of introducing a good LBI system, regardless of the context of the place. In the analysis of the next questions, the negative impacts of poor LBI systems have been discussed. Each of the participants listed at least one negative effect of that supposition. The last question was about the impact of policy on postal distribution and vice versa. 22% of the participants do not see any important impact, which is quite high when compared with the previous questions.

To design an accepted LBI system by KRG, the results of this study can be considered useful. The proposed system uses a short code with a constrained number of alphanumeric characters, rather than a long series of 13 numeric digits, which are currently applied in the KRI. The proposed LBI codes are based on using a short set of characters with high granularity. This is the main reason for its acceptance by KRI citizens. As the proposed LBI system is preferred by those who completed the survey, thus, the system possess the feature of ease of use.

8 Conclusion

8.1 Research Problem Synopsis

LBI is being widely utilised for both economic and social development. Without LBI, it can be difficult to reach individuals or places, trade outlets cannot be identified by customers, and public services can be slow. In most societies, a person needs an address to be recognised as an individual, a citizen, or a consumer. However,an inefficient LBI system in some developing countries, and KRI as an example, is the main reason for conducting this study. A study and analysis has been done in this regard to improve LBI in general and KRI's LBI system specifically. In addition, the unavailability of a unified LBI system in the KRI causes confusion and subsequent disregard for the system by the citizens, since three different LBI systems have been applied in the three main cities of the region. As presented in the introductory chapter and in Chapter 1, any area (region, country) needs a single unified LBI system for its cities and towns, in order to build an active addressing system. To improve an LBI system, a set of aims and objectives have been expressed, which define the scope of this work.

8.2 Research Aims and Major Achievements

The main aims of the thesis defined from an extensive literature review in this area are as follows:

1- To develop an LBI system that can provide high granularity.

Achievement: In this study, the SR_LBI technique has been introduced to define individual locations. Seven different alphanumeric codes have been used with a length of up to 7 characters in a single code.

2- To test the acceptance of the developed LBI system by KRI citizens

Achievement: The acceptance of the proposed system has been tested based on Technology Acceptance Model (TAM). The test is based on the level of Perceived Ease of Use (PEU) and Perceived Usefulness (PU). The results show that the proposed system is more preferable by KRI citizens than the current inactive systems.

3- To discover the impacts of the acceptable LBI system in KRI.

Achievement: The impacts of the acceptable LBI system have been discovered by conducting an open-ended questionnaire based on five different aspects. The selected aspects are the LBI format, technology, availability of detailed information about the locations, the economy and government policies.

4- To justify the utility of the developed LBI system in different countries.

The utility of the research outcomes has been justified by conducting qualitative interviews. The proposed technique has been assessed based on the novelty, applicability, scalability and flexibility factors.

8.3 Research Outcomes

A comprehensive investigation has been conducted to offer further contributions to the existing literature concerning the enhancement of LBI, with a view to improve the current understanding of the design process. The main conclusions from each aspect of this report can be described as follows.

Objective 1: To propose a new technique for LBI system design, as a modified version of the UK postcode, and provide a sense of direction and distance from the central area within the LBI codes.

Conclusion: The SR_LBI technique has been introduced as a developed version of the UK postcode system. The technique can be used to design LBI for cities, towns or any areas

separately, as discussed in Chapter 3 - SR_LBI. The main features of the proposed technique are as follows. First, the technique is able to generate up to 4,800,000 codes (addresses) using up to 7 characters, which means a high granularity. Second, the generated codes are intelligent addresses, which possess a sense of direction from the centre of the area (north, east, south and west), using specific numbers for each direction. In addition, the technique divides the area into consecutive zones, from zone 0, the central area, up to zone 99 as an outer zone, to give the generated code a sense of distance from the centre of the area.

Objective 2: To apply the technique and design a new LBI system for the KRI as an alternative to the current systems.

The proposed SR_LBI technique has been applied as an alternative LBI system for Erbil, the capital of the KRI. The circular growth of the city over the years, and its consecutive ring roads are taken into account. The circular citadel of Erbil, located in the centre of the city, is considered zone 0, and the circular ring roads have been used for zone division. In addition, four main roads, connecting the city within neighbourhood districts have been chosen to divide the city into four main sections of North, East, South and West. The technique has been applied successfully and the steps of the design have been presented in Chapter 3 - SR_LBI technique, in further detail.

Objective 3: To propose a number of hypotheses based on the technology models of TAM and DTPB to determine the factors of LBI system acceptance.

Conclusion: The hypotheses, as presented in Chapter 5 - Conceptual Framework, have been formulated based on the main factors of TAM and DTPB models. The model factors are: Perceived Ease of Use, Perceived Usefulness, Compatibility, Family and Friends, Self-efficacy, Government support, Attitude Toward Behaviour, Subjective Norm, Perceived Behavioural Control and Behaviour Intention.

Objective 4: To justify the acceptance of a proposed model for the KRI by delivering a questionnaire based on TAM and DTPB models.

Conclusion: The collected data has been analysed based on TAM and the design factors of Perceived Ease of Use (PEU) and Perceived Usefulness (PU) have been used. The results show that the PEU has a direct effect on individual's attitude towards acceptance of the SR_LBI technique in the KRI. Moreover, the perceived usefulness of the SR_LBI technique is another factor that positively affects an individuals' attitude towards using an LBI system.

Objective 5: To analyse and measure user acceptance using SPSS and Amos graphic.

Conclusion: After determining the factors that may influence the acceptance of the SR_LBI technique in the KRI, an extensive data analysis has been conducted based on SPSS and Amos graphic. Participants from the KRI have been asked to comment on the Perceived Ease of Use (PEU) and Perceived Usefulness (PU) of the proposed LBI system for the KRI, based on the SR_LBI technique. The results show that the majority of the respondents answered positively regarding the proposed LBI code that is designed based on the SR_LBI technique.

DTPB has been used to examine the factors that affect the individual's intention to use LBI. The results show that government support (GS) has a significant effect on the individual to use the system in the KRI. The study concluded that one of the main reasons behind the inactivity of the current LBI system in the KRI is the government changing the LBI system several times, using long numeric codes in the design (up to 13 characters) and a lack of government support.

Objective 6: To discover the impacts of the acceptable LBI system in the daily life of KRI citizens by conducting a qualitative survey.

Conclusion: A qualitative survey has been conducted based on an open-ended questionnaire. Five questions were formulated to achieve aim #3. The online tool (Google forms) has been used and the questionnaire was published via emails and special pages of social media. The data was collected online using Google sheets.

Objective 7: To analyse the discovered themes within the data and measure the impacts of the acceptable LBI system in different aspects of daily life.

Conclusion: The collected qualitative data has been analysed using a thematic analysis. The similar discovered themes have been joined together and the total themes have been classified into positive and negative themes. As presented in section 7.5, most of respondents answered positively and the statistics of the results have been presented using pie and bar charts.

Objective 8: To justify the outcomes of this research by conducting qualitative interviews with decision makers and experienced people in the fields relating to LBI systems.

Conclusion: Qualitative interviews have been conducted with decision makers and experienced people in fields relating to LBI systems. Discussions have been made with seven interviewees, focussing on about four main topics, which are the novelty, applicability, scalability and flexibility of the proposed technique. Generally, the study was an assessment of the outcomes that are raised in the current thesis.

Objective 9: To analyse the data and present the advantages and disadvantages of the proposed technique.

Conclusion: The data has been presented and discussed in section 7.7. Based on the answers, the advantages and disadvantages of the proposed technique have been highlighted. For each sections of the discussion, different point of views have been presented and discussed. Generally, the participants support the proposed system as a

method to be used to design the LBI system for those countries who do not yet have this system. In addition, for countries who already have an LBI system, the idea of switching their system to a new developed system is not supported by some of the participants. However, some of the participants supported the idea of changing towards better systems and defended their idea by mentioning success stories of many system changes that happened in the past in certain countries.

8.4 Thesis Contributions

1. A new intelligent LBI technique for LBI design called SR_LBI has been proposed and explained. The main feature of this method is the perception of the approximate position of a specific point from the centre of an area.
2. The research contributes to the field of technology acceptance through the development of the technology acceptance research model. This research shows the power of the technique based on the results from the participants. The KRI citizens' actual usage and their intention to use the proposed LBI system based on SR_LBI technique have been measured as a result of testing and verifying the theoretical framework as discussed in section 7.4. This outcome is expected to be useful for KRG and other future research studies.
3. The collected data was analysed by applying Structural Equation Modelling (SEM) Amos Graphic that has useful features, especially in modelling multivariate relations, and might be useful for similar future works.
4. The outcomes of the qualitative survey on the impacts of the accepted LBI system in the KRI might be useful for decision makers, as well as for future studies about this topic.
5. In Chapter 7, the Results and discussion, the proposed LBI system through using SR_LBI technique is shown to be acceptable by KRI citizens, due to the ease of use and usefulness of the system based on the Technology Acceptance Model (TAM).
6. In this study, the main reasons behind the lack of use of LBI in KRI have been discovered by using the Decomposed Theory of Planned Behaviour (DTPB) model, as explained in Chapter 7 - Results and Discussion.
7. The results of the interviews is good justification of the effectiveness of the proposed technique. The detailed interview data that presented in section 7.7 is good

justification of the utility and novelty of the proposed technique in this research. Hence, the technique might be useful for LBI designers and decision makers.

8.5 Further work

This research aims to improve addressing systems by using a new technique for LBI design. In addition, the study is a significant step toward creating an active LBI system for the KRI. The proposed system could be accepted by the KRI as a national project to be implemented in the future. The system is flexible, and can be extended to cover the whole of Iraq.

In order to make the LBI system fully functional, the following steps are required:

- The importance of LBI appears when it applies to human activities in daily life. In order to activate an LBI system in the KRI, comprehensive studies are needed to propose effective ways of applying the system in the service sectors, with respect to the rules and regulations of KRG.
- In principle, LBI has been implemented to manage and facilitate postal services. Without activating the postal services, the system cannot be applied easily in many service sectors. Analytical studies are required to show efficient and applicable ways to activate postal services in KRI. Moreover, it is important investigate an effective way to motivate KRI citizens to make full use of LBI in their daily life.
- Today's technology tends to increase productivity by reducing time consumption and the possibility of making mistakes in human daily activities. As such, many businesses rely on an addressing system to provide a high level of accuracy in finding addresses in a fast and efficient way. To this extent, the development of a bar-code based LBI system might be a good alternative for this purpose. Comprehensive studies are needed in this regard in order to introduce applicable suggestions.
- To show the effectiveness of any new technique or system, comparison studies are needed to highlight the strong and weak points of any system. A qualitative comparison study between the proposed SR_LBI technique and the UK LBI system can provide opportunities for LBI system professionals to evaluate the proposed technique

8.6 Limitation

The research proposed a new technique for LBI system design. However, the research does have certain limitations. First, the research findings may be limited to the research population, nevertheless, the subject area (LBI) is new for the majority of KRI citizens. Then, as has been discussed in Chapter 6 - Methodology, the population that have been used to answer the research questionnaire were familiar with LBI systems in countries in which they were studying or in developed countries where LBI system is active. Second, the majority of the research population were male, because the majority of the students that participated in this study live and abroad and were male. Finally, the publications and online resources in the area of LBI systems and postal addresses are severely limited.

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Appendices

Appendix 1 the first quantitative study

Development of a Kurdistan Location Based Identification System

I am, Sara Mohammed Amin, undertaking a research project to determine the viability of a location based identification system. Location identity is critical information for administrative, emergency response, research, marketing, mapping, GIS, routing and navigation, and many other purposes. Moreover, in developed countries many applications are applying using paper posts. The applications are sending and the results are receiving by post without direct contact with that office.

To this end we would kindly ask you to work through the following short questionnaire and try to complete as much as possible. It will take you less than 10 minutes of your time. Your response is of the utmost importance to us.

Please do not enter your name or contact details on the questionnaire. It remains anonymous.

Should you have any queries or comments regarding this survey, you are welcome to contact us by e-mail us at Sara.MuhamadAmin@hud.ac.uk

Yours sincerely

Top of Form

Are you male or female?

- o Male
- o Female

What is your age range?

- o 18 - 25
- o 26 - 35
- o 36 - 45
- o 46 - 55
- o Above 55

What is your highest educational level attained?

- o None
- o Primary
- o Secondary
- o Institute / University
- o MSc / PhD
- o Other:

Where are you from?

- o Kurdistan
- o Iraq
- o Other:

Do you know your home address?

- Yes
- No

Do you use your home address in daily life?

- Yes
- No

How frequently would you use your address?

- Once a week
- Once a month
- Many times a month
- Many times a year
- Once a year
- Once every few years

Which one do you prefer to be your home address?

- 44001207123
- A2 1BQ

Why you chose that address

- Easy to remember

- o ☐ Easy to memorise
- o ☐ I used to use this one
- o ☐ It is less character
- o ☐ I prefer this one
- o ☐ Other: ____

Using the addressing system would enable me to accomplish my tasks more quickly.

	1	2	3	4	5	
Strongly disagree	○	○	○	○	○	Strongly agree

Using the addressing system would make it easier for me to carry out my tasks.

	1	2	3	4	5	
Strongly disagree	○	○	○	○	○	Strongly agree

Using the addressing system in my life increases my productivity.

	1	2	3	4	5	
Strongly disagree	○	○	○	○	○	Strongly agree

Using the addressing system will save time.

	1	2	3	4	5	
Strongly disagree	○	○	○	○	○	Strongly agree

Using an addressing system allows me to manage my work more effectively.

	1	2	3	4	5	
Strongly disagree	○	○	○	○	○	Strongly agree

Using an addressing system gives me greater control over my work.

