Information Technology Disaster Recovery Plan (IT DRP) Framework – A study on IT Continuity for Smart City in Abu Dhabi Smart Government

خطة آلية العمل لاستمرارية واستعادة تكنولوجيا المعلومات والاتصالات في حالات الكوارث - استمرارية تكنولوجيا المعلومات والاتصالات في حكومة أبوظبي الذكية

by

LINDA KHALED MOHAMMED AL HASSAN

A thesis submitted in fulfilment

of the requirements for the degree of

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Dr.Khaled Shaalan

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The British University in Dubai

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Abstract

The growth in urbanization in the world of today in unprecedented, supported with information technology to meet the growing demands of the humankind. Over the years, technology application in various fields of business has increased, with one such concept been seen in the form of smart cities. The heavy reliance on technology today has facilitated governments to improve public services and achieve satisfaction amongst its users. Similarly for businesses, it has boosted global communication, trade and development. However, the reliance on information technology has also increased the challenges with one such being disaster recovery. In this research study, the aim was to develop a IT DRP framework to support the Abu Dhabi Government in the initiatives of smart city services to assure its system and IT continuity.

An extensive literature review was conducted to identify the key parameters that dictate the efficiency of an IT framework, and the challenges, barriers and risks that are involved in securing IT disaster recovery. Past literature in the area of smart cities and information technology had led to the identification of the gap of IT disaster recovery which is found missing. While a large extent of the literature deals with securing firms in the event of a natural disaster, however, no significant finding was made in terms of a well-developed IT disaster recovery framework. This applies especially in the area of public services such as those offered by Abu Dhabi Smart City. Also, given the focus of the past researchers on IT continuity for corporates, this research study design was framed to incorporate the case of Abu Dhabi Smart City.

Based on the factors identified in the literature review, i.e. factors influencing smart city services and the components of IT disaster recovery, a conceptual framework was developed. The concept was reviewed and examined in light of the past literature in the area of IT disaster recovery and the challenges or barriers that restricted their application in smart city services. A quantitative method was adopted as the research design for data collection from experts, IT professionals and policy makers from Abu Dhabi Government, UAE as the sample. A detailed

statistical analysis was conducted to identify the relationships between the key variables i.e. smart city services and IT DRP and how the framework can be implemented in case of an IT disaster to secure IT services continuity.

Upon data analysis, the researcher was able to identify the core components of IT DRP and Smart city which were then conjoined together to formulate the revised framework. Post review of each individual factor, correlation testing and hypothesis testing was conducted that examined the relationship between smart city variables and IT DRP variables. The analysis revealed that all the components of IT DRP and Smart city are inter-connected.

As per the findings from the responses of the IT personnel associated with smart city projects in Abu Dhabi Government and the analysis of data, distinct from data validation, some additional factors are discovered. Based on this, few changes are made to the framework which involves addition of new factors and removal of less dominant factors from the framework for smart city IT DRP. The new comprehensive framework for smart city IT DRP for smart government services was tested as well as evaluated for validity. It was found that the framework proposed with the subcomponents of IT DRP and Smart city have a strong relationship when integrated together.

After conducting the research and drawing important conclusions, the researcher offers recommendations for policy makers as well as researchers. The government can adopt the proposed framework for analysis of the numerous external factors having the potential to impact the plans in one way or the other and to devise more intelligent plans and strategies accordingly. In case of academic researchers, his study suggests to investigate on how to identify and then manage the identified stakeholders effectively for better results. They can look into the details of how by keeping in view the specific needs of the public, government can formulate more effectual policies to administer such large ICT projects. They can explore the different techniques adopted by the government entities and how they determine the order in which they execute their different tasks. It is suggested that they should look into the several facets of this smart city project so as to make planning in compliance. It is also recommended that the organizations and government should constantly monitor their security systems to avoid any sort of data breach and keep them up to date.

Keywords: IT Disaster Recovery, Smart City, ICT, Disaster Recovery Planning, IT Continuity, IT Disaster

ملخص

شهد العالم تنامياً سريعاً لم يسبق له مثيل نحو التمدن عن طريق الدعم في مجال تكنولوجيا المعلومات والاتصالات لمواكبة الطلب المتنامي من البشر. وعلى مر السنين زاد الطلب علي تطبيق التكنولوجيا في مختلف مجالات الأعمال، وأحد هذه المفاهيم هي المدن الذكية. وقد ساعد الاعتماد الشديد على التكنولوجيا اليوم الحكومات على تحسين الخدمات العامة وتحقيق الرضا لدى مستخدميها. وبالمثل بالنسبة للشركات، فقد عززت الاتصالات العالمية والتجارة التنمية. بيد أن الاعتماد على تكنولوجيا المعلومات قد زاد أيضا من التحديات التي تواجهها عملية من بينها التعافي من الكوارث. في هذه الدراسة البحثية، كان الهدف هو تطوير إطار تكنولوجيا المعلومات لدعم حكومة أبوظبي في مبادرات خدمات المدن الذكية لضمان استمرارية النظام وتكنولوجيا المعلومات. وقد جرى استعراض موسع للأبحاث السابقة لتحديد المعايير والعناصر الرئيسية لتحديد كفاءة إطار إستمرارية تكنولوجيا المعلومات والتحديات والمخاطر التي ينطوي عليها تأمين استرداد الأنظمة والبرامج في حالات الكوارث.

وقد أدت الدراسات السابقة في مجال المدن الذكية وتكنولوجيا المعلومات إلى التعرف على الفجوة والثغرات في التعافي من الكوارث في تكنولوجيا المعلومات، على الرغم من أن كثيراً من الدراسات قد تناولت تأمين المؤسسات في حالة وقوع كارثة طبيعية، إلا أنه لم يتم التوصل إلى نتائج هامة تؤدي الي استنتاج إطارعمل متطور لتكنولوجيا المعلومات في مجال التعافي من الكوارث. وهذا ينطبق بشكل خاص في مجال الخدمات العامة مثل تلك التي تقدمها مدينة أبوظبي الذكية. ونظرا لتركيز الدراسات السابقة على استمرارية تكنولوجيا المعلومات للمؤسسات، فإن هذا البحث يتناول بالدراسة مدينة أبوظبي الذكية. واستنادا إلى العوامل المحددة في استعراض المراجع، العوامل التي تؤثر على خدمات المدن الذكية ومكونات التعافي من الكوارث في تكنولوجيا المعلومات، تم وضع إطار مفاهيمي.

وقد تم استعراض مفهوم " المدينة لذكية" و" خطط استمرارية الاعمال لخدمات تقنية المعلومات والاتصلات" و " التعافي من الكوارث في خدمات تكنولوجيا المعلومات" والتحديات التي تحد من تطبيقها في خدمات المدن الذكية. في هذا البحث تم اتباع المنهج الكمي لجمع البيانات من الخبراء والمتخصصين في مجال تكنولوجيا المعلومات وصانعي القرار كعينة في حكومة أبوظبي، بالإمارات العربية المتحدة. وقد أجري تحليل إحصائي مفصل لتحديد العلاقات بين المتغيرات الرئيسية مثل خدمات المدن الذكية واستمرارية خدمات تكنولوجيا المعلومات وكيف يمكن تنفيذ الإطار في حالة حدوث كارثة في تكنولوجيا المعلومات وتأمين استمرارية الأنظمة والبرامج.

وفقا لنتائج تحليل البيانات، تمكن الباحث من التعرف على العناصر الأساسية لإستمراية خدمات تقنية المعلومات والاتصالات والعناصر الرئيسية للمدينة الذكية، وتم إجراء مراجعة لكل عنصر على حدى، واختبار الارتباط واختبار الفرضيات التي تدرس العلاقة بين متغيرات المدينة الذكية ومتغيرات إستمراية خدمات تقنية المعلومات والاتصالات.

أظهرت نتائج التحليل المستخلصة من ردود الموظفين في حكومة أبوظبي بأن جميع العناصر الأساسية لإستمراية خدمات تقنية المعلومات والاتصالات والعناصر الرئيسية للمدينة الذكية هي مترابطة مع بعضها البعض.

وتم اكتشاف بعض العوامل الإضافية، وبناء على ذلك، تم إجراء بعض التغييرات على الإطار بإضافة عوامل جديدة وإزالة العوامل الأقل تأثيرا من إطار إستمرارية خدمات تقنية المعلومات والاتصالات في المدن الذكية. حيث تم اختبار الإطار الجديد الخاص بإستمرارية خدمات تقنية المعلومات والاتصالات في المدن الذكية وتقييم مدى توافقها حيث بين الإطار المقترح مع المكونات الفرعية التي لديها علاقة قوية عند دمجها معا.

بعد إجراء البحث والتوصل الي الاستنتاجات، قدم الباحث توصيات لصانعي القرار والباحثين. حيث يمكن للحكومة والمؤسسات أن تعتمد الإطار المقترح لتحليل العوامل الخارجية العديدة التي يمكن أن تؤثر على خطط استمرارية أعمال تكنولوجيا المعلومات بطريقة أو بأخرى، وأن تضع خططاً واستراتيجيات أكثر ذكاء وفقا لذلك.

ومن الجانب الأكاديمى، فأن هذه الدراسة تقترح البحث في كيفية تحديد المستفيدين وإدارتهم على نحو فعال للحصول على نتائج أفضل. ويمكنهم النظر في تفاصيل الكيفية من خلال مراعاة الاحتياجات المحددة للجمهور وكذلك الحكومة عن طريق وضع سياسات أكثر فعالية لإدارة هذه المشاريع الكبيرة مع ضمان استمرارية خدمات تكنولوجيا المعلومات والاتصالات في المدن الذكية. ويمكنهم استكشاف التقنيات المختلفة التي تعتمدها الجهات الحكومية وكيفية تحديد ترتيب تنفيذ مهامهم المختلفة. ويقترح البحث أن ينظروا الي جوانب عديدة من مشروع المدينة الذكية لجعل التخطيط لها هو الأمثل. كما أوصى الباحث أيضا بأن تقوم المؤسسات والحكومة بمراقبة أنظمتها الأمنية باستمرار لتجنب أي نوع من إختراق البيانات والاحتفاظ بها.

كلمات البحث: التعافي من كوارث تقنية المعلومات والاتصالات، المدينة الذكية، تكنولوجيا المعلومات والاتصالات، التخطيط للتعافي من الكوارث، استمرارية خدمات تقنية المعلومات والاتصالات.

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List of Abbreviations

AI	Artificial Intelligence
BS 25999	2006 British Standard
CBA	Cost Benefit Assessment
CC	Continuous Computing
CCM	Corporate Continuity Management
CMC	Continuity Management Component
CP	Continuity Planning
CRM	Customer Relationship Management
DCV	Demand Control Ventilation
DR	Disaster Recovery
DRP	Disaster Recovery Planning
EAI	Enterprise Application Integration
ECPC	The Electronic Commerce Policy Committee
EDP	Electronic Data Processing
EM-DAT	Emergency Events Database
ERP	Enterprise Resource Planning
FSC	Financial Resources Component
GCC	Gulf Cooperation Council Countries
GPS	Global Positioning System
HQ	Head Quarters
HVAC	Heating, Ventilation, and Air Conditioning
ICT	Information and Communication Technology
IoT	Internet of Things
IS	Internet Systems
ITSM	IT Service Management
ITSCM IT	Service Continuity Management
ITC	Information Technology Components

IT DRP	Information Technology Disaster Recovery Plan
IT	Information Technology
ITIC	Implementation Component
MIST	Masdar Institute of Science and Technology
MNC's	Multi-national Corporates
MSP	Managed Service Provider
NCB	National Computer Board
NTUC	National Trades Union Congress
OSC	Organizational and Structural Component
PACS	Picture Archiving and Communication System
PC	Personal Computer
PC	Process Components
PEOC	People Components
PPP	Public Private Partnerships
RTO	Recovery Time Objects
SCM	Supply Chain Management
SMEs	Small and Medium Enterprises
SPSS	Statistical Package for the Social Sciences
SPC	Security and Privacy Component
TOE	Technology-Organization-Environment Framework
UAE	United Arab Emirates
USCBP	US Customs and Border Protection

1. INTRODUCTION TO THE RESEARCH

1.1 Introduction

The world of today has witnessed numerous changes and tremendous growth, with ideas transmitted on a global scale and at remarkable pace bringing together the global human system. It is achieved primarily due to the realization of information technology and the globalization in this area. For the modern day firms such as of today, these two elements are vital as it is employed in almost all its elements. Amongst the sections is the area of security or risk planning, which is the major factor behind successful operations. In efforts to bridge the gap between various processes (be it in a company or at state or national level regulations), the concept of being 'Smart' emerged. One such concept is that of smart city, which is defined as *'a city with the capability to keep track of the situations in a city like its environment and the activities and actions of the citizens in certain area'* (Desouza & Flanery 2013). Furthermore, in the smart cities, a prime aspect concerns being up to date on the collection of data about people leading o continuous development and meeting excellence in service delivery. This is addressed through an effective balance of efficient services, higher automation, increased monitoring (of the people, the city and the environment), and most importantly, the city management.

In smart cities, a known trend is achieving transparency in municipal operations and enhancing the city infrastructure for monitoring purposes through development of a sensory network, thereby boosting performance (Ashton, 2009). In addition, it supports improving connectivity in the city through IoT (internet of thing) leading to effective communication with citizens for various city services (Naphade et al., 2011; Tan & Wang, 2010). It is researched that smart city fundamentals are oriented towards capturing data in real time through an intelligent system. Such a system allows integration of various applications which allows environment development for effective land use, improving overall environment of the city, enhancing planning for transportation activities, boosting security for the people and the city, amongst other (Dey, 2015).

Based on the concept of evolution at a continual phase, smart city concept is to support the city development, growth and future expansion, in which IT is the central element. As technology continues to become a more integral part of the system to include operations at every level of the

organization, it also aids to increase the operations of the city, leading to increased accuracy and supporting the government in prevention of crime, disaster management and recovery, emergency management, citizen protection, transportation, social services and urban planning amongst others (KARADA, 2013). Hence, it is said that for smart cities, the concept is closely linked with IT, that boosts the city performance in operations, and improves the overall quality of living through enhanced facilities and services.

With the heavy reliance of smart cities on information technology and its integration for optimal performance, the concept of disaster recovering emerges. Globally, smart cities are gearing up to become IT dependent and to integrate it as a part of their routine processes. This leads to heavy reliance on IT systems and infrastructure which needs high need for availability of the system as well as high recovery capacity in the case an unexpected event or outage. As observed, the planning for IT continuity is interlinked with It disaster recovery planning (DRP) (Anderson, 2008). Disaster recovery planning is a research area which has received an increasing focus in the recent IT publications. It is a crucial component in any process to ensure a critical operation of the organization is available when needed.

Disaster can strike anytime, and the best way to handle it is to be prepared. Many organizations do not realize the importance of DRP and often find DRP more rigorous to implement (Hawkins et al., 2000). Also, a point to note it the reluctance of most organizations to develop a DRP until a disaster occurs. In addition, the occurrence not only effects the organizations' operation, but also causes loss in terms of data, operations, and/or time. For example, the tragic events of September 11, 2001 force organizations to reconsider their outlook towards disaster plans. Such events project DRP as a mandatory requirement for all organizations considering the heavy reliance on IT. It was rather a "wake up call" for most global organization that clearly understood the importance of DRP. Past events such as the one discussed above have played a fundamental role in leading firms to integrate an information technology DRP in order to ensure the system competence when needed (such as in event of a disaster) (Scigliano, 2002). As stated by Snedaker (2013), IT DRP is no longer an option as of today, it forms an essential part of organizations (as of today) in order to operate successfully. It signifies that role of reliable IT services as an integrated aspect of operations, in both public as well as private sector. Ensuring the continuity of such IT services in organizations, the need for an effective DRP is noted.

IT DRP basically can be explained as an all-inclusive documentation of well-planned actions that are to be arranged before, during, and after a calamitous event (Scigliano, 2002). Also, it can be defined as a well-documented action based process that guides an organization to IT disaster recovery, while protecting its IT infrastructure (pre, during and post disaster) (Sahebjamnia et al. 2015). Similarly, to apply IT DRP in a smart city, there is a requirement for usage of different technologies to meet the high standards and complexities in operations. In smart cities, organizations have to use advanced IT services and systems to integrate their processes effectively, in lower time and high speed (Asimakopoulou & Bessis 2011).

In view of IT and DRP in smart cities, a need for clear DRP & framework is noted to support organizations in smart cities such as in Abu Dhabi, United Arab Emirates to achieve efficient and fast recovery of operations. While the concept of a smart city is extensive, it cannot be limited in nature to just one firm. It involves different firms and different sectors (both private/public) with capacity to implement the advancements in technology to provide reliable services to the people. These sectors (all) play a crucial role the development of smart city through the integration of efficiency within the functions and also, the inclusion of reliable and fast technologies. Figure 1.1 illustrates the areas where smart city is used. Each of the areas under smart city is interlinked and interconnected with each other through IT framework that allows each area to quickly exchange /share /review information with ease (Derudder, 2012). In the occurrence of an emergency or a disaster, the IT framework is hindered thereby effecting the communications partially or total halt. In such a situation, the areas of the smart city requires a strong DRP that protect the information technology system and ensures quick recovery with a high level of security.

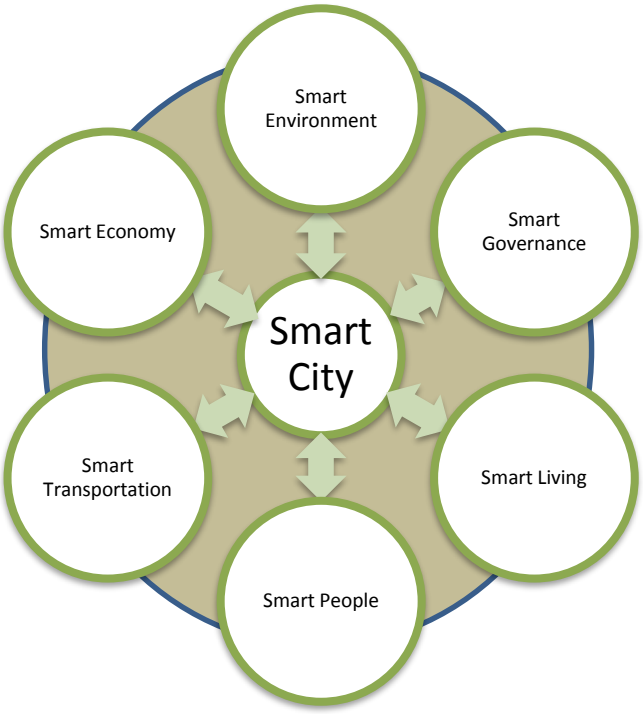

Figure 1.1: Areas of Smart City

Source: (Derudder, 2012)

The research conducted in the area of smart city disaster recovery, almost negligible research is found. From the concept of smart city development which is witnessing a significant growth, the role of governments in its development through strategic goals setting is also noted (Derudder, 2012). The United Arab Emirates (UAE) is one of those countries wherein the ruling government has identified the necessity to smart cities in order to become a smart economy. In the same perspective, the development of UAE in the form of a smart economy cannot and the contribution made by smart cities cannot be neglected. To achieve its goals as per its strategic plan, the smart city sector in UAE, focussing on advanced information technologies and services integration, under the government. One such initiative is the Smart Dubai, launched under the vision of the Ruler of Dubai (Smart Dubai, 2017). By analysing the smart city initiatives in the UAE and the areas under focus (as listed in figure 1.1), the government of UAE has taken the above initiative through the proposition of modern IT inclusion in the core areas to as a unified effort to achieve its national strategy. Within the technology dilemma in smart cities, as highlighted by Bhaskar (2014), it is found that the GCC (Gulf Cooperation Council Countries) countries including the UAE require an information technology plan on long-term supported

with training in order to efficiently protect/maintain its data, security, storage and backup recovery and also, challenges associated with development of smart city (Bhaskar 2014). Smart cities, as found earlier, has the potential to improve the communication in the government services and lead to an economic benefit. It is noted that the smart city technology market globally is expected a growth to US 20.2 billion by the year 2020, over USD 6.1 billion as noted in year 2012 (Bhaskar 2014).

1.2 Significance of the Research

The area of IT DRP is of high importance, given the high probability of occurrence of unexpected events that may cause damage to infrastructure and the system, creating a hindrance in system performance and associated services. In smart cities, disaster continuity is linked with IT DRP, with the latter being exposed to risks from events that are both man-made and natural. The question is: is current framework (plan) development to support the smart city concept of Abu Dhabi able to survive any probable IT disaster that may befall the system and overall operations? The study on continuity in general and the role of IT DRP cannot be based on a theoretical aspect, but requires to be rather reviewed in light of the challenges and its relation to smart city. Hence, this research will contribute towards:

1. An extensive performance evaluation of IT DRP in Abu Dhabi Government, UAE through a series of surveys with experts in the field of smart cities.
2. Development of a new IT DRP framework (plan) proposed to improve continuity and security aspects in event of an IT disaster in Abu Dhabi Government.