	1	2	3	4	5	
Strongly disagree	○	○	○	○	○	Strongly agree

Addressing systems are easy to learn.

	1	2	3	4	5	
Strongly disagree	○	○	○	○	○	Strongly agree

Addressing systems are easy to operate.

	1	2	3	4	5	
Strongly disagree	○	○	○	○	○	Strongly agree

Interaction with the addressing system does not require a lot of mental effort.

	1	2	3	4	5	
Strongly disagree	○	○	○	○	○	Strongly agree

My family would think that I should use the addressing system.

	1	2	3	4	5	
Strongly disagree	○	○	○	○	○	Strongly agree

Most friends would think that I should use the addressing system

1 2 3 4 5

Strongly disagree	○	○	○	○	○	Strongly agree

I would feel comfortable using the addressing system on my own.

1 2 3 4 5

Strongly disagree	○	○	○	○	○	Strongly agree

I am confident of using an addressing system even if I have never used such a system before

1 2 3 4 5

Strongly disagree	○	○	○	○	○	Strongly agree

I am confident of using an addressing system if I have just seen someone using it before.

1 2 3 4 5

Strongly disagree	○	○	○	○	○	Strongly agree

The government supports using the addressing system in the Kurdistan Regional Government.

	1	2	3	4	5	
Strongly disagree	○	○	○	○	○	Strongly agree

The Kurdistan government is active in setting up the facilities to activate addressing system.

	1	2	3	4	5	
Strongly disagree	○	○	○	○	○	Strongly agree

Using the an addressing system is a good idea

	1	2	3	4	5	
Strongly disagree	○	○	○	○	○	Strongly agree

I like the idea of using an addressing system.

1 2 3 4 5

strongly disagree	○	○	○	○	○	strongly agree

People who influence my behaviour would think that I should use the addressing system.

1 2 3 4 5

strongly disagree	○	○	○	○	○	strongly agree

People who are important to me would think that using the addressing system is a good idea.

1 2 3 4 5

strongly disagree	○	○	○	○	○	strongly agree

I would be able to use the addressing system.

1 2 3 4 5

strongly disagree	○	○	○	○	○	strongly agree

Using the addressing system is entirely with my control.

1 2 3 4 5

strongly disagree	○	○	○	○	○	strongly agree

I plan to use the addressing system if available.

1 2 3 4 5

strongly disagree	○	○	○	○	○	strongly agree

I intend to use the addressing system in the near future.

1 2 3 4 5

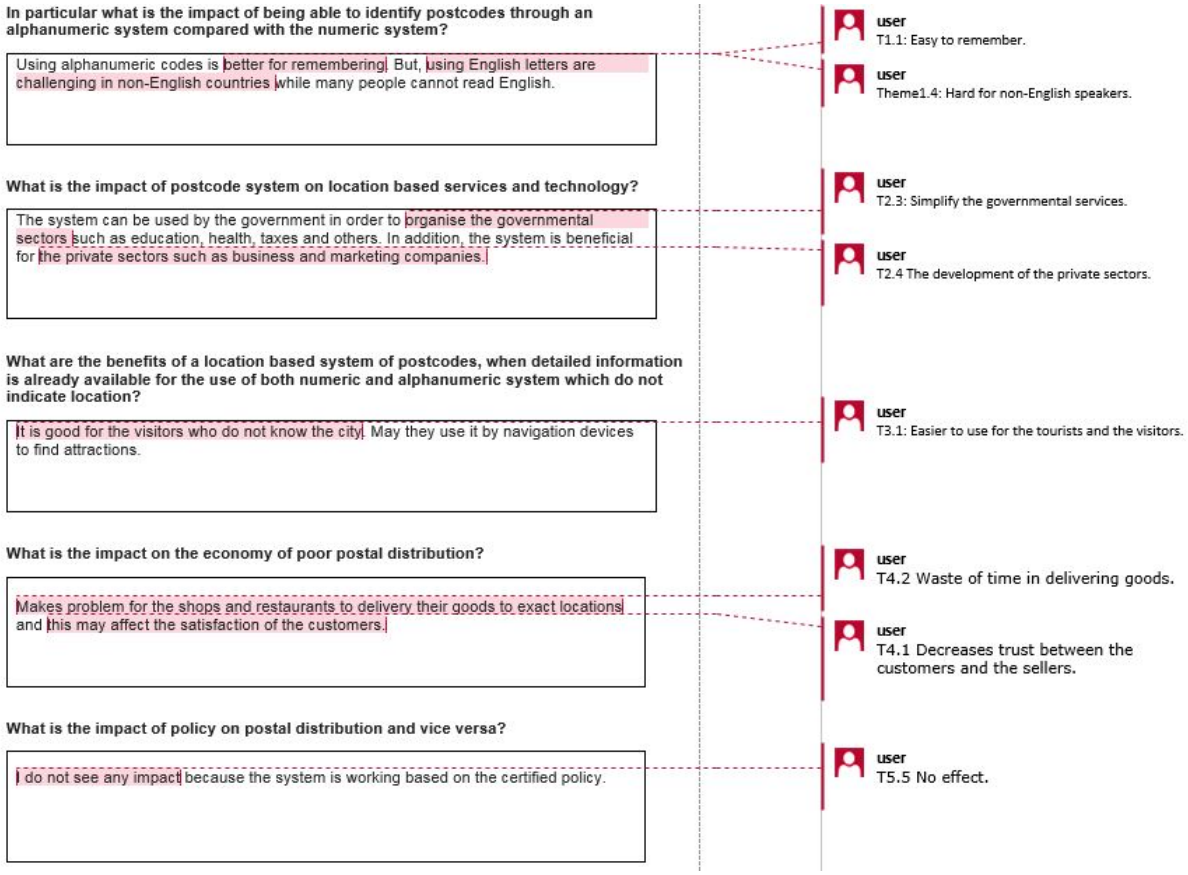
Very unlikely	○	○	○	○	○	Very likely

I will use the addressing system in the near future.

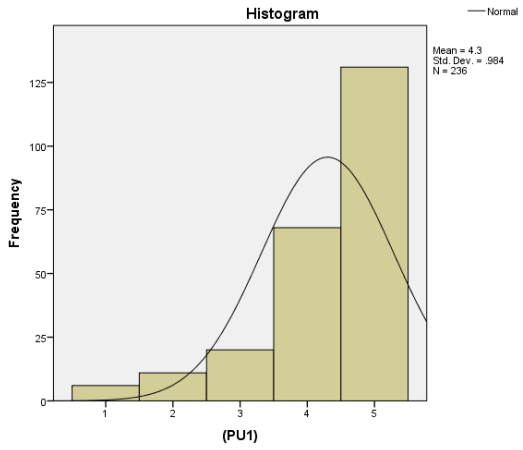
1 2 3 4 5

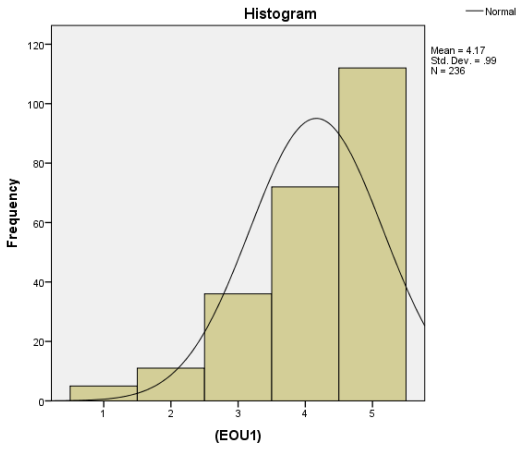
Very unlikely	○	○	○	○	○	Very likely

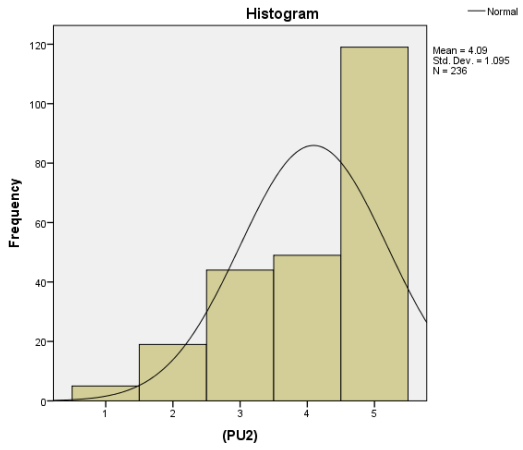
Appendix 2 the second qualitative study

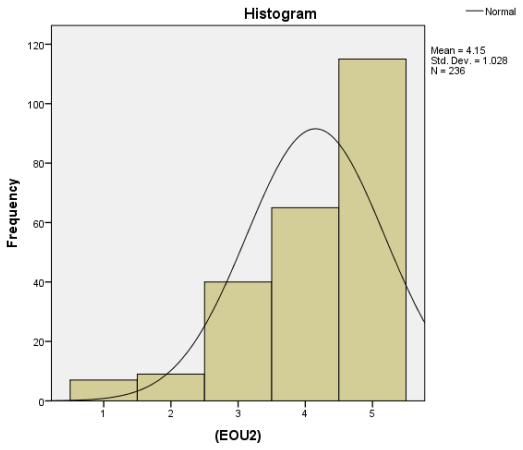


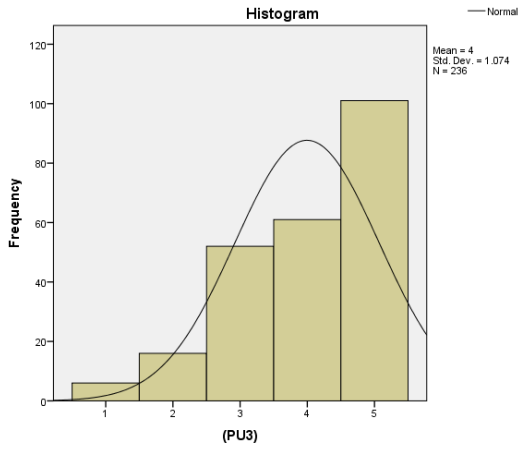
Appendix 3 Normality results

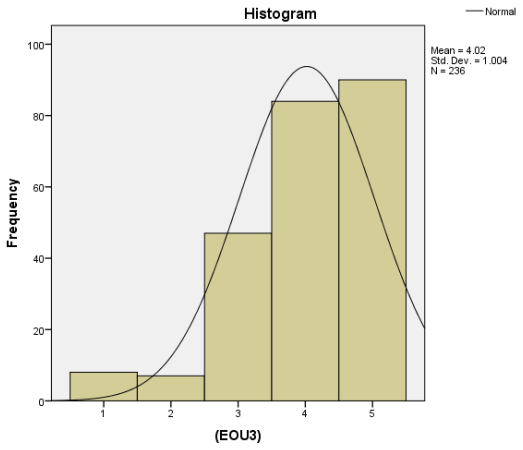


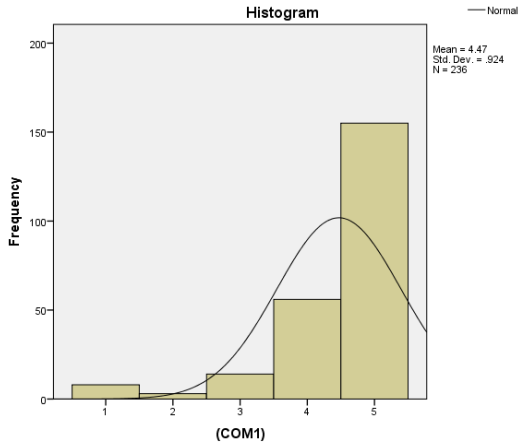








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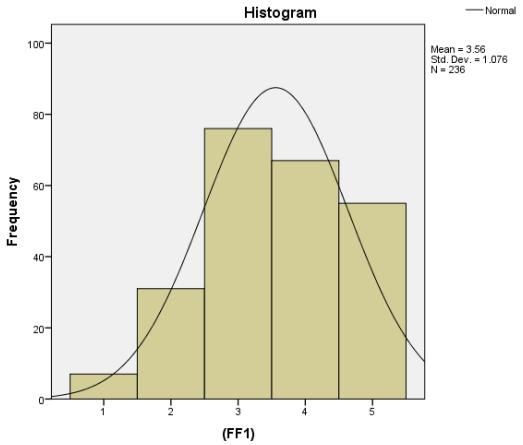
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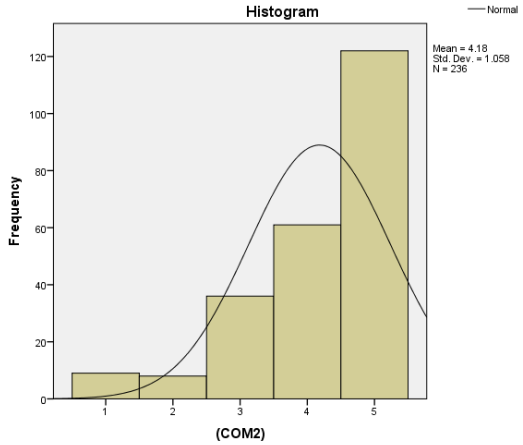
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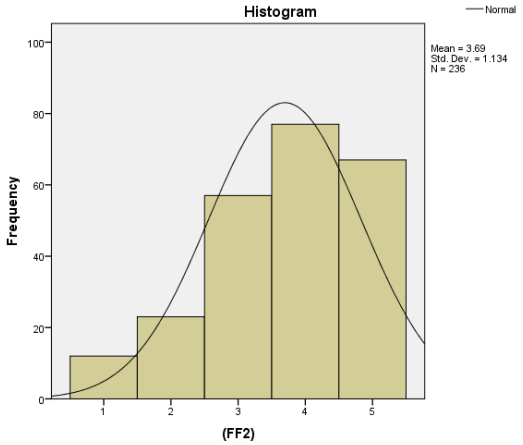
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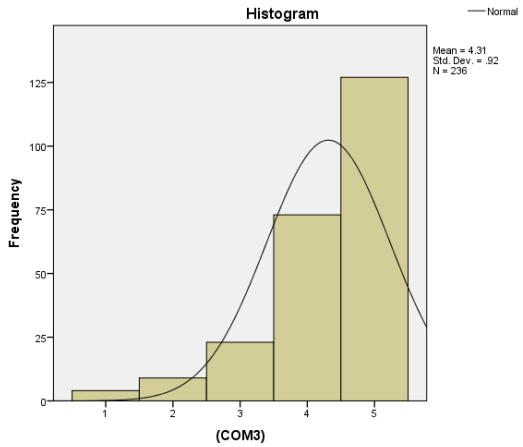
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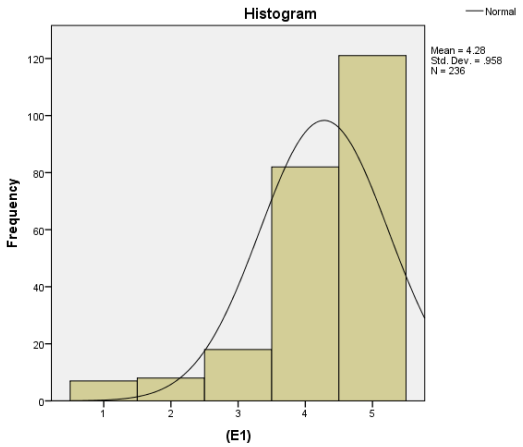
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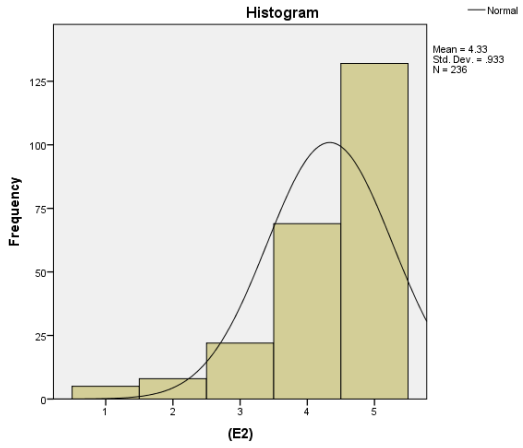
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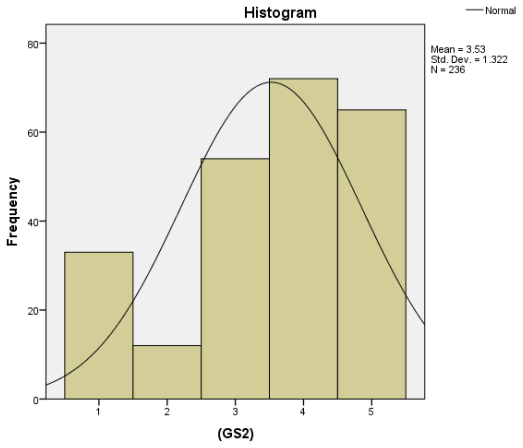
(E2)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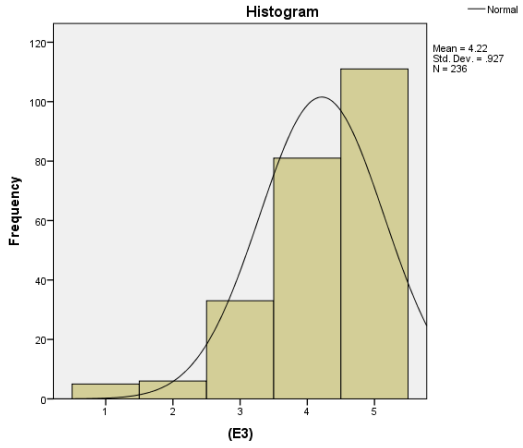
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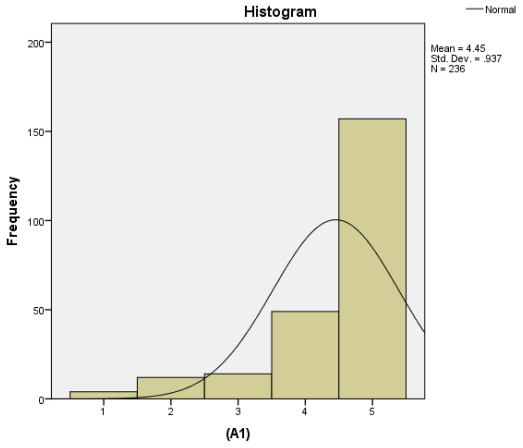
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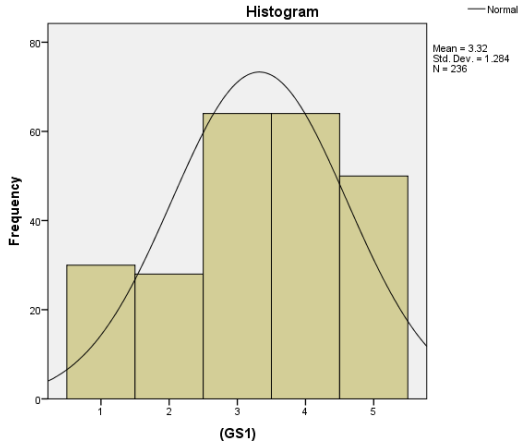
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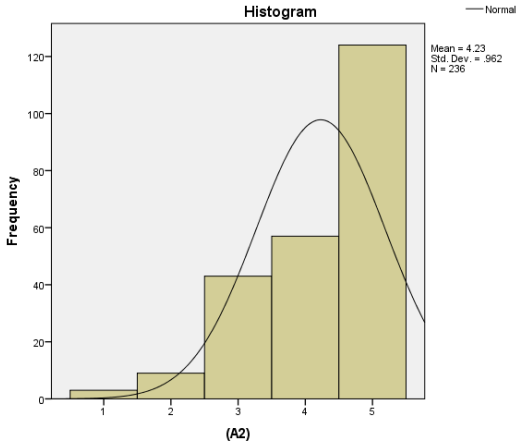
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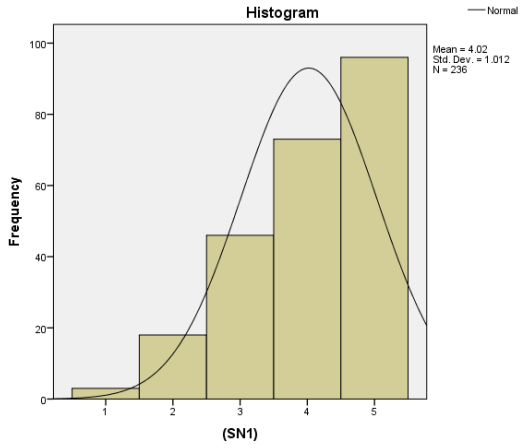
(A2)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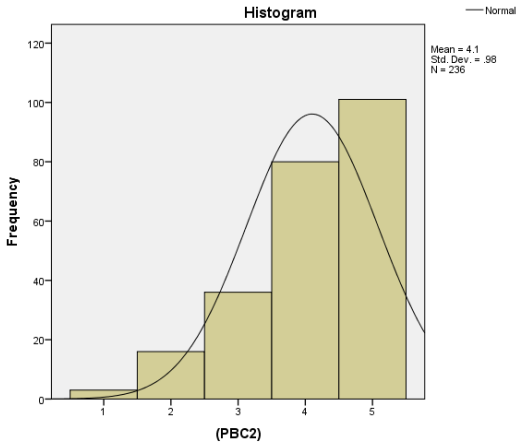
(SN1)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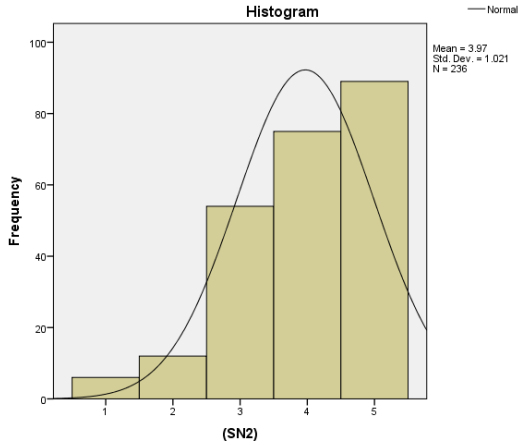
(PBC2)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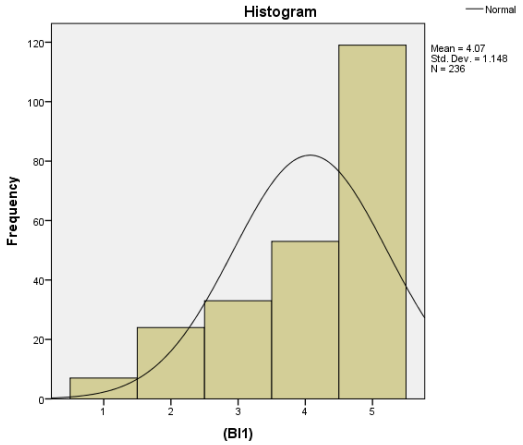
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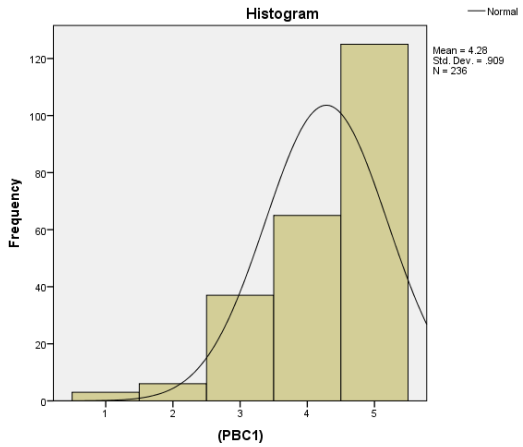
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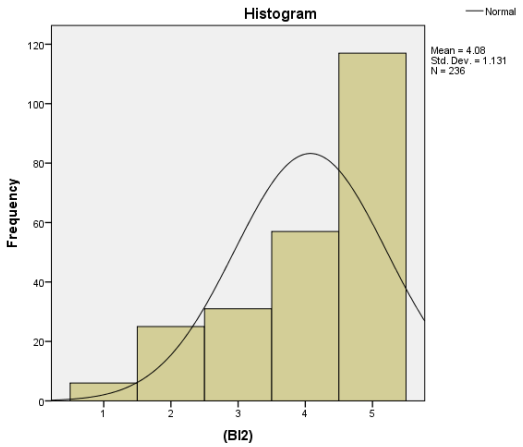
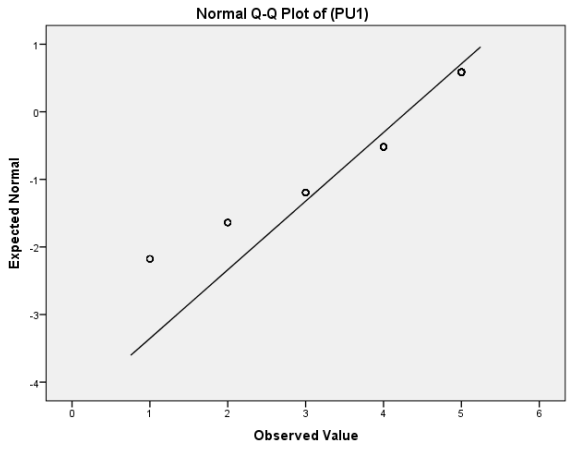
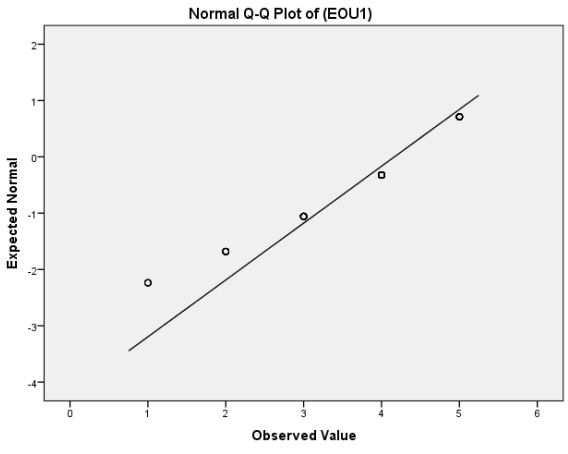
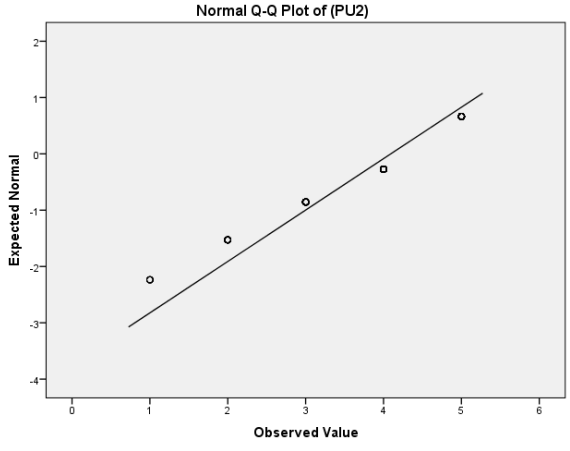
Frequency
(PBC1)