1.3 Problem Statement

The role of information technology is not hidden especially in the operations function, be it at firm level or industry level. Its role is extended to the core functions, becoming an integration part of today's trade applying a technologically advanced environment. Smart cities are considered as the future, emerging as a dominant industry. Smart cities enable governments to transform into smart governments, connecting all industries through a strong IT framework. In Abu Dhabi, the vision of the government to transform its current economy into a knowledge driven economy is reliant on IT. However, one lingering threat is disruption in the IT systems

and IT services. Emergent disasters effecting IT services and continuity are required to be addressed with a thorough planning. The focus should be developed not only the implementation of recovery operations for IT disasters, but also, pre-disaster planning and future response. While 24x7x365 response is the focus, the need for effective recovery in any unseen emergency or disaster should be reviewed. To enable the areas under smart city in Abu Dhabi with focus on DRP framework, one critical parameter under consideration is the infrastructure integration – a noted challenge for many global smart cities. For advanced IT, the concerns /challenges are noted as technological disasters which reflect the need for developing a reliable IT DRP to manage the technological challenges while maintaining the best quality of service in the Smart City. In this research, the focus is on the IT Continuity Services in Smart City framework for improved governance to be developed for Abu Dhabi Smart City in UAE. IT corporations and IT researchers have proposed the idea of smart cities with focus on specific obstacles (on small scale) such as smart healthcare, smart traffic management system, smart energy, or smart buildings. However, no research was found in the areas of DRP framework development, targeting strengthening of smart cities in general or smart cities in Abu Dhabi. Hence, in this research the aim is to propose and develop an information technology disaster recovery plan to improve smart city performance and quality of the service can be maintained in Smart City. Some of the key emergencies declared in countries from around the world are shared in the table 1.1. As observed, the most prominent of the IT disasters listed is the 2013 healthcare system crash in the US.

Date of declaration	Country Affected	Nature of the Emergency	Effect
2000	Global	Crash of computer systems globally with the beginning of the year 2000, widely known as the Millennium Bug	An estimated amount of £400 billion were spent on the recovery operations (as projected by the house of commons)
2005	Australia	Failure of the cargo system in 2005 at the customs service in Australia	Due to the failure, cargo was left unattended over many days leading to global delays. An overall cost of USD 200 – 250 million were utilized for recovery.
2007	USA	Faulty network card at USCBP (US Customs & Border Protection) led to sharing of incorrect data across the airlines network	Standstill at the Los Angeles airport leading to a grounding of all flights.

2007	Australia	Failure of the health payroll system by the technical failure of the system developed by tech giant IBM, against a contract worth USD 6 million	The failure resulted in mismanagement of salaries of health care professional accounting to 80,000 in Queensland healthcare system.
2013	USA	IT emergency due to failure of the system to accommodate the huge influx of visitors to access health care facilities	Health care services were disrupted leading to heavy dependency of the users on outdated technology
2013	Global	IT emergency due to crash of the widely used worldwide travel reservation system	The global aviation industry was in a shock due to the crash leading to delays and cancellations by over 300 airlines
2017	Global	Ransonware cyber-attack affecting operations of government, private firms, banking institutions globally	The overall network and operations were paralyzed with the cyber-attack, demanding a ransom and threating to leak sensitive private information public.

Table 1.1: Emergencies declared around the World

Source: (Barker, 2017; Financial Review, 2017; Lessware, 2017; Tradearabia.com, 2016; Khaleejtimes.com, 2017; Syria360, 2015; Armitage, 2013)

IT services systems might faces issues that may not have been identified currently, and hence, a backup to protect the IT systems against any unpredictable disaster and sub events is required to be developed by IT managers (Meissner et al., 2002). IT DRP concept is found to be partially integrated with mainstream IT research on smart cities, primarily in terms of services system (Shropshire & Kadlec, 2009; Mohamed, 2014). Many studies are conducted on IT DRP (Omar et al., 2011;Yang et al., 2015) but very few studies provide reliable evidence on the challenges in IT DRP of a smart city system. Considering these gaps, this research study will examine and evaluate the IT DRP of Smart city System in Abu Dhabi Government. The aim is to justify if the government has an effective ITDRP available for its smart city systems and to what level is it implementation. Bhasker (2014) reflects on the findings from World Bank on MENA cities by noting that cities in the Middle East face natural disasters three time more than in the 80's. This requires cities to develop a recovery framework for disasters (which may be human or natural). The findings reflect on the role of IT in development of an effect DRP and how training of the manpower associated can affect its success with least difficulties.

In view of the above consideration, a thorough research of the past literature in the area of DRP will be undertaken to review the level of IT needed to support DRP operations in smart cities. Based on the findings, IT DRP framework will be developed that ensures continuity of IT

services with the system of smart city with high efficient. The research is expected to have practical implications in support to Abu Dhabi, in UAE and act as guidance in ensuring IT continuity through an effective IT DRP framework.

1.4 Rationale for Research Selection

The needs of modern day companies is integrated with IT and any threat that leads to loss of information or hindering the processes can question the overall integrity of the system. As discussed in the section 1.3, IT emergencies are growing to be a prominent threat to firms worldwide, by effecting their operations on a day-to-day basis to causing massive financial losses. The questions here is: 'Can firms continue to function within the challenging corporate environment without critical applications, operations or data?' The rationale for selection of disaster recovery for IT operations as the key theme is primarily the need for continuity in IT operations even during a disaster. The need for an IT DRP framework can arise from IT hardware /software failure, human errors, natural issues or even the requirement of customers for service availability 24x7. However, the main reason for the selection of this research area is the necessity to minimize the potential economic losses arising from the disaster and reducing the disruptions caused in the IT operations, thereby achieving an orderly recovery. Mitigation of IT disasters can only be achieved through a pre-developed plan in place that connects the critical areas of the IT operations during disasters to ensure continuity of services. This research will be a guide for future researchers in expanding the IT DRP framework for smart cities globally, and developing the elements of the framework further to meet the evolving aspects of smart cities of future.

1.5 Aim of the Research

In the research, the aim is to develop a IT DRP framework to support the Abu Dhabi Smart Government in the initiatives of smart city services to assure its system and IT continuity.

In order to achieve this aim, the following research objectives were formulated:

1. To review and compare the existing frameworks in relation to IT DRP and their application in a disaster situation affecting the IT continuity of Abu Dhabi Smart City services.
2. To identify, analyse and evaluate the prime factors in the IT DRP framework of Abu Dhabi government for smart city system in terms of security and IT continuity in even of an IT disaster. This objective aims to understand the benefits and limitations of the current IT DRP system applied for smart cities.
3. To suggest improvements in the current IT DRP framework adopted by Abu Dhabi smart governments to support its Smart Cities through the development of IT DRP plan that can ensure high security and reliability of smart city system during an IT Disaster.

1.6 Research Questions

The following research questions were developed to achieve the above objectives:

1. What is the existing IT DRP framework used for Smart City in Smart Government Services in general and Abu Dhabi smart city in focus?

2. What are the factors that limit the application of the current IT DRP framework of Abu Dhabi Smart City, in terms of safety and efficiency?
3. How can Abu Dhabi Smart City switch to a reliable IT DRP framework without affects its current IT continuity?

The above developed research questions are aimed at assessing the existing frameworks adopted/ implemented by other smart cities globally to ensure a high level of security and reliability of smart system in terms of IT disasters. In addition, the questions will aid in assessing the key aspects of the technology used in smart cities system in general and Abu Dhabi in specific. Based on the literature review conducted, the following hypotheses are developed:

Hypothesis 1	There is a significant relationship between IT DRP components and Smart City Systems components leading to an efficient and effective integrated Smart City IT DRP Model
Hypothesis i	The information technology, People and Process components of Smart City in smart government services has an effect of IT DRP Implementation Component
Hypothesis ii	The information technology, People and Process components of Smart City in smart government services has an effect of IT DRP Continuity Management Component
Hypothesis iii	ITDRP Implementation Component is effected by Smart City Financial Resources Component and Security and Privacy Component in smart government services
Hypothesis iv	The technology knowledge and practice of Smart City Components is related to the Education and Experience level of the IT personnel in smart government services
Hypothesis v	The technology knowledge and practice of IT DRP components is related to the Education and Experience level of the IT personnel in smart government services

In smart cities, as it is noted that every system applies a different technology, the nature of recovery during IT disasters may be different. Hence, the need is to first examine the IT within the Abu Dhabi smart cities system to understand the nature and extent (in effect) of the IT disasters. Also, the effect on the citizens of the smart cities in terms of satisfaction due to service disruption may be evaluated. Based on the findings identified during the analysis, a revised framework for IT DRP will be presented in view of smart cities in general to ensure continuity of IT services through concentration on the most important elements within the framework.

1.7 Research Scope

The scope of this research entails the study of information technology and smart city parameters to develop a framework for IT disaster recovery for smart city in Abu Dhabi. To achieve the aim and address the research problem stated earlier, this research will conduct a detailed review of the existing IT DRP frameworks (globally). A review and evaluation of the factors (identified in the literature review) will be conducted leading to development of the conceptual framework suitable for Abu Dhabi government smart city system in term of IT continuity.

1.8 Thesis Outline

The outline of this thesis is organised as follows:

Chapter 1: In this chapter, a review of the background on Smart Cities and IT disaster recovery is presented, narrowing down to the problem statement and significance. The chapter also presents the key research question and objections along with a summary of chapters in this thesis.

Chapter 2: The literature review presents a detailed review on smarty city and disaster recovery, focussing on information technology and its role in strengthening smart city operations. The concepts and issues covered in this chapter are smart cities, Information technology in smart city, and Disaster recovery plans and its basic concept in smart city along with a conceptual framework.

Chapter 3: The methodology chapter presents the research philosophy and strategy selected for the research on IT DRP in smart cities. The chapter outlines the Research Design and Approach with justification on the selection of quantitative method; followed by the data collection process, research setting, instruments and data analysis.