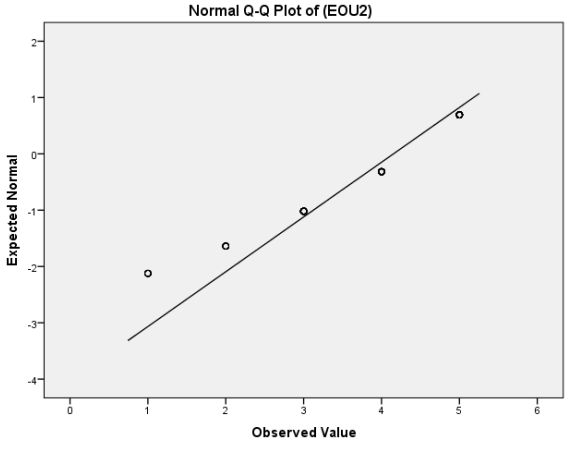

Histogram
Normal
Mean = 4.08
Std. Dev. = 1.131
N = 236
Frequency
(BI2)

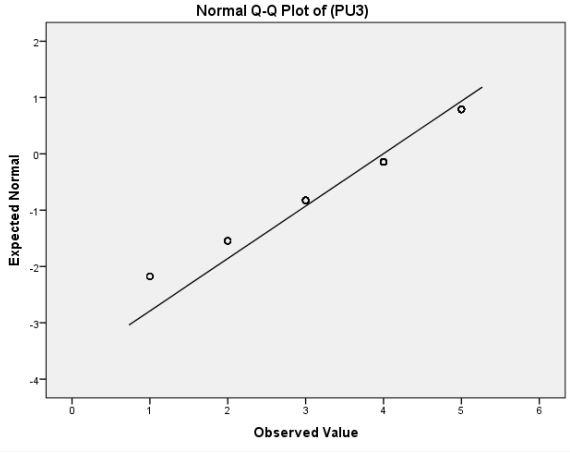
Appendix 4 Q-Q Plot Results

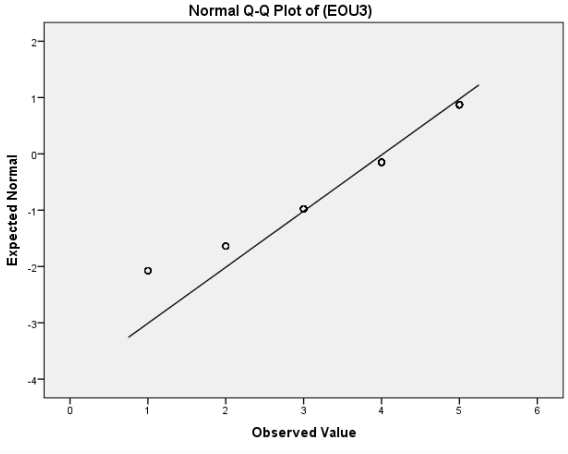


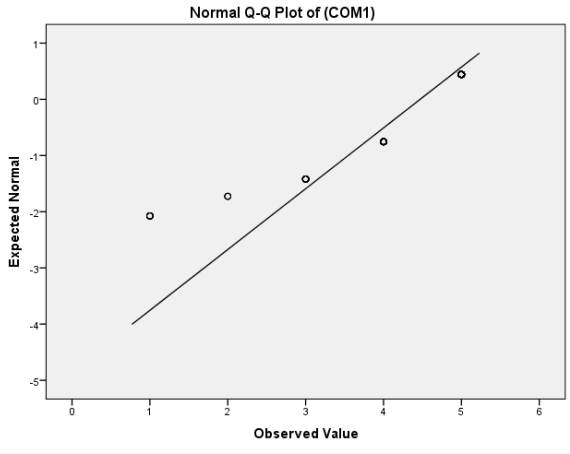


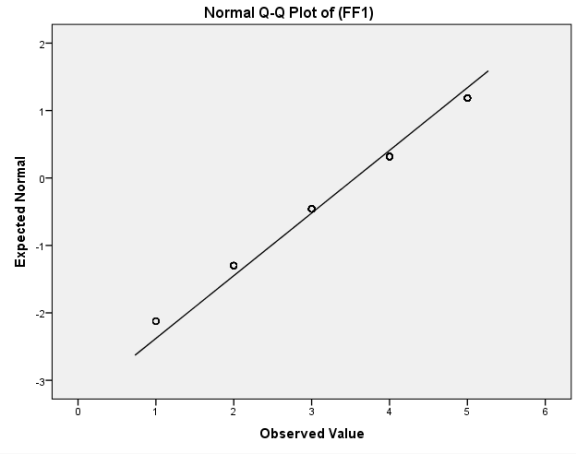


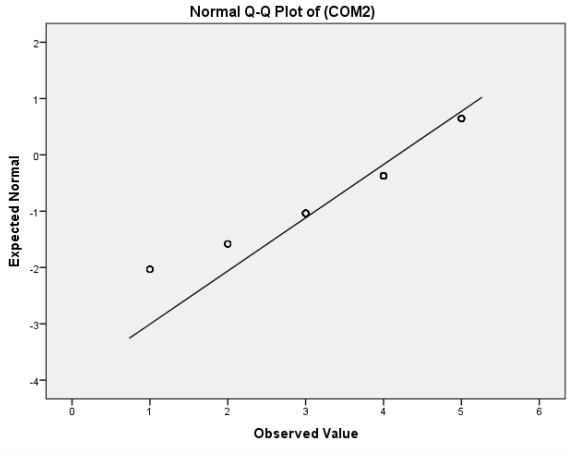


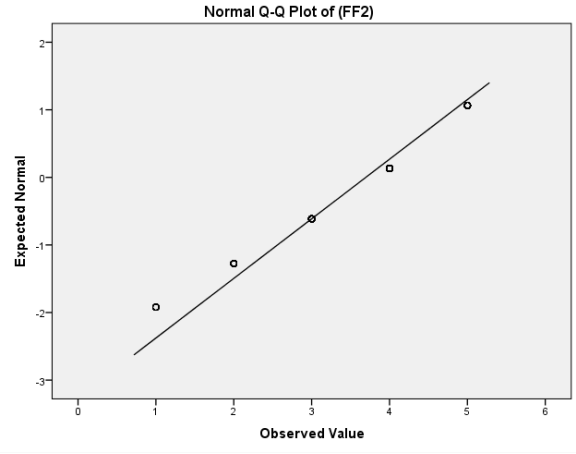


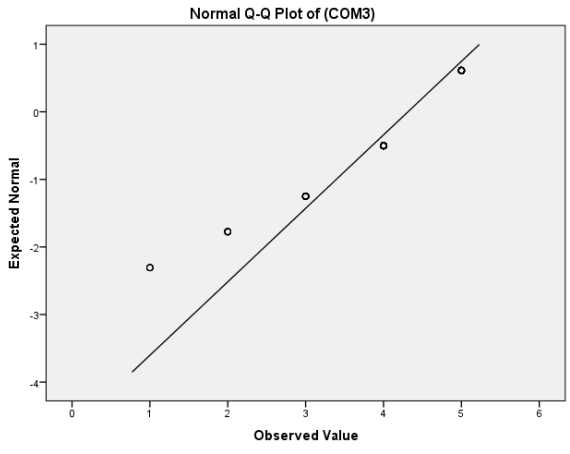


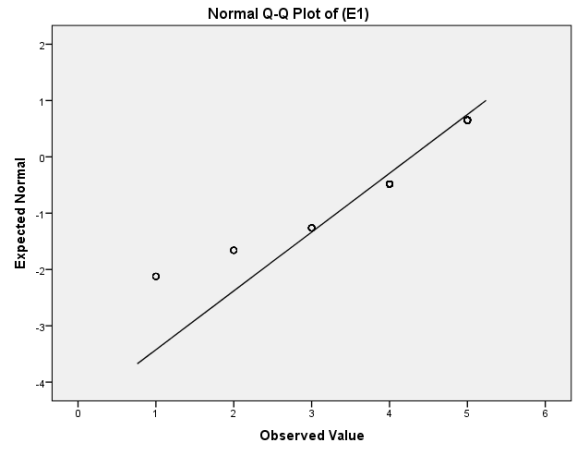

Normal Q-Q Plot of (COM1)
Expected Normal
Observed Value

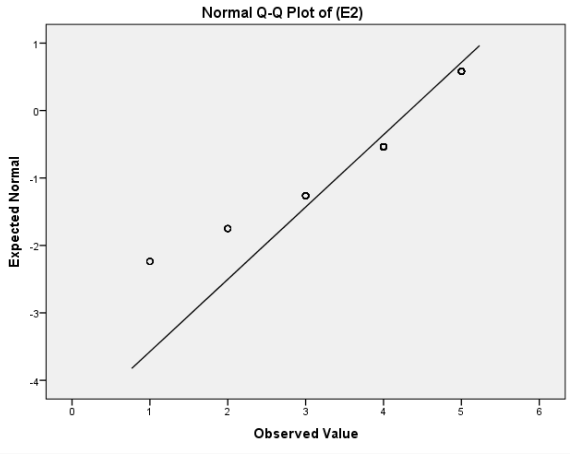

Normal Q-Q Plot of (FF1)
Expected Normal
Observed Value

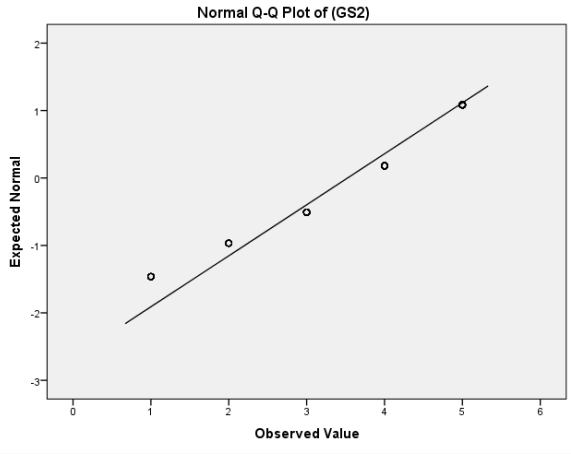

Normal Q-Q Plot of (COM2)
Expected Normal
Observed Value

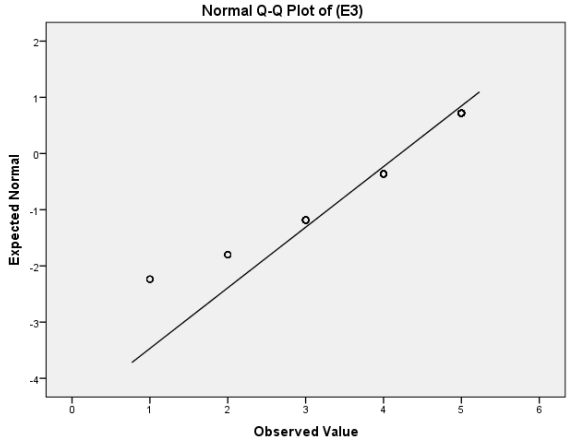

Normal Q-Q Plot of (FF2)
Expected Normal
Observed Value

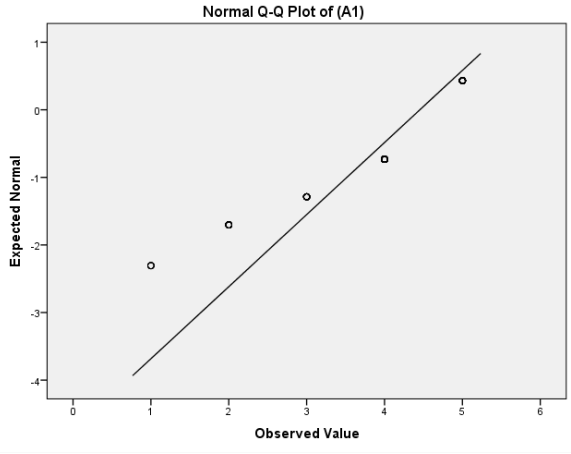

Normal Q-Q Plot of (COM3)
Expected Normal
Observed Value

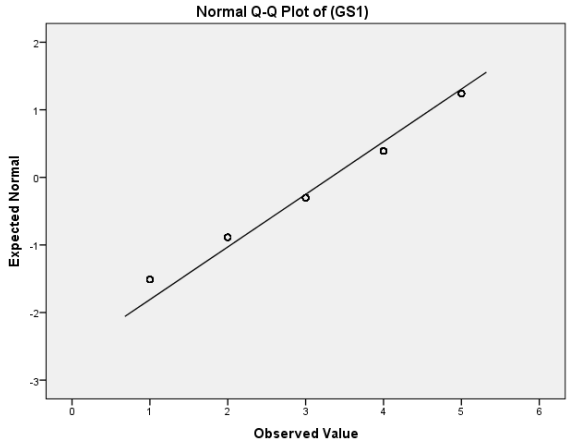

Normal Q-Q Plot of (E1)
Expected Normal
Observed Value

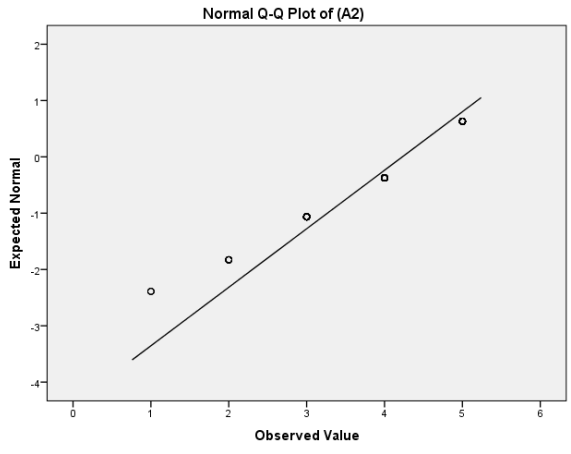

Normal Q-Q Plot of (E2)
Expected Normal
Observed Value

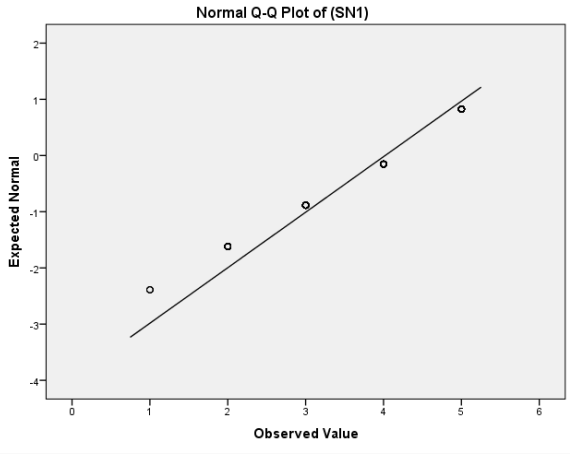

Normal Q-Q Plot of (GS2)
Expected Normal
Observed Value

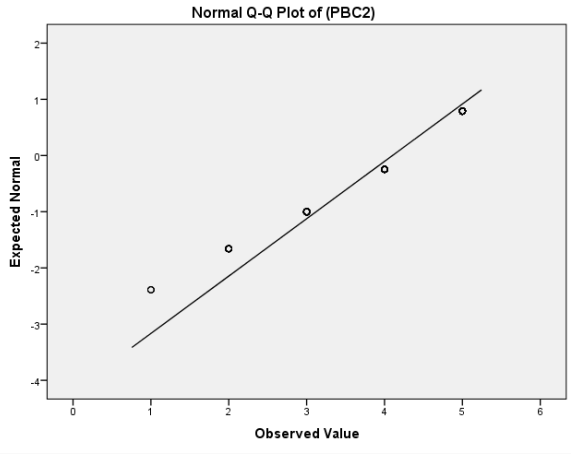

Normal Q-Q Plot of (E3)
Expected Normal
Observed Value

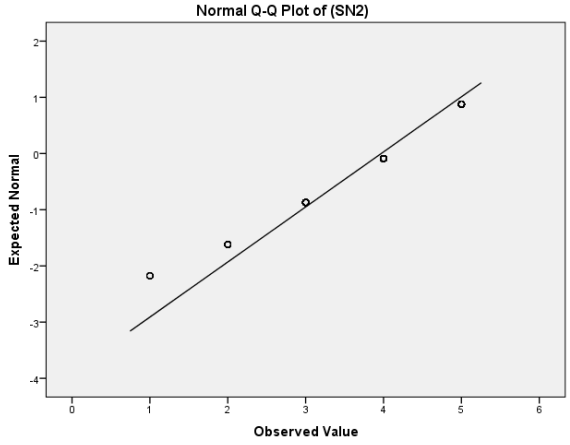

Normal Q-Q Plot of (A1)
Expected Normal
Observed Value

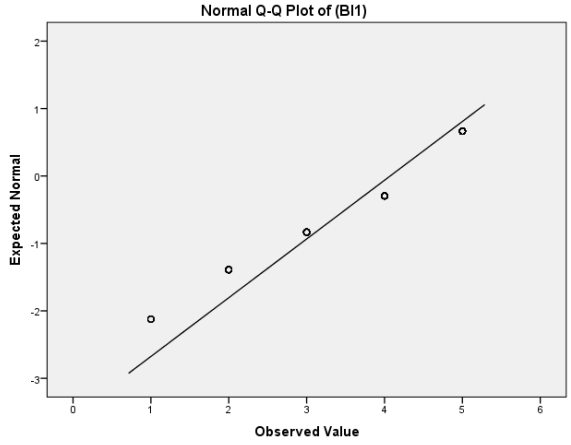

Normal Q-Q Plot of (GS1)
Expected Normal
Observed Value

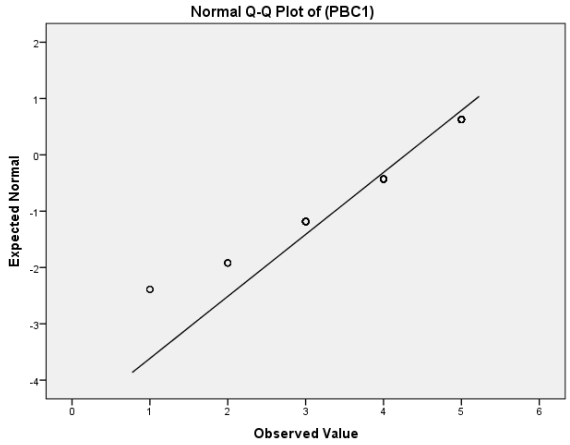

Normal Q-Q Plot of (A2)
Expected Normal
Observed Value

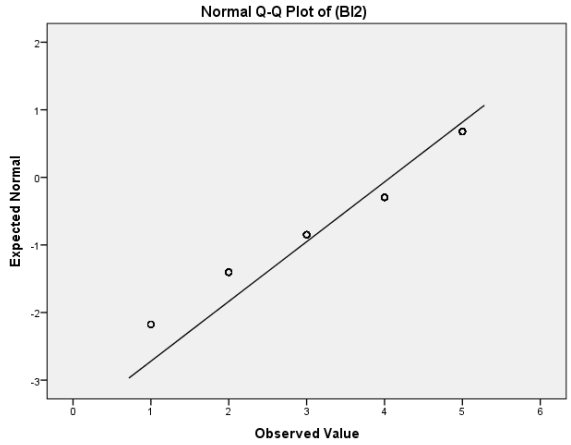

Normal Q-Q Plot of (SN1)
Expected Normal
Observed Value


Normal Q-Q Plot of (PBC2)
Expected Normal
Observed Value


Normal Q-Q Plot of (SN2)
Expected Normal
Observed Value


Normal Q-Q Plot of (BI1)
Expected Normal
Observed Value


Normal Q-Q Plot of (PBC1)
Expected Normal
Observed Value


Normal Q-Q Plot of (BI2)
Expected Normal
Observed Value

Appendix 5 the study questionnaire in Kurdish language

پەرەپێدانی سیستەمی ناسینەوەی ناوونیشان (ئەدرێس) لە کوردستان بۆ خزمەتگوزارییە گشتییەکان

من سارا محمدامین، توێژینەوەیەک ئەنجام دەدەم لەسەر هەڵسەنگاندنی کارایی سیستەمی دۆزینەوە و داستێشانکردنی شوێن. دەستێشانکردنی شوێن زانیارییەکی زۆر گرینگە بۆ مەبەستی کارگێری، بەهاتاجوون وفریاکەوتن، توێژینەوە، کڕین و فرۆشتن، نەخشەسازی، سیستەمی زانیاری جوگرافی جی ئای ئێس، سیستەمی ئاڕاستەکردن و بۆ زۆر مەبەستی جۆراوجۆری تر. لەوڵاتە پێشکەوتووەکان زۆرێک لە خزمەتگوزارییە کان پشت بە نامەی کاغەز دەبەستن. مامەڵەکان دەتێردرێن و ئەنجامەکان ودەدەگێرێنەوە ئەنها لە ڕێگەی نامەوە بەڵێ سەردانیکردنی خاوەن مامەڵە بۆ بەڕێوەبردنی و دانێردەکان.
بۆگەیشتن بەم مەبەستە، داوا لە بەڕێزتان دەکەین کە بەشداربن لەم ڕاپرسییە کورتە و وەڵامدانەوەی پرسیارەکان بەپێی توانا. کەمتر لە ١٠ خولەک لە کاتی نۆی پێویستە. وەڵامدانەوەی ئێوە زۆر گرینگە بەلامانەوە.
ئکایەناوی خۆت و ناونیشانت مەنووسە. تەنێنی بەشداربوان پارێزراوە.
لە هەبوونی هەر پرسیارو ڕوونکردنەوەیەک دەربارەی ئەم ڕاپرسییە، پەیوەندیمان پێوە بکە بە ئیمەڵی
Sara.MuhamadAmin@hud.ac.uk

جۆری ڕەگەز

- مێ
- نێر

تەمەنت لەنێوان؟

- ٢٥_١٨
- ٣٥_٢٦
- ٤٥_٣٦
- ٥٥_٤٦
- ٥٥ بەسەرەوە

دوا پلەی زانستیت؟

- ○ نەخوێندەوار
- ○ سەرەتایی
- ○ ئامادەیی
- ○ پەیمانگا / زانکۆ
- ○ ماستەر / دکتۆرا
- ○ Other : _____

خەلکی چ شوێنێکی؟

- ○ کوردستان
- ○ عێراق
- ○ Other : _____

ئایا ناونیشانی مالّەوەتان ئەزانی (ئەدریس) ژمارەی خانوو؟

- ○ بەڵێ
- ○ نەخێر

ئایا ناونیشانی مالّەوەتان (ئەدریس)بەکار دێنی لەژیانی ڕۆژانەتدا(ژمارەی خانوو)؟

- ○ بەڵێ
- ○ نەخێر

ژمارەی او جارانەی (ژمارەی خانوو) بەکاری دێنی چەندێکە؟

- ○ یەک جار لە هەفتەدا
- ○ یەک جار لە مانگێکا
- ○ چەند جارێک لە مانگێکا
- ○ چەند جارێک لە ساڵێکدا
- ○ ساڵی یەک جار
- ○ یەک جار لە چەند ساڵێکدا

کام لەمانەت پێ باشە ناونیشانی مالت بێت (ئەدریس)؟

- ○ 44001207123
- ○ A2 1BQ

بۆچی ئەمەیانت پێ باشە؟

- ☐ ئاسان بە بیرت دێتەوە
- ☐ ئاسانە لەئەزبەر کردنی
- ☐ لەبەکار هێنانی ئەمەیان راهاتومە
- ☐ کورتترە
- ☐ ئەمەیانم زیاترە
- ☐ Other: _____

بەبەکار هێنانی سیستەمی پۆست و ناونیشان (ئەدریس) کارەکانم زووتر تەواو دەکەم

	5	4	3	2	1	
بەتەواوی لەگەڵی نیم	○	○	○	○	○	بەتەواوی لەگەڵیم

بەبەکار هێنانی سیستەمی پۆست و ناونیشان (ئەدریس) ئاسانتر کارەکانم تەواو دەکەم

	5	4	3	2	1	
بەتەواوی لەگەڵی نیم	○	○	○	○	○	بەتەواوی لەگەڵیم

بەکار هێنانی سیستەمی پۆست و ناونیشان (ئەدریس) وەبەر هێنانم زیاتر دەکات لەژیانی رۆژانەمدا

	5	4	3	2	1	
بەتەواوی لەگەڵی نیم	○	○	○	○	○	بەتەواوی لەگەڵیم

بەبەکار هێنانی سیستەمی پۆست و ناونیشان (ئەدریس) هۆیە بۆ پاشەکەوتی کات

	5	4	3	2	1	
بەتەواوی لەگەڵی نیم	○	○	○	○	○	بەتەواوی لەگەڵیم

بەکار هێنانی سیستەمی پۆست و ناونیشان (ئەدریس) هۆیە بۆ ز یاتر کاراکردنی کارەکانم

	5	4	3	2	1	
بەتەواوی لەگەڵی نیم	○	○	○	○	○	بەتەواوی لەگەڵیم

بەکارهێنانی سیستەمی پۆست و ناونیشان (ئەدریس) هۆیە بۆ کۆنترۆلکردنی کارەکانم

	5	4	3	2	1	
بەتەواوی لەگەڵی نیم	○	○	○	○	○	بەتەواوی لەگەڵیم

فێربوونی سیستەمی پۆست و ناونیشان (ئەدریس) ئاسانە

	5	4	3	2	1	
بەتەواوی لەگەڵی نیم	○	○	○	○	○	بەتەواوی لەگەڵیم

بەکارهێنانی سیستەمی پۆست و ناونیشان (ئەدریس) ئاسانە

	5	4	3	2	1	
بەتەواوی لەگەڵی نیم	○	○	○	○	○	بەتەواوی لەگەڵیم

ئاشنابوون بە سیستەمی پۆست و ناونیشان (ئەدریس) پێویستی بە زیرەکی و بیرتیژی زۆر نیە

	5	4	3	2	1	
بەتەواوی لەگەڵی نیم	○	○	○	○	○	بەتەواوی لەگەڵیم

ئەندامانی ماڵەوەمان پێیان وایە ئەبێ من سیستەمی پۆست بەکاربێنم

	5	4	3	2	1	
بەتەواوی لەگەڵی نیم	○	○	○	○	○	بەتەواوی لەگەڵیم

زۆرینەی ڕەفیقەکانم پێیان وایە ئەبێ من سیستەمی پۆست بەکاربێنم

	5	4	3	2	1	
بەتەواوی لەگەڵی نیم	○	○	○	○	○	بەتەواوی لەگەڵی نیم

هەست بە ئارامی دەکەم کاتێک خۆم ئەتوانم پۆست بەکاربهێنم

	5	4	3	2	1	
بەتەواوی لەگەڵی نیم	○	○	○	○	○	بەتەواوی لەگەڵیم

لەخۆم دڵنیام کەتوانای بەکارهێنانی سیستەمی پۆستم هەیە ئەگەر پێشتریش بەکارم نەهێنابێ

	5	4	3	2	1	
بەتەواوی لەگەڵی نیم	○	○	○	○	○	بەتەواوی لەگەڵیم

لەخۆم دڵنیام کەتوانای بەکارهێنانی سیستەمی پۆستم هەیە ئەگەر کەسێ لەبەر چاوم بەکاری هێنابێ