Chapter 4: The chapter 4 examines the results generated through the aid a statistical evaluation package, allowing the testing of the hypothesis presented in the chapter 1. The chapter presents a detailed discussion on the main findings based on the data collected along with an acceptance or rejection of the hypothesis.

Chapter 5: This chapter revisits the framework developed for an integrated model of IT DRP and smart city, reviewing the validation of the framework and which components were identified to play a dominating role in the success of the framework under execution.

Chapter 6: In this chapter, the conclusion and recommendations for this research study are presented along with the research limitations. The recommendations were developed to support policy makers and academic researchers.

1.9 Chapter Summary

In this chapter, the introduction and background to the research topic was presented, along with the aim and objectives. It also reflected on the research significance and problem statement that led to the identification of this research area on IT DRP in smart cities. In the next chapter, the literature review and conceptual framework is presented.

2 LITERATURE REVIEW AND FRAMEWORK

2.1 Introduction

In this chapter, a methodical literature review has been carried out to identify the various factors of a smart government services and IT DRP. Furthermore, the chapter also discusses the concept of smart city, it evolution, its definition and its characteristics. In order to gain a better understanding of the concept of smart city, the researcher has provided examples of existing smart cities such as Seoul, Abu Dhabi and Singapore. The examples help to understand the concept of smart city and smart government and also the underlying importance of information and communication technology (ICT) for the implementation of a smart city. The chapter also focuses on explaining the Information Technology Disaster Recovery Plan (IT DRP), which is an important component of smart city to keep the smart government services continuous and up and running. IT DRP system is vital in smart city as it enables government and organizations to retrieve back lost data in case of a disaster or disruption, thus allowing to continue serving the client without any delay.

The chapter after explaining in detail what IT DRP stands for and discussing its components, it presents a theoretical framework for IT DRP in smart city. This framework combines the factors of smart government services along with IT DRP factors to propose a new framework with important hypothesis that are discussed in detail, citing relevant studies in that sphere.

2.2 Smart City Concept and its Evolution

The world is transforming at an unimaginable speed, arising new requirements each day. There has been a rise in city population due to movement of individuals from pre-urban to urban areas (Bohli et al., 2015). It is being expected that 70 percent of the world population will start residing in cities by 2050 (Lierow, 2014). A major challenge that is linked with the rising population is the development of smart cities and the role of information technology (IT) (Bohli et al., 2015). There is a widespread presence of information and communications technologies (ICTs) in urban areas and have been acting as a basis for flexibility and long term sustainability of smart cities. ICT has led to empowering the citizens in such a manner that it can create solutions for urban issues (van der Graaf and Veeckman, 2014). The smart cities are the ones that can utilise ICT for

increasing the overall quality of life followed by contributing towards sustainable development (Chourabi et al., 2012).

The evolution of smart cities began in the year 1970 when digital configuration was adopted by urban areas (Ishida and Isbister, 2000) where focus was laid on technology and non-material arrangements that formed the physical spacing of the city. The present focus in now on innovations that has been maintained by broadband networks and intellect that now showcase the growth of city (Elmquist et al., 2009; Schaffers et al., 2011). Several definitions as well as contributory work has been given by research scholars, large corporates, etc. that are driven by globalization where all of them have focussed on describing the adoption of new configuration of local origin (Nam and Pardo, 2011). As per the above introduction, the labels that have been used commonly are of digital or smart city but research scholars are on an agreement with the description of these two labels (Tregua et al., 2015; Shen et al., 2011). Projects that are run by supranational institutions are of the perception that sustainable city is nothing but an evolved smart city. Still, interventions related to smart city have often been criticised on account of inclusiveness issues (Walravens, 2011) as well as breaking of urbanism (Vanolo, 2014) and in general terms using the smart city just as a label (Hollands, 2008). A crucial role is retained by new technology in both the conceptualizations (Feldman and Audretsch, 1999). Review of literature studies further depict that ICT are the representation of infrastructure that shape the digital city whereas ICT in smart city is all about the tools that are used for governing and managing the urban areas so as to improve the services by making use of innovative technologies (Lee et al., 2013; Anttiroiko et al., 2013). There is a presence of two relevant definitions that can be used for describing the conceptualization of smart city.

A smart city is formed when investments made in transport, communication, human and social capital leads to creation of sustainable economic growth, managing natural resources with the help of governance and ensuring higher quality of life (Caragliu et al., 2011, p. 50). The recent rise in interest of smart cities is on account of the concern towards sustainability, increase in internet based technology (Schaffers et al., 2011, p. 434). The working definition of smart city for fulfilment of the purpose of this paper is as follows. Smart city can be defined as those urban settlements that make use of telecommunication technology so as to increase ability to live work and sustain (Deakin, 2013; Chourabi et al., 2012).

The movement towards smart city began after the year 2010 on account of progress in technology and smart services that connects the government with the people (Cocchia, 2014). There has been an acquisition of a centralised role by the smart cities in territorial government and development. The last 10 years have witnessed that developed and emerging nations of the world are changing their administration, applying smart development strategies such as the smart cities to improve the city services and administration (OECD, 2013; Caragliu et al., 2011). These cities have got a presence of more political power and governing takes place in a more autonomous manner. This kind of decentralisation makes the city as one of the most crucial political actors so as to define and implement urban strategies that are of innovative and qualitative origin so as to produce a high quality urban life. The analysis of author about the international literature on innovation carried out in cities depicts that the smart city concept happens on account of investigation and empirical application of urban review.

2.2.1 Definition Analysis of Smart City

There are a number of ways that smart cities have been described and there are a myriad of theoretical alternate adjectives that have been used to replace the word "smart" with intelligent or digital. The term is very frequently used in the programs of the people who make the policy decisions and hence the precise and collective nature of the definition of smart cities is hard to recognize in the wider perspective as an international trend (Chourabi et al., 2012). As described by Hollands (2008), smart city is an “urban labelling” occurrence, and while bringing clarity to the meaning of the term, it stresses on the multiple facets of it that are veiled behind the use of the term. Additionally, there have been various attempts by scholars to exhibit the notion of smart city from different outlooks. For example, Karadag (2013) describes “smart” as an amalgamation of various elements like awareness, memory, constructing, accepting, problem-solving, gaining knowledge, analysing, and decision-making which work in tandem, taking swift measures in order to make proficient decision. Additional studies have presented the following definitions of the term and highlight the appealing perception of smart city and how it augments the quality of life.

Source	Definition
Toppeta (2014)	A smart city endures to integrate Information and Communication Technologies (ICT) and Web 2.0 technology alongside urban planning methodologies so as to locate intelligent, innovative and competent solutions, adding to augmented stability and liveability for its citizens.
Anttiroiko et al., (2013)	A city that highlights a specific notion of a localised community in which the local administration, organisations and the citizens make use of the ICTs to revitalise and reinforce the function of the community towards the service economy and also lead to creating new jobs in the community and hence enhance the standard of living of the members of the community.
Caragliu et al. (2011)	At the point when human and social capital and conventional (transport) and cutting edge (ICT) correspondence foundation fuel reasonable financial development and a high quality and standard of life, alongside an insightful administration of normal assets, through participatory administration.
Lombardi et al. (2012)	The concept of a smart city is often marked by the utilization of information and communications technology (ICT) in the fields of education, social assets and the ecological issues.
Harrison et al., (2010)	A city that establishes the connection between tangible, ICT, social and business infrastructure to influence the cumulative aptitude of the city.
Caragliu et al., (2009)	A city that puts in resources into the social and human capital and the conventional and contemporary (ICT) communication network with an aim to uphold fiscal growth and a better life quality, with a prudent organization of natural resources by the use of inclusive administration.
Holland (2008)	To be an urban area with a major portion of the adult populace who have a college education.
Giffinger et al. (2007)	A city which is innovative and progressive in its fiscal, social, administrative, infrastructure, ecological, communicative outlook with the wise amalgamation of the presence and the working of a sovereign, self-governing and attentive citizens.
Komninos (2006)	Regions with an increased aptitude for acquiring knowledge and modernization, which is based on the foundation of innovation and the ingenuity of its inhabitants, their establishments of education and their communicative infrastructure and digital information administration
Coe et al., (2001)	A city, the inhabitants of which are capable of gaining knowledge, adjust and to use their creative ideas for innovation. Additionally, the citizens are capable of using the innovations and advancements for the good of the community.
Hall et al. (2000)	A city that is able to bring about regulation and integration of all of its imperative infrastructure frameworks – roads, tunnels, bridges, subways, rails, airports, seaports, water, electricity, communication could conduct optimization of resources better, strategize its safety and preventive measures, monitor security and patrolling factors whilst enhancing quality and delivery of services to its citizens.

Table 2.1: Definitions of Smart City

The Table 2.1 show cases that the various definitions of a smart city is predominantly associated with the idea of sustainability and it is not limited to the distribution of ICT, rather it deals with the requirements of the citizens and the community. Nam and Pardo (2012) have emphasized the discrepancy between the notion of a smart city and other associated terminology along the lines of the following three aspects: people, community and technology. From the technological perception, a smart city can be identified as a city which exhibits a major use of ICTs. These technologies have infused into the market-driven utilization into smart inventions and services, artificial intelligence (AI) and machines capable of working smarter. An example of this is a smart home which is furnished with a number of mobile terminals and devices implanted, which work in tandem with the various sensors (Klein and Kaefer, 2008). In circumstances like this, the smart city is an augmentation of the smart space encompassing the whole city. Conversely, there are some uncertainties regarding the technological aspects of a smart city as it emerges from the presence of comparable terms in connection to the notion of the smart city like virtual, ubiquitous, digital and smart. Terms like these allude to a more precise and less comprehensive levels of acuteness and hence the notion of a smart city generally encompasses and build upon them.

Digital city is an area where interaction takes place amongst people followed by sharing of knowledge and information (Schuler, 2002) in digitalised format due to the presence of physical / virtual ICT infrastructure (Dameri and Cocchia, 2013; Schuler, 2002). Green city is the one that focuses on economic development followed by bringing a reduction in pollution and emissions of greenhouse gases so as safeguard the overall atmosphere and biodiversity (OECD, 2010; Batagan, 2011). Knowledge city focuses on developing knowledge and sharing it at the level of individual and institution (Yigitcanlar et al., 2008; Edvinsson, 2006). The above 3 areas have been examined in varied literatures (Dameri, 2014). The different city labels as depicted above emphasize on specific type of issues as depicted in table 2.2 below.