	5	4	3	2	1	
بەتەواوی لەگەڵی نیم	○	○	○	○	○	بەتەواوی لەگەڵیم

حکوومەت بەهەموو شێوەیەک پشتگیری سیستەمی پۆستی کردووە لە هەرێمی کوردستان

	5	4	3	2	1	
بەتەواوی لەگەڵی نیم	○	○	○	○	○	بەتەواوی لەگەڵیم

حکوومەت کارایە لە جێبەجێکردنی سیستەمی پۆست

	5	4	3	2	1	
بەتەواوی لەگەڵی نیم	○	○	○	○	○	بەتەواوی لەگەڵیم

بیرۆکەی بەکارهێنانی سیستەمی پۆستم بەدڵە

	5	4	3	2	1	
بەتەواوی لەگەڵی نیم	○	○	○	○	○	بەتەواوی لەگەڵیم

ئەو کەسانەی کە کاریگەرییان هەیە لەسەر بڕیاردانم پێیان وایە دەبێ سیستەمی پۆست بەکار بێنم

	5	4	3	2	1	
بەتەواوی لەگەڵی نیم	○	○	○	○	○	بەتەواوی لەگەڵیم

ئەو کەسانەی کە گرینگن بەلامەوە پێیان وایە بەکارهێنانی سیستەمی پۆست بیرۆکەیەکی زۆر باشە

	5	4	3	2	1	
بەتەواوی لەگەڵی نیم	○	○	○	○	○	بەتەواوی لەگەڵیم

ئەو کەسانەی کە گرینگن بەلامەوە پێیان وایە دەبێ من سیستەمی پۆست بەکاربێنم

	5	4	3	2	1	
بەتەواوی لەگەڵی نیم	○	○	○	○	○	بەتەواوی لەگەڵیم

من ئەتوانم سیستەمی پۆست بەکار بێنم

	5	4	3	2	1	
بەتەواوی لەگەڵیم	○	○	○	○	○	بەتەواوی لەگەڵی نیم

بەکارهێنانی سیستەمی پۆست لەژێر کۆنترۆلی خۆمدایە

	5	4	3	2	1	
بەتەواوی لەگەڵیم	○	○	○	○	○	بەتەواوی لەگەڵی نیم

من پلانی بەکارهێنانی سیستەمی پۆست م هەیە

	5	4	3	2	1	
بەتەواوی لەگەڵیم	○	○	○	○	○	بەتەواوی لەگەڵی نیم

من نیازی بەکارهێنانی سیستەمی پۆست م هەیە لە داهاتوویەکی نزیکدا

	5	4	3	2	1	
بەتەواوی لەگەڵیم	○	○	○	○	○	بەتەواوی لەگەڵی نیم

هەولی بەکارهێنانی سیستەمی پۆست م هەیە لە داهاتوویەکی نزیکدا

	5	4	3	2	1	
بەتەواوی لەگەڵیم	○	○	○	○	○	بەتەواوی لەگەڵی نیم

Appendix 6 The Preliminary questionnaire

Sara Mohammed Amin.

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Email: sara.muhamadamin@hud.ac.uk

25 July 2014

Dear sir/madam

We, Sara Mohammed Amin, are undertaking a research project to determine the viability of a location based identification system. To this end we kindly request that you complete the following short questionnaire regarding your experience of finding a given location using the devised postcode. It should take no longer than 10 minutes of your time. Your response is of the utmost importance to us.

Please do not enter your name or contact details on the questionnaire. It remains anonymous.

Should you have any queries or comments regarding this survey, you are welcome to contact us by telephone at + 441484472336 or e-mail us at sara.muhamadamin@hud.ac.uk.

Yours sincerely

Sara

Section A: Background information

This section of the questionnaire refers to background or biographical information. Although we are aware of the sensitivity of the questions in this section, the information will allow us to compare groups of respondents. Once again, we assure you that your response will remain anonymous. Your cooperation is appreciated.

Please answer the following questions by crossing (x) in the relevant block or writing down your answer in the space provided.

1. Gender: Male ☐ Female ☐

2. Age: Under 18 ☐ 18 to 34 ☐ 35 to 64 ☐ 65 or over ☐

3. Ethnicity: Arabic ☐ Kurdish ☐ Turkman ☐ Other ☐

4. How would you describe your economic status?

☐ Below average ☐ Average ☐ Above average ☐ Affluent

5. Your highest educational standard?

☐ None ☐ School ☐ Undergraduate ☐ Postgraduate ☐ PhD

6. How would you describe the area in which you are residing?

☐ Urban ☐ Suburban ☐ Rural

7. How would you describe your employment status

☐ Unemployed ☐ Private Sector ☐ Public Sector ☐ Student ☐ Retired

Section B: Address information

The following questions relate to the addressing system used in Erbil.

Please answer the following questions by crossing (x) in the relevant block or writing down your answer in the space provided.

8. Do you or have you used the current postcode system used in the city of Erbil

☐ Yes ☐ No

9. If yes, describe how satisfied you are with the addressing system.

☐ Very satisfied ☐ Satisfied ☐ Neutral ☐ Dissatisfied ☐ Very Dissatisfied

10. What is the reason for your level of satisfaction/dissatisfaction? Select all that apply

☐ It is easy to remember.....

☐ It is difficult to remember.....

I cannot find a location from the address.....

I can easily find a location from the address.

The address system is too complicated.....

I have no particular reason.....

Other reason.....

I have no interest in the address system.....

If you can, please provide a Reason for why you have no Interest in the postcode system

11. Do you use the postcode in combination with a more detailed address

Yes No

12. Do you use an address without a postcode

Yes ☐ No ☐

13. Could you find the approximate location of an address from a given postcode

Yes ☐ Yes but only for specific postcodes ☐ No ☐

Please answer the following questions by crossing (x) in the relevant block or writing down your answer in the space provided.

14. Do you know the postcode for your place of residence

Yes ☐ No ☐ N/A ☐

15. Do you know the postcode for your place of work or study

Yes ☐ No ☐ N/A ☐

16. Would you like to see the current postcode addressing system replaced by an easier/better system?

☐ Yes ☐ Maybe ☐ No

17. If the current system was to be replaced by an easier system, would you be prepared to use it?

☐ Yes ☐ Maybe ☐ No

Section C: Comparing Postcode Systems

Please answer the following questions by crossing (x) in the relevant block or writing down your answer in the space provided.

The following questions relate to the current postcode addressing system used in Erbil and an alternative postcode addressing system.

18. Given the two postcodes A and B, which format would you prefer? Both formats represent a place within the Citadel

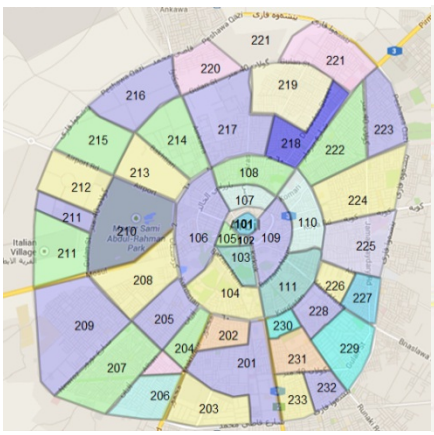
A.

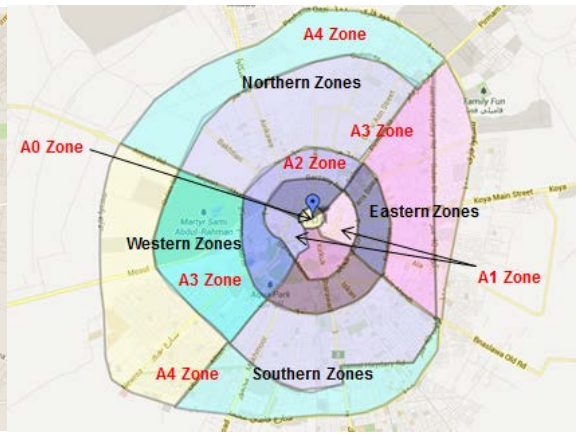
Arbil code	Zone and neighbourhood	Alley	Property
5-digits	3-digits	3-digits	2-digits

44001-108-001

(**44001108001**)

☐





B.

Arbil code	Zone	Direction	Alley	Property
1-digits	1-digit	1-digit	2-digits	2-digits

A-2-1-AA

(**A2 1AA**)

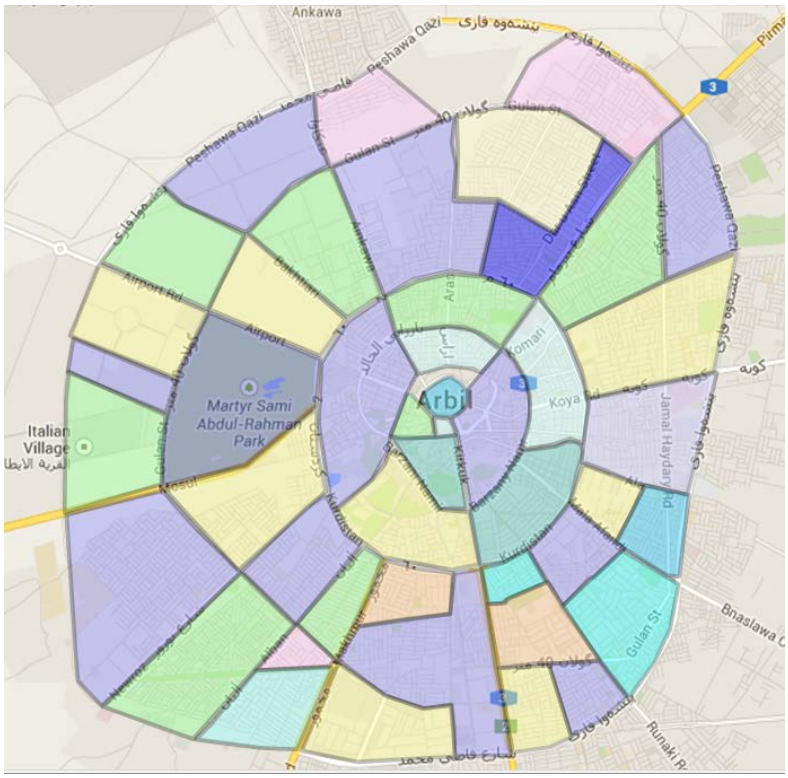
☐

19. For what reason do you prefer postcode A or B

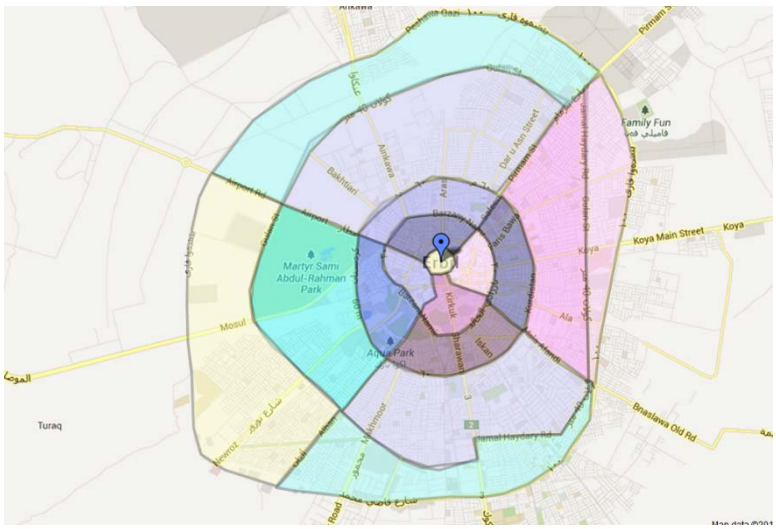
Sec

Please complete the test by finding the approximate location on the map of the specified postcodes.

1: “44001107100” 2: “44001231100” 3: “44001219100”



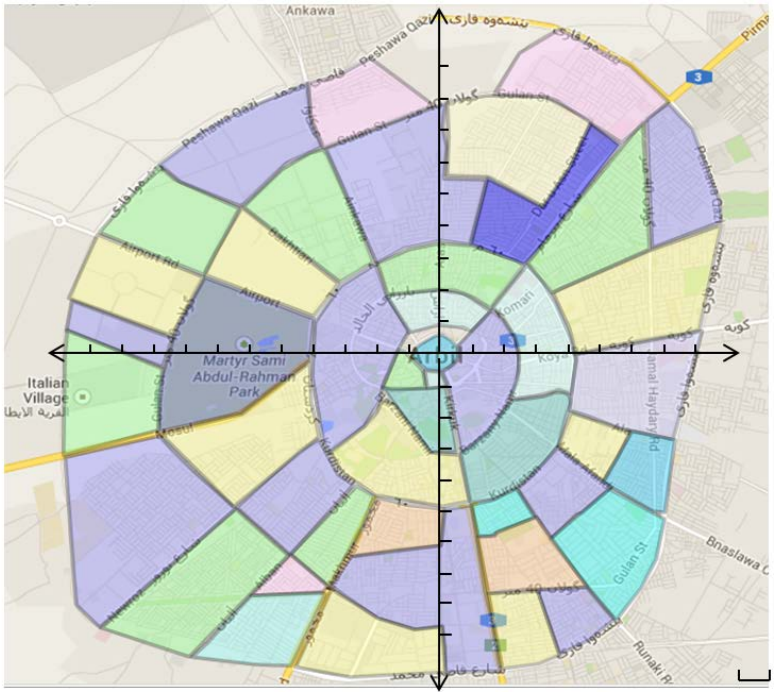
1: “A3 1AA” 2: “A2 3BA” 3: “A3 7BC”



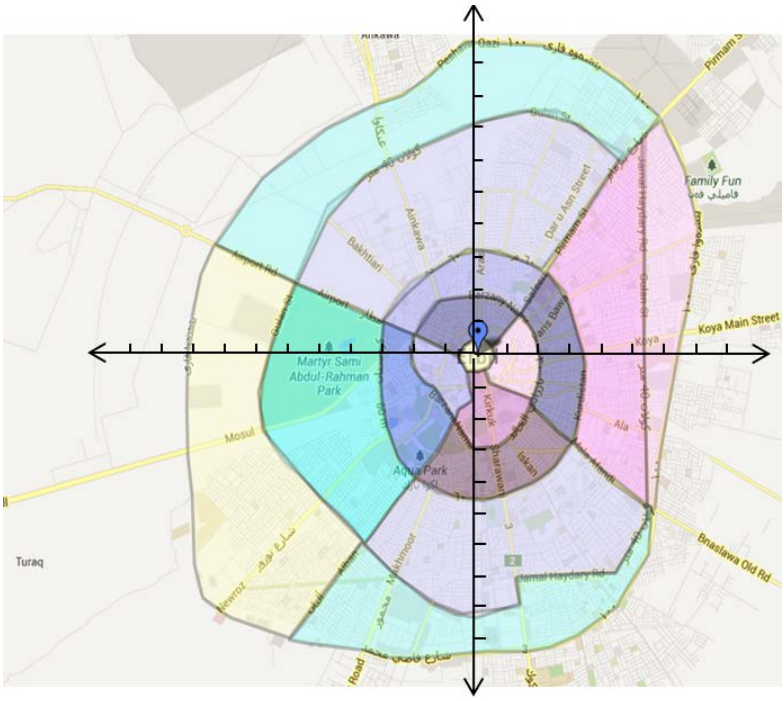
Section E: A simple Test

Please complete the test by estimating the distance and direction of the specified postcodes.

1: “44001115100” 2: “44001200100” 3: “44001179100”



1: “A1 5AA” 2: “A3 1BA” 3: “A4 3BC”



Section F: Feedback

If you can, please provide us with any feedback you can offer about the postcode systems and the questionnaire you have completed.

20. Do you have any recommendations for changing or improving the existing postcode system

21. Do you have any recommendations for changing or improving the proposed postcode s

Appendix 7 The results of Preliminary questionnaire

This section is concerned with the preliminary questionnaire that was conducted in July 2014. The survey intent was to gather information from KRI's citizens about LBI systems in general and their views about the proposed SR_LBI technique. The survey has been conducted in a group meeting, by explaining the meaning of LBI systems in general and the SR_LBI technique in particular, since most of the participants were not familiar with LBI system. For each group discussion, the explanation of LBI and SR_LBI took at least 20 minutes and an extra 12 minutes for answering the questions. A total of 8 group discussions have been made and only 55 participants successfully filled out the questionnaire. The collected data represented a general view about LBI system by the citizen of the region.

According to the results of the first survey, a plan was made to publish a second survey. The new survey focused on the KRI students who were studying in developed countries where LBI systems were active. The reason for this selection was to collect data from people who are familiar with LBI systems. The preliminary questionnaire has been presented in appendix 6. The participants were 56% male and 44% female.

Most of the participants (56%) were undergraduate degree holders, as shown in Figure 1. According to age range, the majority of the participants (71%) were between 18 and 34 years old, followed by 13% between 35-64 years, 11% under 18 years and 5% above 64 years old, as shown in Figure 2. The majority of the participants (89%) are using well-known places as a reference to locate their destinations, as presented in Figure 3. The participants were asked about their experience with the current LBI system in the KRI. 50% of them were answered neutrally (neither satisfied nor dissatisfied with the system), as shown in Figure 4. This result represents a lack of knowledge about LBI systems from the participants. However, one third of them were dissatisfied with the current system. Based

on the SR_LBI technique, an alternative alphanumeric LBI systems has been proposed for the KRI. The participants have been asked to choose between the current numeric system and the proposed system. As expected, 89% of them preferred the proposed system to the current system as shown in Figure 5. They justified their choice as the proposed system is short and easy to memorise and remember.

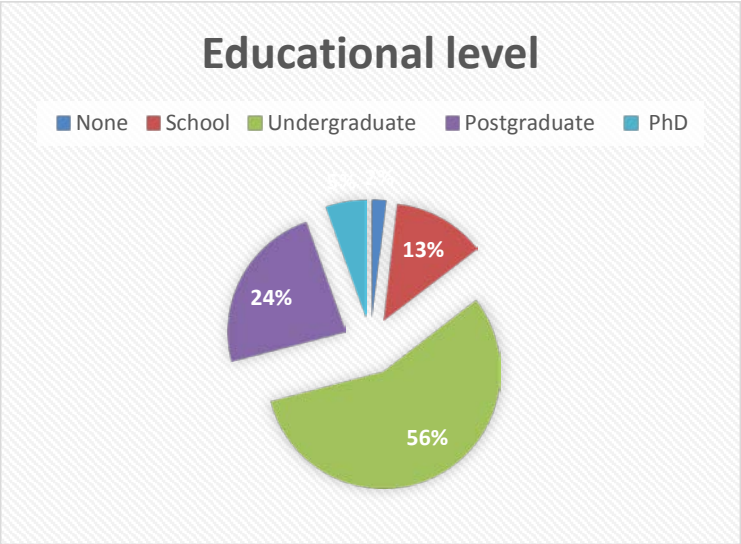


Figure 1 Highest educational standard for the participant

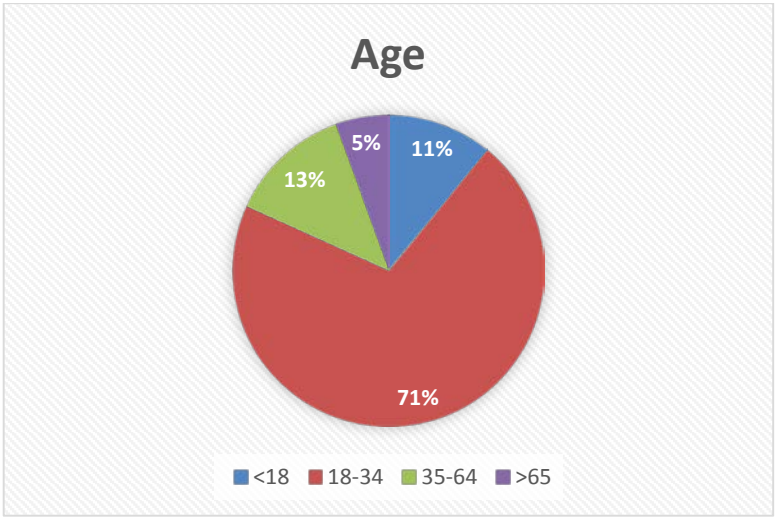


Figure 2 Participant Age

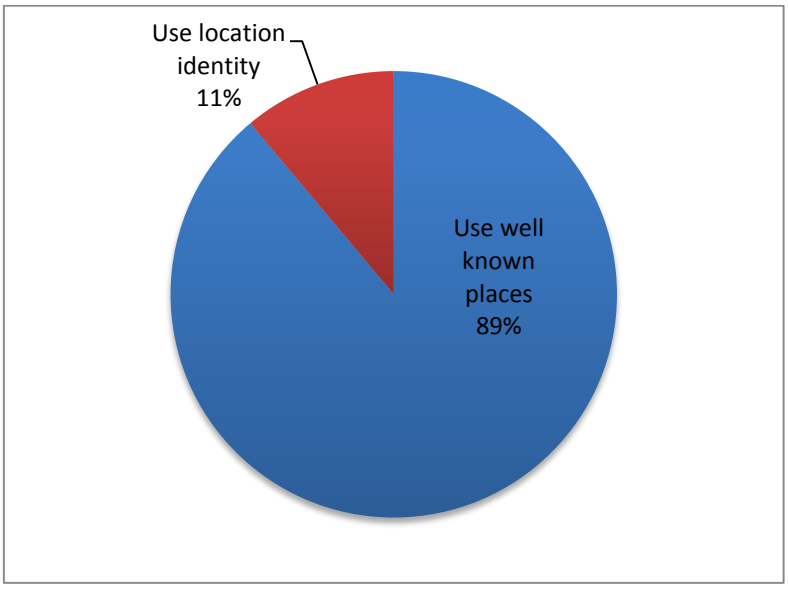


Figure 3 The average of using the available LBI system

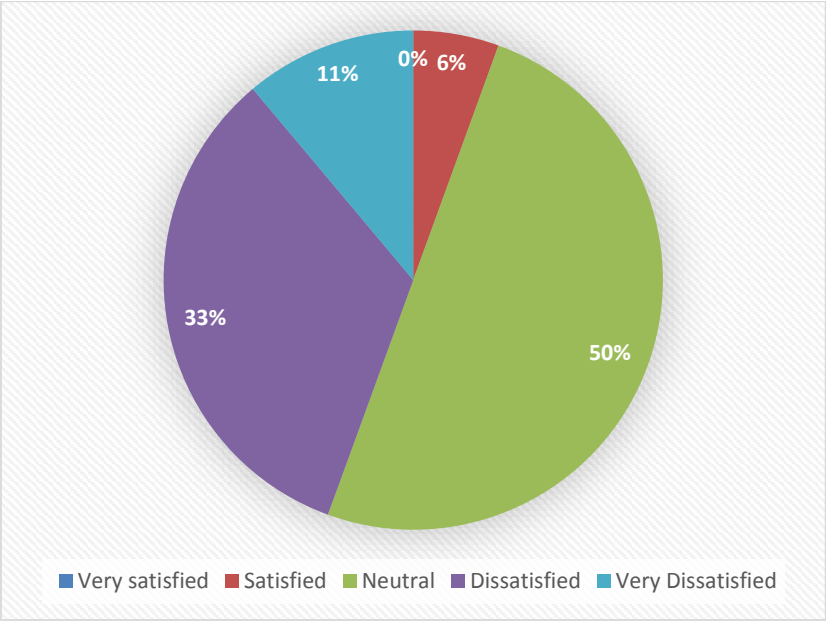


Figure 4 To which extend they are satisfied with the applied LBI system

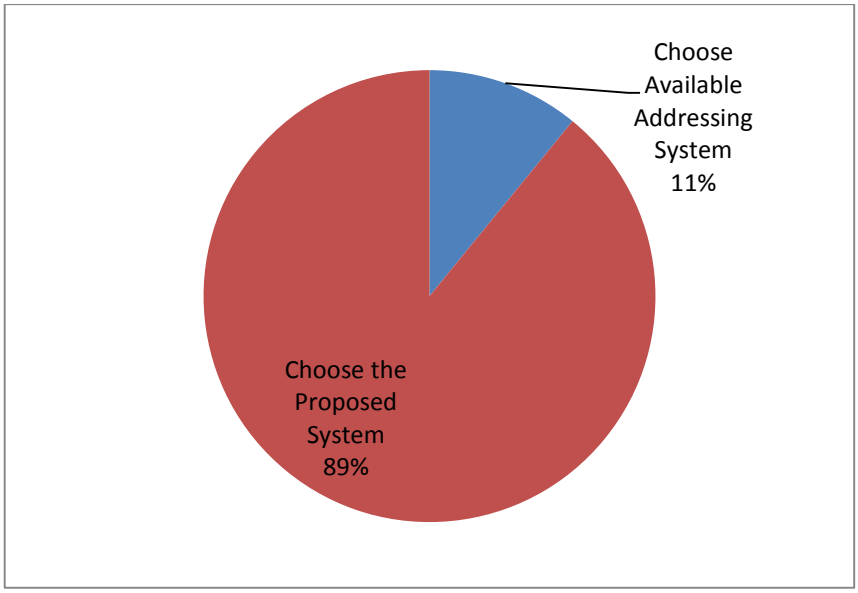


Figure 5 Choosing between an applied LBI and SR_LBI system

Appendix 8 The list of Existing LBI systems

Country	Format	Additional information
Afganistan	NNNN	The first two numbers (from 10-43) identify the province and the last two numbers (from 01-50) identify city delivery zones and (from 51-99) town delivery zones. Ref: 1- MCIT(2011) Introduction of Postal Code System in Afghanistan. 2- **http://mcit.gov.af/en/news/874**
Albania	NNNN	Ref: UPU (2014) http://www.upu.int/fileadmin/documentsFiles/activities/addressingUnit/albEn.pdf
Algeria	NNNNN	http://www.geopostcodes.com/Algeria
Andorra	CCNNN	http://www.geopostcodes.com/Andorra
Argentina	LNNNNLLL	From 1974 to 1998, the first four digits are used and then the ANNNNAAA has been added. The first letter is the province code, then the four old digits, then the last three letters correspond a side of the block. Ref: http://www.upu.int/fileadmin/documentsFiles/activities/addressingUnit/argEn.pdf

Armenia	NNNN	Ref: http://www.geopostcodes.com/Armenia
Australia	NNNN	Ref: http://www.geopostcodes.com/Australia
Austria	NNNN	The postcode indicate the nearest post offices in the area. http://www.geopostcodes.com/Austria
Azerbaijan	CCNNNN	"Azərpoçt - Official website of the Postal Service of Azerbaijan". http://www.azerpost.az/index.php?language=en
Bahrain	NNN, NNNN	The code is known as block number. 101 to 1216 are valid block numbers. The first digit indicates one of Bahrain municipalities. PO can be used without mentioning block number or city name, just PO box followed by country name. Ref: http://postal-codes.net/bahrain
Bangladesh	NNNN	Ref: http://www.geopostcodes.com/Bangladesh
Barbados	CCNNNNN	Ref: http://www.geopostcodes.com/Barbados
Belarus	NNNNNN	http://www.geopostcodes.com/Belarus
Belgium	NNNN	Ref: http://worldpostalcode.com/belgium/
Bhutan	NNNNN	Ref: http://www.geopostcodes.com/Bhutan
Bosnia and Herzegovina	NNNNN	Ref: http://www.geopostcodes.com/Bosnia_Herzegovina