Labels for smart city	Sources	Issues Identified
Intelligent city **Learning city** **Information city** **Knowledge city**	Anthopoulos and Tougountzoglou (2012) OECD (2010) Komninos (2008) Ergazakis et al. (2004)	Information sharing & availability Learning and innovation Knowledge creation / sharing Schooling / education Skills & understanding Awareness of citizens

Digital city **Virtual city** **Wired city**	Hollands (2008) Schuler (2002) Ishida (2002) Qi and Shaofu (2001)	Information Data Communication Internet Interaction Digital communities Broadband Computer & network
Sustainable city **Green city** **Eco-city**	Batagan (2011) OECD (2010) Roseland (1997)	Behaviour of people Green technologies Environmental preservation Green energy
Smart city	Dameri (2013) Caragliu et al. (2011) Giffinger et al. (2007)	Smart people Awareness amongst citizens Smart community Sustainable economic growth High end technology Government participation Quality of city life

Table 2.2: Labels of Smart City and Issues Identified by Past Researchers

Smart city emerges when there is a merging of the above given city concepts thereby differentiating itself from other city models and creating an integrated vision for urban life in terms of economy, government, society, culture, transportation and greenery (Caragliu et al., 2011; Dameri, 2013). Chourabi et al. (2012), Nam and Pardo (2011) and Giffinger et al. (2007) have suggested a smart city framework where there is an integration of the above given aspects so as to create a unique and strategic vision for the future city. In the wake of investigating among various reviews we can characterize the smart city as: A created urban zone that delivers a reasonable financial improvement and makes an ideal place for individuals to live by expanding the personal satisfaction, through exceedingly upgrade of numerous key zones; administration, economy, individuals, environment, versatility and assembled environment. Upgrade of these key ranges can be accomplished through human capital and framework for data and correspondence innovation.

2.2.2 Characteristics of Smart Cities

Smart city has got a significant presence in academic literatures as well as research and is related to many such concepts (digital city, knowledge city, information city, ubiquitous city and

intelligent city). All these have a major emphasis on applying ICT in urban management (Lee and Lee, 2014). The present smart city initiatives have focussed on making use of ICT for increasing the efficiency, transparency as well as accountability in communicating and carrying out dealings between government and general population. ICT has played a very important role in creation of smart cities where a good amount of city investment is used for developing new technologies (Perboli et al., 2014). A smart city is thus able to develop as well as manage innovations that aid in delivery of information to all areas of person's life with the help of applications that are interactive and based on internet (Kuk and Jansson, 2011).

As seen in the figure 2.1, Smart cities has a presence of 6 features being smart economy that has factors such as innovativeness, flexible labour market, entrepreneurship, trademarks, production and worldwide amalgamation (Giffinger et al. 2007; Chatterjee and Kar, 2015; Kumar, 2015). Smart city and its development is linked to creating an urban situation that gives rise to new industrial activities (Bronstein, 2009). The next element of a smart city is smart individuals known by their education, creativeness, open mind set, social and cultural plurality, and flexibility. It is about superiority of communal interactions that occur in cities, being open towards cultures, developing human capital, educating people and role of information and communication technology in improving the participation and reducing digital division (Giffinger et al., 2007). Smart government is about participating in decision-making, services of public and social origin, political approaches and transparent authority.

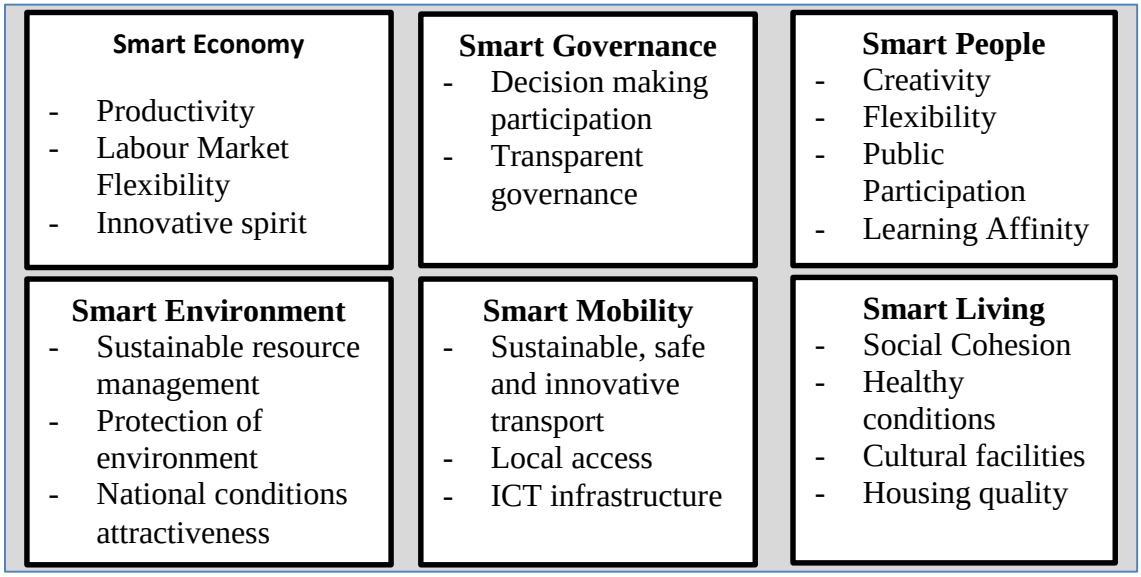

Figure 2.1: Characteristics of the Smart City Model Source: (Giffinger et al. 2007)

Smart governance is about participation of the individuals in decision-making processes (Kolsaker and LeeKelley, 2008), creation of services meant for improving life (Bélissent, 2010) and implementing different tools for collaborating, integrating the services and exchanging data (Maltby, 2013). Smart mobility is focussed on having local and global access, transport that is creative and sustainable followed by a well-developed ICT infrastructure. Smart mobility refers to transport system that is safe and secure (Bifulco et al., 2014) and can be accessed locally, nationally as well as internationally. A study of smart environment has been done with respect to reducing pollution, managing resources naturally and preserving the natural resources by efficiently using resources and substituting the lesser ones so as to attain sustainable goals (Tanguay et al., 2010). Smart environment includes managing resources, pollution, protecting environment and having the presence of attractive natural conditions. Then comes smart living which is about good quality, in terms of overall health, house, safe surroundings, good culture and tourism (Giffinger et al., 2007).

There has been an evolution in an approach towards smart cities by giving focus on elements that favour smartization process. It is only after integrating the domains there can be creation of sustainable growth and a better life for smart cities (Anthopoulos and Tougountzoglou, 2012). The integration of smart initiatives in urban context has been attained with the help of diverse efforts given by stakeholders (Tregua et al., 2015) that play a crucial role in analysing the pre requirements for creation of cities that has improved life quality (Giffinger et al., 2007). The Stakeholders are inclusive of industrial players, agencies of central or national level like European Union as well as the research scholars. The efforts put by them in studying the smart cities has resulted in creating models that gather varied dimensions of urban life that can be improved by implementing smart city projects. The above features have been grouped into drivers as they have a crucial role to play in overall development of smart cities and have undergone many changes during recent times. The path is depicted in studies starting from the oldest and running up to most recent.

The identification of drivers for smart cities allows us to review the focus on the smart cities and how it relates to the model presented by Giffinger et al. (2007). The table 2.3 depicts about the earliest attempt made by Centre of Regional Science of Vienna University of Technology for creation of a smart city model which is the most cited and used on a frequent basis (Schaffers et

al., 2011). Smart city in this respect is the one that is performing well in 6 areas being smart economy, people, governance, mobility, environment and living (Giffinger et al., 2007). The given model on smart city was updated with the help of European Parliament in order to map Smart cities in European Union. It has been depicted that European Union has highlighted ICT in all the 6 features that have been mentioned before. ICT can be regarded as an important feature that has presence of many qualities like being an across-the-board driver as well as main enabler for the cities that address the issues in a smart way.

Sources	Drivers
EU-European Parliament (2014)	Economy Governance Mobility People Environment Living
Smart Cities Council (2013)	Transportation Energy Telecommunication Healthcare Public safety and security City administration Waste management Buildings Building management Education Payments Human services Water
Bélissent (2010) **Giffinger et al., (2007)**	Economy Living People Environment Governance Mobility

Table 2.3: Drivers of Smart Cities

2.2.3 Role of IT in Smart City Development and Future Sustainability

Smart city works on optimally using the interconnected information in order to understand and control its operations followed by ensuring limited resource usage. A crucial role is thus played by ICT as it manages the digital platform so as to create information and knowledge network (Kitchin, 2014). This not only helps in aggregating information of the city for analysis but can also be used to better understand the functioning of city. The City administrators and

stakeholders can utilise the information for creating policies and regulations by which life of the citizens can be improved (Cocchia, 2014).

There can be a linkage of smart city initiatives to diffusing and integrating new technologies especially ICT as well as data management functionalities. This has been expanded from acquiring the elementary data followed by its processing as well as interpretation. These were exploited on account of diffused mobile devices that allow people for participation (Kirwan, 2015) thereby contributing in overall urban environment. A crucial role is played by people that are the human component (Nam and Pardo, 2011), in the smartization process thereby leading to conceptualising technology as an intelligent tool that can be utilised for creating cities that has the presence of improved quality (Bulu, 2014) followed by enhancing the participation of human beings by co-creation of services (Kirwan, 2015). This participation should further lead to avoidance of social marginality (Huston et al., 2015; Vanolo, 2014).

ICT in a smart city has the skill to capture and share information in a timely manner. It is not just important to have a city that is well equipped to respond to a given situation, but the need is to provide and share information on specific problems like traffic congestion or utilities outage. If provision of information takes place on a real time basis and in accurate manner then potential action can be taken by cities' before escalation of issue (Lee, Phaal and Lee, 2013). A Smart City is thus a predictive city where there can be a forecast of specific events and incidents thereby improving overall life quality that further enables the citizens to be well informed about the situation so that an educated decision can be made as to what should be the next course of action (Meijer and Bolívar, 2016). Figure 2.2 show cases the multi-faceted role of ICT in making of the smart cities.

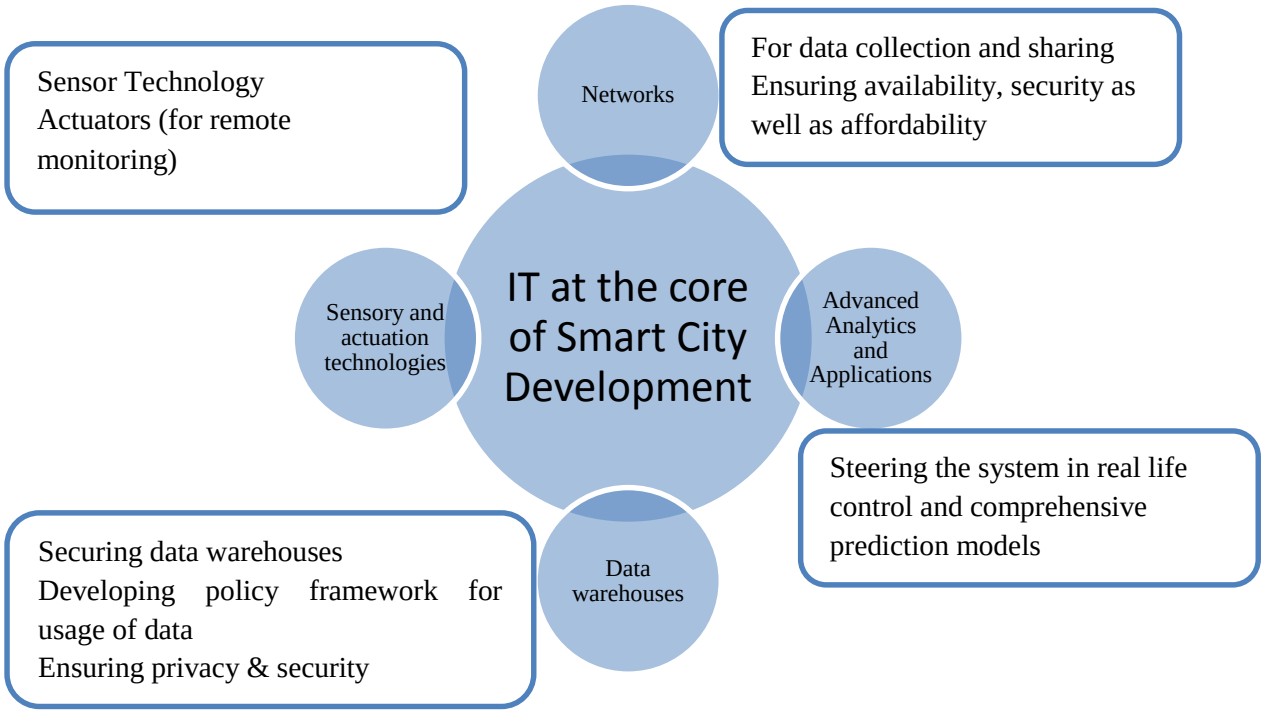

Figure 2.2: Role of IT Infrastructure in Smart City Models

Digital infrastructure can be viewed by forming varied digital supporting layers in a smart city that have been described below:

Connectivity Layer: This layer encloses cellular (3G, 4G, 5G), WiFi, Bluetooth, sensors, gatherers and the Internet of things when all is said to be done (Meijer and Bolívar, 2016; Bawany and Shamsi, 2015). These can then be requested by private/open administrators; districts/ distinctive government elements; neighbourhood/elected ones. Solid network framework then makes an attempt to authorise access followed by permitting urban communities for catching and reacting to information in an adequate manner (Chourabi et al., 2012).

Datacenter/Operations Layer: With respect to the data that has been produced and assembled, the data centre/operations layer ensures that information is kept in store and can be received to crosswise over diverse workplaces and applications (Ersoy, 2017; Meijer and Bolívar, 2016).

Analytics Layer: It is the layer where city area can take all the gathered data and change it into crucial bits of knowledge and activities (Chourabi et al., 2012; Kitchin et al., 2015). Urban communities are now in a position to influence arrangements so that they can structure as well as break information. There has been a movement of urban communities towards Big Data

investigation by which a wide ranged data can be examined be it organized, semi-organized, and unstructured (Meijer and Bolívar, 2016). Investigation can also be done for executing prescriptive activities so as to ideally designate the assets.

Applications Layer: city area carry out the execution of diverse applications that are flat and industry-particular followed by catching and collecting information on diverse stages (online administrations, cell phones, tablets, sensors and autos) (Kitchin et al., 2015; Goodspeed, 2015). This will further ensure that clients have a consistent ordeal by actualisation of applications that has the capacity to synchronize with administrations from different substances thereby enhancing its general proficiency. For example, governmental officials can send solitary application by which client will get access to capacity from varied offices in comparison to discrete and unique frameworks (Meijer and Bolívar, 2016; Chourabi et al., 2012).

End-User Layer: This layer can go from an individual (subject, an inhabitant, or a guest) to open or private organizations (Goodspeed, 2015; Ersoy, 2017). Data can be caught in this layer through applications, advanced cells, tablets, sensors or Global Positioning System. In a long run, the layer ingests results of Smart City activities (Kitchin et al., 2015; Meijer and Bolívar, 2016). The layer is required to be adequate so that the city can be perceived as Smart that makes use of varied answers for incorporating data within city frameworks and areas followed by drawing in with native people, firms and groups in novel ways.

Data Sources & Integration: Modern cities should ensure towards catching of information from varied sources being web administrations, phones, sensors or internet of things (Ersoy, 2017; Chourabi et al., 2012). The urban areas should then depict as to how the information will be ordered and stored and which would be given a right for getting cross wised over diverse elements (open and private). In early stages, issues with respect to information quality and interoperability should be supervised by urban communities followed by taking care that all the smart cities are not Greenfield activities (Bawany and Bawany, 2015). Activities can also be taken for modernising the biological systems that will have information which cannot be disposed of. Cooperative energies should be accompanied by urban communities over old and new biological systems and the information that has been generated.

Analytics and Big Data: by making use of advancements in big data, urban areas can enhance their overall experience, give answers for issues and also measure the overall execution of process. Urban areas can then influence the arrangements so as to carry out examination from varied sources of information (Khan et al., 2015). The information can then be understood by carrying out investigations so that results can then be measured on the basis of examining characterized measurements. This can further be encouraged by prescriptive investigation which is all about picking up the bits of knowledge on what moves should be made in order to achieve a specific result. This will led to arranging clients and organizations that has a focused and modified management (Rathore et al., 2016). A transport firm will then have a capacity to pick up experiences on which is the ideal course to be taken if there is clogging of activity.

Data Governance: Governmental authorities are required to address how to carry out administration of the information that has been caught followed by maintaining a harmony between safety, accessibility, and security and quality of information. It should also be guaranteed by the government officials that information has been overseen lawfully and not shared with outsiders without a prior approval (Shelton and Zook, 2014). Information administration arena of Smart City cannot disengage cybercrime laws as they address Internet and the frameworks that are linked to it.

There are many physical functions in a city that are exhibited in different infrastructural forms being water, waste, buildings and many others. Every element present in the infrastructure acts as a system that is further made of many sub systems, constituents and devices that act like communications data network in order to communicate amongst them. The city is thus made of above given infrastructure verticals that give rise to system of systems. Clear nexus exists between the systems; for instance; a building after making use of energy and water generates waste and if the individual smart systems are joined together, the government can track the utilities consumption and wastage using smart IT infrastructure in real-time thereby regarded as smart (Li et al., 2015). However, it is also true that elements of city infrastructure have a tendency to work in silos and smart cities require a combined treatment of all smart set-ups. Developing cities in smart manner will take place when infrastructure parts are thought upon and planned by government officials and residents in a holistic manner. Smart initiatives can only be deployed when there is a presence of technological elements such as hardware in form of

wireless equipment's, sensors; software's related to artificial intelligence and expert systems so as to give rise to a physically-digitalised environment of smart cities (Li et al., 2015; Schaffers et al., 2011).

An increased attention have been given by the scholars on the relation that exists between technology as well as urban life and a few studies (Lombardi et al., 2012) have assessed the need of a new holistic system in order to integrate acquisition of data, its querying as well as mining that can be understood by developing collective open platforms and universal information and communication technology infrastructures. Smart city should further make an attempt to deploy smart technologies that combine the application of server and network infrastructure, software systems, as well as client devices in order to connect to different types of urban services (Åkesson et al., 2008). The above process can be facilitated by the usage of ICT. One approach in this regard can be aggregation of diverse data streams of the city in one roof so as to allow for data collection and integration from individual domains thereby giving rise to a system that has a presence of increased efficiency and also allows for fresh insights. The operation centres work as nerve centre for the diverse smart initiatives by provision of technological foundation as required for an integrated view. However, the integrated approach with respect to the smart infrastructure should extend outside these measures and infiltrate the manner by which individuals ponder about the infrastructure. Smart infrastructure should further be regarded as a system that allows for integrating the core areas of sustainability being social, economic and environmental in the said urban context.

Smart city has a presence of developed ICT applications like GPS by which there can be an enhancement in the transport as well as management of traffic; database technologies meant for fitness, energy effectiveness, and teaching; pattern recognition software for improving security and mobile technologies for engagement of people towards social activities (Bulu, 2014). ICT's role has a relation with developing smart initiatives in the city followed by having an understanding about the challenges that occur while sustainability developing the urban landscape (Lombardi et al., 2012; Meijer & Rodríguez-Bolívar, 2015;). There has been a widespread analysis of sustainability with respect to ICT and its application in a smart manner by the research scholars, associations well as international companies (Lombardi & Vanolo, 2015) which have led to creation of diverse definitions that focus on a particular dimension whether it

is economic, social or environmental in deploying smart projects. The very first attempt that was made to define sustainable development has taken economic and social dynamics into account thereby creating a broad meaning with triple bottom line (Bulu, 2014; Rogers and Ryan, 2001).

Sustainability as a definition has been utilised for underlining the importance of preserving natural resources, creating social equity and developing the economy with respect to a said systemic vision so as to assist in attainment of goals. A proposal has been given by different scholars to apply sustainability inside territories where Beatley (2000) gives focus on the idea of smart growth in urban areas while Schilling and Logan (2008) focuses on making of sustainable strategies in the city so as to create new urban areas with respect to local communities; Talen (2011) has focused on the replacement of unsustainable situations with sustainable ones. There is a presence of many other operational inferences of sustainability in urban setting which has been suggested by Yigitcanlar and Lönnqvist (2013) who have given emphasis on the role of knowledge in designing the cities as well as strategies for overall sustainability of urban development; Hollands (2015) has further laid emphasis on the role played by sustainability in smart cities and the set of opportunities that are offered by technologies for attainment of sustainable goals.