Brazil	NNNNN-NNN	From 1971 to 1992 only the first part was used. In 1992, the last three digits have been added to indicate buildings and post offices. Ref: http://www.correios.com.br/english/the-brazil-post/history-and-facts/inovation
Brunei	AANNNN	Ref: http://www.geopostcodes.com/Brunei
Bulgaria	NNNN	Ref: http://www.geopostcodes.com/Bulgaria
Cambodia	NNNNN	Ref: http://www.geopostcodes.com/Cambodia
Canada	ANA NAN	Ref: http://www.geopostcodes.com/canada
Cape Verde	NNNN	Ref: http://www.geopostcodes.com/Cape_Verde
Chile	NNNNNNN, NNN-NNNN	Ref: http://www.geopostcodes.com/Chile
China	NNNNNN	In China, a postal code is called *youbian.* The first two digits indicate a subordinate division. However, there is no postal system used in Mainland China. Ref: http://www.china.org.cn/english/MATERIAL/120745.htm
Colombia	NNNNNN	Ref: http://www.geopostcodes.com/Colombia
Costa Rica	NNNNN- NNNN	The second part NNNN has been added in 2007. Ref: http://realestateincostarica.org/costa-rica-postal-codes/
Croatia	NNNNN	Ref: http://www.geopostcodes.com/Croatia
Cuba	NNNNN	Ref: http://www.geopostcodes.com/Cuba

Cyprus	NNNN	Ref: http://www.geopostcodes.com/Cyprus
Czech Republic	NNN NN	Ref: http://www.geopostcodes.com/Czech_Republic
Denmark	NNNN	Ref: http://www.geopostcodes.com/Denmark
Dominican Republic	NNNNN	Ref: http://www.geopostcodes.com/Dominican_Republic
Ecuador	NNNNNN	Ref: http://www.geopostcodes.com/Ecuador
El Salvador	NNNN	Ref: http://www.geopostcodes.com/El_Salvador
Egypt	NNNNN	Ref: http://www.geopostcodes.com/Egypt
Estonia	NNNNN	Ref: http://www.geopostcodes.com/Estonia
Ethiopia	NNNN	The postal code system is only used for Addis Ababa addresses. Ref: http://www.geopostcodes.com/Ethiopia
Finland	NNNNN	The code is usually ends with 0 except when indicates the PO box number ranges. The last digit is usually 0, except for postal codes for PO Box number ranges. Ref: http://www.upu.int/fileadmin/documentsFiles/activities/addressingUnit/alaEn.pdf
France	NNNNN	Ref: http://www.upu.int/fileadmin/documentsFiles/activities/addressingUnit/fraEn.pdf

Georgia	NNNN	Ref: http://www.geopostcodes.com/Georgia
Germany	NNNNN	The codes also known as Postleitzahl (PLZ), first introduced after the German reunification. Ref: http://www.geopostcodes.com/Germany
Greece	NNN NN	Ref: http://www.geopostcodes.com/greece
Guatemala	NNNNN	The first two digits indicate the department, the third digit the route and the last two digits the post offices. Ref: http://www.geopostcodes.com/Guatemala
Guinea	NNN	Ref: http://www.geopostcodes.com/Guinea
Guinea Bissau	NNNN	Ref: http://www.geopostcodes.com/Guinea_Bissau
Haiti	NNNN	Ref: http://www.geopostcodes.com/Haiti
Honduras	CCNNNNN	Ref: http://www.geopostcodes.com/Honduras
Hungary	NNNN	A single code defines an settlement (or more than one settlements) except the six largest towns. Ref: http://www.geopostcodes.com/Hungary
Iceland	NNN	Ref: http://www.geopostcodes.com/Iceland
India	NNNNNN, NNN NNN	Ref: http://www.geopostcodes.com/India
Indonesia	NNNNN	Ref: http://www.geopostcodes.com/Indonesia

Iran	NNNNNNNN NN	Ref: http://www.postcode.post.ir/_Geography/Documents/postal%20code.%20PDF.pdf
Iraq	NNNNN	Ref: http://www.geopostcodes.com/iraq
Ireland	ANN ANAN, ANN AANN, ANN ANAA, ANW ANAN, ANW AANN, ANW ANAA. Note: 'W' is the letter W	The postcode of Ireland (Eircode) is designed to indicate the individual properties rather than streets/areas. The first three characters indicate the area (city or town) and the second four characters indicate an individual properties. Ref: https://www.eircode.ie/
Israel	NNNNNNN	Ref: http://www.geopostcodes.com/Israel
Italy	NNNNN	Ref: http://www.europacco.com/en/postal-code/italy.php
Jamaica	NN	Ref: http://jamaicapost.gov.jm/corporate_news/press_releases/july18.htm
Japan	NNN-NNNN	Ref: http://www.geopostcodes.com/Japan
Jordan	NNNNN	The codes indicate PO Boxes only. Ref: http://www.geopostcodes.com/Jordan
Kazakhstan	NNNNNN	Ref: http://www.geopostcodes.com/Kazakhstan
Kenya	NNNNN	The codes indicate PO Boxes only. Ref: http://www.geopostcodes.com/Kenya

Korea, South	NNNNN	Previously NNN-NNN (1988~2015), NNN-NN (1970~1988) Ref: http://www.upu.int/fileadmin/documentsFiles/activities/addressingUnit/korEn.pdf
Kuwait	NNNNN	The codes indicate PO Boxes only. Ref: http://www.geopostcodes.com/Kuwait
Kyrgyzstan	NNNNNN	Ref: http://www.geopostcodes.com/Kyrgyzstan
Laos	NNNNN	Ref: http://www.geopostcodes.com/Laos
Latvia	CC-NNNN	Ref: http://www.geopostcodes.com/Latvia
Lebanon	NNNNN, NNNN NNNN	The first four numbers indicate the region or postal zone and the last four numbers indicate the buildings. Ref: http://www.upu.int/fileadmin/documentsFiles/activities/addressingUnit/lbnEn.pdf
Lesotho	NNN	Ref: http://www.geopostcodes.com/Lesotho
Liberia	NNNN	http://www.geopostcodes.com/Liberia
Lithuania	CC-NNNNN	Ref: http://www.geopostcodes.com/Lithuania
Luxembourg	NNNN	Ref: http://postal-codes.net/lebanon_postal_codes/
Macedonia	NNNN	Ref: http://www.geopostcodes.com/Macedonia
Madagascar	NNN	Ref: http://www.geopostcodes.com/Madagascar

Malaysia	NNNNN	Ref: https://youbianku.com/files/upu/MYS.pdf
Maldives	NNNNN	Ref: https://youbianku.com/files/upu/MDV.pdf
Malta	AAA NNNN	Ref: https://youbianku.com/files/upu/MLT.pdf
Mauritius	NNNNN	Ref: https://youbianku.com/files/upu/MUS.pdf
Mexico	NNNNN	Ref: http://www.upu.int/fileadmin/documentsFiles/activities/addressingUnit/mexEn.pdf
Moldova	CCNNNN, CC-NNNN	Ref: https://youbianku.com/files/upu/MDA.pdf
Monaco	980NN	The French addressing system is used with MC prefix. The code range 98000-98099. Ref: https://youbianku.com/files/upu/MDA.pdf
Mongolia	NNNNNN	Ref: https://youbianku.com/files/upu/MNG.pdf
Montenegro	NNNNN	Ref: http://www.upu.int/fileadmin/documentsFiles/activities/addressingUnit/mneEn.pdf
Morocco	NNNNN	Ref: https://youbianku.com/files/upu/MAR.pdf
Mozambique	NNNN	Ref: https://youbianku.com/files/upu/MOZ.pdf
Myanmar	NNNNN	Ref: https://youbianku.com/files/upu/MMR.pdf
Nepal	NNNNN	Ref: http://www.geopostcodes.com/Nepal

Netherlands	NNNN AA	The four digits define an area and the last two letters indicate PO boxes, offices, a group of habitations or factories. Ref: http://www.upu.int/fileadmin/documentsFiles/activities/addressingUnit/nldEn.pdf
New Zealand	NNNN	Ref: https://youbianku.com/files/upu/NZL.pdf
Nicaragua	NNNNN	Ref: https://youbianku.com/files/upu/NIC.pdf
Niger	NNNN	Ref: https://youbianku.com/files/upu/NER.pdf
Nigeria	NNNNNN	Ref: https://youbianku.com/files/upu/NGA.pdf
Norway	NNNN	Ref: https://youbianku.com/files/upu/NOR.pdf
Oman	NNN	The codes Indicate P.O. Boxes only. Ref: https://youbianku.com/files/upu/OMN.pdf
Pakistan	NNNNN	Ref: https://youbianku.com/files/upu/PAK.pdf
Palestine	NNN	Ref: http://www.geopostcodes.com/Gaza
Panama	NNNN	Ref: http://www.upu.int/fileadmin/documentsFiles/activities/addressingUnit/panEn.pdf
Papua New Guinea	NNN	Ref: https://youbianku.com/files/upu/PNG.pdf
Paraguay	NNNN	Ref: https://youbianku.com/files/upu/PRY.pdf
Peru	NNNNN, CC NNNN	Ref: http://www.upu.int/fileadmin/documentsFiles/activities/addressingUnit/perEn.pdf

Philippines	NNNN	Ref: https://youbianku.com/files/upu/PHL.pdf
Poland	NN-NNN	Ref: http://www.geopostcodes.com/Poland
Portugal	NNNN-NNN	Ref: https://youbianku.com/files/upu/PRT.pdf
Romania	NNNNNN	Ref: https://youbianku.com/files/upu/ROU.pdf
Russia	NNNNNN	Ref: http://www.geopostcodes.com/Russia
Saint Lucia	LCNN NNN	The first two characters are always LC. Ref: https://youbianku.com/files/upu/LCA.pdf
Saint Vincent and the Grenadines	CCNNNN	Ref: http://www.upu.int/fileadmin/documentsFiles/activities/addressingUnit/vctEn.pdf
Samoa	CCNNNN	Ref: http://www.geopostcodes.com/Samoa
Saudi Arabia	NNNNN-NNNN, NNNNN	NNNNN for PO Boxes. NNNNN-NNNN for home delivery. Ref: http://www.esri.com/news/arcnews/winter1011articles/saudi-arabia.html http://www.upu.int/fileadmin/documentsFiles/activities/addressingUnit/sauEn.pdf
Senegal	NNNNN	Ref: https://youbianku.com/files/upu/SEN.pdf
Serbia	NNNNN	Ref: https://youbianku.com/files/upu/SEN.pdf

Singapore	NNNNNN	Each building has its own code. Ref: https://youbianku.com/files/upu/SGP.pdf
Slovakia	NNN NN	Ref: http://www.geopostcodes.com/Slovakia
Slovenia	NNNN, CC-NNNN	Ref: http://www.geopostcodes.com/Slovenia
Somalia	AA NNNNN	Ref: https://youbianku.com/files/upu/SOM.pdf
South Africa	NNNN	Ref: https://youbianku.com/files/upu/ZAF.pdf
Spain	NNNNN	The first two numbers indicate the province, ranged 01-52 Ref: http://www.upu.int/fileadmin/documentsFiles/activities/addressingUnit/espEn.pdf
Sri Lanka	NNNNN	Ref: https://youbianku.com/files/upu/LKA.pdf
Sudan	NNNNN	Ref: https://youbianku.com/files/upu/SDN.pdf
Swaziland	ANNN	The first letter indicates one of the four districts of Swaziland. Ref: https://youbianku.com/files/upu/SWZ.pdf
Sweden	NNN NN	Starts from 100 00 and the highest number is 984 99. Ref: https://youbianku.com/files/upu/SWE.pdf
Switzerland	NNNN	Ref: http://www.upu.int/fileadmin/documentsFiles/activities/addressingUnit/cheEn.pdf

Tajikistan	NNNNNN	Retained system from former Soviet Union. Ref: https://youbianku.com/files/upu/TJK.pdf
Tanzania	NNNNN	Ref: https://youbianku.com/files/upu/TZA.pdf
Thailand	NNNNN	Ref: http://www.upu.int/fileadmin/documentsFiles/activities/addressingUnit/thaEn.pdf
Trinidad and Tobago	NNNNNN	The first two numbers define a district from 72 districts. The next two numbers indicate a carrier route and the last two numbers indicate a building or a zone. Ref: https://youbianku.com/files/upu/TTO.pdf
Tunisia	NNNN	Ref: https://youbianku.com/files/upu/TUN.pdf
Turkey	NNNNN	The first two numbers indicate the city. Ref: https://youbianku.com/files/upu/TUR.pdf
Turkmenistan	NNNNNN	Ref: https://youbianku.com/files/upu/TKM.pdf
Ukraine	NNNNN	Ref: https://youbianku.com/files/upu/UKR.pdf
United Kingdom	A[A]N[A/N] NAA	Ref: http://www.upu.int/fileadmin/documentsFiles/activities/addressingUnit/gbrEn.pdf
United States	NNNNN, NNNNN-NNNN	Ref: http://www.upu.int/fileadmin/documentsFiles/activities/addressingUnit/usaEn.pdf
Uruguay	NNNNN	Ref: http://www.geopostcodes.com/Uruguay

Uzbekistan	NNNNNN	Ref: https://youbianku.com/files/upu/UZB.pdf
Venezuela	NNNN, NNNN-A	Ref: https://youbianku.com/files/upu/VEN.pdf
Vietnam	NNNNNN	Ref: https://youbianku.com/files/upu/VNM.pdf
Zambia	NNNNN	Ref: http://www.upu.int/fileadmin/documentsFiles/activities/addressingUnit/zmbEn.pdf