2.2.3.1 Smart government services

There is a presence of two dimensions within the concept of smart government being public service management as well as administration of the local government. As per view points of Pardo et al. (2011), the smart city with respect to management of government is about enhancing the effectiveness of the management in front as well as back office operations of city government. The managerial innovation of a smart government is thus defined as a technique for creating capabilities within the organization as well as management so as to make effective usage of technological tools. City service system as per the other studies is defined as the operational activities and coordinating the service delivery that has been delivered by the city authority (Lee et al. 2014). The 20th GCC E-government and E-services conference (2014) depicts the key difference that is present between the smart city and smart government that is on the basis of driving forces, geographical and vertical focus, approach, roles as well as technology coverage.

In the context of the smart city, the major drivers include competition, environmental sustainability, and development while that of smart government is on public value.

Smart city emphasizes on multiple domains in 1 tier city that is led by private stakeholders, technology as well as enterprise service providers. While technology domains of smart government are more focused towards processes and technologies so as to ensure towards creating of flawless information in the governmental firms. The emphasis of technology coverage in smart city is further on the connection of city systems that are based on information and communication technology; instrumentation infrastructure as well as the practices adopted by the smart government. The approach adopted by the smart city is up-bottom that is headed by prime minister while that of smart government is bottom-up which is headed as per the necessity and concerns. The smart city model as per Giffinger et al. (2007) emphasizes on smart governance as a greater category which further includes smart government where governance comprises of participating in the process of decision making as well as transparency of operations. It has further been believed by Walravens (2010) that key requirement of smart government is efficiently managing the city operations as well as delivery the services where well-organized city administration may further provide services to citizens and aid in fostering corporate essentials to the service-based economy of present times.

One of the important factors in managing the city operations is by utilizing techniques of communication and collaboration for delivering services to city departments as well as ensure that key decision makers take part in the process of decision making and also monitor the delivery of services. Smart government services are thus a platform wherein relations between government and citizens can be sustained. A number of modes can be used to identify this fact in electronic form being e-government which deals with functioning policies in the city; e-governance in which active role is played by citizens with respect to government policies and programs; e-administration where administrative services are customized for the citizens; Then is the learning city which emphasizes on the learning technique that has been made by the citizens (Lee et al., 2014). Smart government as per researchers has been defined as the one which assimilates data, communication as well as technologies for the purpose of planning and managing over multiple domains, areas, and jurisdictions so as to give rise to sustainable public worth (Gartner, 2014). The concept showcases advanced government that generates

opportunities for the societies by which service access can be availed by them at any time, any location and with any device. It is also to be noted that the smart government services are yet to reach its full capacity as the concept of smart city further includes 11 categories being management; transport; health, medical care and welfare; environment; preventing crime and disaster; facilities management work and employment (Lee et al., 2012; Gartner, 2014).

The smart city concepts have further expanded itself into many terms like information city, intelligent city, and knowledge city among others. Smart city performance is further inclusive of smart economy, smart individuals, smart governance, smart movement, smart environment and smart existence. It can further include features like human capital as well as education thereby depicting that smart city can cover a lot of aspects than what has been thought of. This leads to a conclusion that there cannot be equality in the overall functioning of the smart city but it is essential to point out that they all include the common and needed aspects so as to enhance life of citizen which can be done by effectively implementing green technologies, development of ICT as well as enhancing environment. The above-mentioned services are given through infrastructure of the city which is based on ICT and the city managers are constantly focusing on improving the quality of citizen's life by up gradation of smart services i.e. innovatively using the ICT for the purpose of city planning and management.

2.2.3.2 Smart government services versus security, safety, availability and continuity

With respect to all the required aspects of the smart city with respect to functioning and development; it is to be noted that security in the digital world is the most important criteria that should be present in multiple forms. Unfortunately, the present world is facing a very common issue being a lack of privacy as entering into the security system of the internet can be done by various kinds of harmless applications such as ads, programs and spam sent on email ids of people (Francis et al., 2007). The issue is present in the internet protocol as well as network architectures that are focused upon in the least manner. The users who try to gain access towards easy solutions and also have an absence of security experts are not able to identify the threats that are present in applications or approaches that may look harmless (Otero, 2015). Hence priority is required to be given on recognizing the importance of built-in security structures in the upcoming internet.

It is further required to be noted that the internet can be shielded against the common threats but a possibility to develop a security system is almost nil as it may face unidentified future threats. However, if there is a presence of well-built security system then there can be a reduction in upcoming threats that may arise in the future. This can occur by evaluating the process by which the attacks get evident and also by forecasting there course. The threats have a presence of multiple shapes as well as forms and assessing their presence can be challenging which would depend on the experience of users. As per the viewpoints of Lewis (2015) smartness is all about being progressive in terms of mobility which is more disruptive in form of Malware, Phishing, and Fraud which are most dangerous threats that can give rise to grave economic issues. Other than this, the underground economy escalates the scale where users get victimized for the fraud plans which allow the criminals to garner full advantage towards faulty security systems that have been built properly. This flexible nature has led to the consequence that the internet can be accessible by multiple methods like computers, smart phones as well as mobiles. The communication technologies are acting as a powerful instrument of marketing that is undergoing changes, as well as developments on an everyday basis and customers of all the groups, are responding towards this market as well. Mobile phones are not just providing communication but entertainment, advertising, location, health thereby attracting people from all the age groups. The system is further becoming more complex and is handling a variety of information.

Increasing complexities of the smart city have led to more cyber-attacks out of which 40 percent of fraudulent transactions are from mobiles (Gupta, 2015). 2122 from 79790 cases of security have taken place in firms in different nations as per data breaches (DBI Statistical Report, 2015). But the number of affected nations has shown a decrease from 95 to 61 thereby indicating that 34 nations have brought improvisations in the technology network security. It has further been identified that the affected industries mostly belong to Public, IT and Financial Services. Hence the need is to focus on sophisticated protection mechanisms followed by developing solutions that can aid in leveraging of digital data so as to be designed from conception state while considering aspects such as security, consistency, confidentiality, information integration, and resilience. The given aspects are likely to ensure towards continuity of services followed by security and wellbeing of the masses against malevolent violations and accidental damages. On the other hand, it is further impossible to render equal protection as well as resilience to every aspect of ecosystem hence the city governance is required to assess the crucial areas that can

attract or encourage the attackers. Also, the government that has the presence of open data can then manage the leadership in ICT as well as governance so as to protect the privacy and identity of citizens. This is as security as well as privacy is very important due to the nature of government data that is very sensitive which may further influence transparency and public participation. Other than this, the legislation also ensures towards protection of critical infrastructure from cyber-attack.

2.2.3.3 The Role of stakeholders in developing Smart government services

There may be involvement of varied stakeholders while developing ICT projects of large scale like Smart Services of government. The issue of limited time span may act as a challenge for the project in terms of developing relation amongst stakeholders (Karlsen et al., 2008). Stakeholders in this regard, are the main success criteria in the area of project management especially with respect to massive socio-economical projects that are influenced by external parties such as society, citizens, and governments (Liisa, Ruuska & Ahola, 2013). The need here is to address the terms of stakeholders so as to capture the overall effectiveness of project management (Aaltonen, 2010). Freeman (1984) has defined stakeholder approach as the one which concentrates on a group that is impacted by focal company or project. The stakeholders have been found to play a successful role in project delivery regardless of the direct and indirect role played by them. There has been a reporting of many project failures on account of unresolved issues as well as tradeoffs that happen amongst project stakeholders (Cleland, 1985). The researchers have thus been encouraged to assess the practice of stakeholder management while executions of the project through the usage of international standards like PMBOK (PMI, 2008). The standards have been developed on the basis of experience possessed by practitioners with respect to the organization as well as industry (Ahlemann et al., 2009). Other than this, the researchers have also stressed on classifying the stakeholders (Mitchell et al.1997; Mathur, 2008) however, studies find it difficult to focus on potential stakeholder groups on account of complexity with respect to the creation of a comprehensive theory. With respect to the numerous stakeholder settings, a noticeable influence is seen by the government on corporate and projects (Freeman, 1984). It has also been argued by Fassin, 2009; Neville and Menguc, 2006 that government has no relation to the typical stakeholder categories hence identification of stakeholders can be done by asking questions such as who are the stakeholders? What are there

wants? How will they try to achieve the wants (Frooman, 1999). The given questions stimulate attention for discovering as to whether there is a presence of some specific features with a particular stakeholder type that may have relation to the government and put an influence over the projects which has led to the introduction of the concept being the governmental stakeholder (Sallinen et al., 2011).

As per the view point of Miller and Hobbs (2006) government, stakeholders are seen through governmental authorities, government actors, states, legislators, regulatory agencies, and institutions. It has also been explained by the author Sivonen (2009) that government makes use of regulatory and legal bodies and central government departments for monitoring the ongoing economic acts and supervising the interest of the public. It is further to be noted that there may be a lack of similarity in the stake of public and government stakeholders (Neville and Menguc, 2006). The role played by governmental stakeholders in projects has a concern towards the morality and ethics (Smyth, 2008) and represent the interest of citizens and society thereby indicating that they increasingly represent the interest of others. Hence, it has been stated by Fassin (2009) that government can order a focal organization to undertake responsibilities that are present within governmental laws and regulations which may lead to the influence of positive or negative origin. The impact caused by government stakeholders on organization led project occurs via limiting or refusing resources that may increase the cost or may delay the overall schedule of the project (Olander and Landin, 2005). For instance, in the case of a spontaneous project that adheres to regulations and does not steer from government stakeholder have lighter monitoring lighter but if the project is through governmental stakeholder then there will be a need to carry out more monitoring and extra stages will be required to be included in timeline and scope. On a contrast, a vital role can be played by the government for engaging the firms to participate in the creation of regulations which will then be obeyed by the firms. It has further been argued by Pernille & Martina (2013) that citizens should be involved in the designing and execution of the new systems and there has also been a development of many methods by which users can be engaged in the design of ICT project. But it is rather very difficult to involve the users in designing of the large scale governmental project, therefore, the government stakeholders communicate to society on behalf of the project (Fassin, 2009). Pernille & Martina (2013) has proposed that attaining desired project outcomes is just not enough from designer's point of view as overlooking stakeholders may lead to missed requirements which may generate

a wrong product. Hence in order to ensure towards acceptance, trust and effective use of the system the project designers are required to give focus on social informatics perspective.

2.2.4 Smart Cities Examples

Urbanization on a rapid pace has resulted in increased pressures on traditional infrastructures of cities where ICT is the main element that can enhance these infrastructures so as to reflect the enormous demands of the society of 21st century. Hence major cities over the globe (Seoul, Hong Kong, Stockholm, and Dubai) have embarked on smart city developments. It is further to be noted that smart phones have created a baseline expectation amongst citizens as they allow information and services to get accessible without emphasizing on the place or time factor. Hence, technology vendors are also implementing smart city technologies for meeting up the demand of citizens and providing them with efficient and cost effectiveness solutions with respect to city services. Smart city projects can further be classified into 3 types being the new smart city (built from scratch); the smart city made from existing city as well as Purpose-driven cities like Masdar- Abu Dhabi (created to meet a specific purpose). For the present report, there has been a selection of Seoul, Singapore and Abu Dhabi that are the well-known smart cities of the world. Seoul has been selected for this study as the city is a blue print for guiding smart city development as well as a petri dish for carrying out technological experiments. The public life of Seoul has been guided by technology in almost all aspects be it integrated public transport or emergency warning system of government. The selection of Singapore for this report can be justified as it is thriving to become the first smart city in the world where its geographical location and political stability is assisting the city to get prepared for the coming future. In the same line, Masdar (Abu Dhabi) as a smart city is working on fulfilling its zero carbon dream by which it could become first green ghost town in the world.

2.2.4.1 Seoul Smart City

Seoul is the capital city of South Korea which has been known for propelling tourism activities and stable economy thereby acquiring 1st position in the e-Government Survey of UN since the year 2003 (Hwang and Choe 2013). Seoul in the year 2011 was regarded as the pioneer city in innovation with respect to data and correspondences and became a smart city by taking varied course of actions where the route was providing support to aggression, changing the management

as well as providing joy to the general masses (Neirotti et al., 2014). The city has also got consignments for applying the advances in data and correspondence to the existing framework in various parts of city followed by upgrading the organisation of open offices. It has further worked on portability, maintaining wellbeing and personal satisfaction of its citizens all over Seoul. In the year 2004, the city started Ubiquitous City also known as U-city venture which intends to provide its citizens with a convenient life that is secure, eco-friendly and humane in origin (Lee, Hancock and Hu, 2014). The smart city venture in Seoul is of concern to the nationals and the objective as of now is to have a large number of smart innovations so as to create a link between the city and its residents.

Three major stages have been undertaken by Seoul to become the smart city which is as follows. At the initial stage, operations of Seoul were enhanced in the area of health, environment, culture ethos and transportation by the government through data implantation and correspondence innovation. The second stage is the vertical organization level where high innovation was executed in the primary city areas, followed by allowing for the organisation of more artistic administrations (Chang et al., 2015). For example, in the area of transport, subjects receive data on people with respect to continuous movement of general transport, mishappenings as well as situations of the street. An increased progression was seen in administrative divisions of all the city parts but smart city administrations are yet to be created in all the areas. The third phase can be regarded as horizontal service level and is that point of development where there is not any difference in the service areas and all part of the city is integrated in the smart city ecosystem in seamless and efficient manner (Vanolo, 2013). The second as well as third phase will see towards the creation of corporate to corporate and corporate to consumer models by making use of the city infrastructure to improve the services. For achievement of administration in smart city framework, there is a need for smart data foundation and innovation correspondence. This framework needs arrangements to be made in order for its development along with correspondence innovation to be developed for future benefits.

The governmental authorities of Seoul has focused on rendering employment to its citizens by spread of data administration and laying a foundation for advancement models on open-source applications. Seoul has started a free Wi-Fi system in greenhouses, courts, metro stations, parks, trams and other means of transport as well as public places. In the same manner, the legislation

authorities have given free Wi-Fi to its subjects that are going to the open structures (Gabrys, 2014). In this regard, there has been a use of public private mechanism to make sure that there is a presence of high speed internet throughout the city. In addition to this, the Wi-Fi network of metropolitan government in Seoul is also free to be accessed by all the citizens that are paying a visit to the public building.

There has been an introduction of smart meters and matrices in the houses as well as industrial units so as to assist in proper energy use within the city. These meters are likely to provide real time information on the consumption of water and electricity. The information is there in monetary unit and further showcases detailed data on energy consumption pattern of every house followed by suggesting a means by which patterns can be adjusted for reducing cost of energy. The city has further pushed towards bringing improvisation in brilliant matrix framework followed by emphasising on how carbon dioxide can be decreased. Seoul has further began the national venture named as smart matrix which is there to assist in a positive environmental change by ensuring that that there is a decrease in outflow of gases (Lee, Phaal and Lee, 2013).

As part of the national strategy of Korea, the smart lattice activity allows it to achieve low carbon development vision to building a green nation. Along with this, the administration highlight of the smart city model works to incorporate operations framework to act as an integral part of the smart city framework. One of the major priorities of Seoul as a smart city was to build a communication network that has been dedicated towards smart services. Hence this gave rise to an administrative optical network known as e-Seoul Net that was formed in the year 2003. It embeds a fibre-optic cable alongside the subway tunnels of Seoul so as to connect the main public building of city to offices and municipalities. Officers can then make a contact with the subsidiary workplaces so as to trade the information with companies and the citizens can also get access to regulatory administrations.

A pilot project has been launched by Metropolitan Government of Seoul that allows the governmental employees to work from offices known as Smart Work Centers that are in close vicinity to their homes. When an employee checks in to a given Smart Work Center for his or her work shifts then a permission is granted to access sophisticated groupware and teleconferencing systems thereby ensuring that there job performance is not affected even if they are absent from

the city hall. Safety Service has been set up in Seoul since the year April 2008 by making use of state-of-the-art facility and CCTV for notifying the authorities and the family in case of emergency situations for children, handicapped, old age people and Alzheimer disease sufferer (Mahizhnan, 1999)

2.2.4.2 Smart city Singapore

Singapore has also set a reasonable amount of advancement for 40 to 50 years and has planned to provide decent surroundings for its residents. The improvements have not been steady or constant but have been redesigned on a regular basis with more advancement. Singapore has thus planned to make itself a cosmopolitan city that has a population of around 5 million, which is dynamic, decent and ever ready to adjust with world level changes. The advancement plan for Singapore is thus based on purpose being Economy, People, Governance, Mobility, Environment and Living (Anthopoulos, Janssen and Weerakkody, 2016).

Economy: Having an access to a well-focused economy acts as a prime basis for city improvements where all the citizens have got a chance to earn a reasonable amount of income and thus attains the position of financial security. Government is further required to provide the residents with more job opportunities so that overall financial health of the country can be improved. Singapore was able to bolster its economy through advancement in transport, air supply, sanitation offices as well as distributing land and office for modern use (Eco-business, 2012). In order to maintain the position of Singapore as global hub, the need is to expand the data economy.

Under data economy, an imperative term is online trade. This aspect has been given due significance as regulatory as well as administrative framework hinder the development brought in through the online portal. All information and transactions being conducted online through the citizens of the smart city should be regulated to ensure safety and security. Within this framework, the security of individuals as well as monetary transactions executed by smart city users is another issue which add on to the data economy issues. The Electronic Commerce Policy Committee (ECPC) that was set up in the year 1997 has given advices to the government so as to create an internet transaction system. These are as follows;

- Private sector should have a crucial role to play in creation of electronic trade.
- Government is required to make a legal system which is steady and dependable.
- Safe environment should be provided by the government.
- Government must act as motivator towards developing online system by intake of joint activities.
- There must be a presence of imaginative and straightforward policies.
- There should be a presence of good E-trade directions that has a presence of global controls and performing artists.

The Singaporean government has a crucial part to play in improving internet transaction system by undertaking joint endeavours. These ought to make government dynamic and a specialist in internet transactions. This will be different from other nations where governmental officials avoid management inclusion and play the part of a controller (Jin et al., 2014).

Individuals: Aptitude towards information technology is a must for development and day to day existence in Singapore. The educational ministry of Singapore has thus made an attempt to arrange a strategy by which PC aptitude can be encourage in education since the year 1997 where IT learning environment is mandatory for every school. The education ministry has thus ensured to provide one computer amongst two youngsters and 30 percent of the educational programs are on PC based learning. A venture known as IT Coach was also started by National computer board (NCB) and National Trades Union Congress (NTUC) so as to expand the IT mindfulness (Koh et al., 2014). The main objective of IT coach was to help in preparing the production lines representatives and specialists and ensure towards PC innovations. IT Coaches were provided with PC, printer, camera and a plan to mentor around 16.000 specialists in 200 days (NCB, 1992).

Administration: There has been a union of Government data and administrations under 1 entrance. There was a start of Singapore Government Online Portal (www.gov.sg) in the year 2004 so as to provide Internet passage for administration data and e-administrations. It was since

the year 2005 that all the administrative firms began to administer from open booths in order to receive data and e-administrations (Detlor et al, 2013). The government raised an attempt to connect to its users through the ICT technology as part of its plan for e-taxpayer. Within this move, the government attempted to clarify various points of changes online to the users focussing on upgrade of the technology. An another e-Government Master Plan (2011-2015) known as eGov2015 was started in the year 2011 with a vision to become a synergistic government that co creates and is able to form a connection with its people. It wishes to integrate the system, process as well as service delivery from inside the government to beyond them (Nycz and Polkowski, 2015).

2.2.4.3 Abu Dhabi Smart City (MASDAR)

Abu Dhabi is the capital of the United Arab Emirates, and holds an influential position to reflect key changes being implemented in the region as a model example to other regions within the country. Some examples include work creation, financial improvement, security, and Smart City development and user wellbeing. The developmental system of Abu Dhabi as shared through the vision Abu Dhabi 2030 whose foundation is based on estidama (an Arabic word) which means sustainability. The Abu Dhabi region wishes to play a primary role in increasing vitality and decreasing the carbon emissions by moving away from the use of fossil fuels towards clean and a differentiated economy. The aim of Abu Dhabi 2030 is a mix of social and economic accomplishments where emphasis will be given on wisely using the oil reserves in order to construct a sound economy and making it a great place in terms of living (Sherif, Shalaby and Altan, 2016). It thus makes an attempt to address the issues by using smart city techniques. $4 billion has been assigned for this project where emphasis will be given on innovation.

Masdar City is a planned city project of Abu Dhabi that has been designed so as to become a hub for clean tech organisations (Madakam and Ramaswamy 2016). It has a presence of Masdar Institute of Science and Technology and the International Renewable Energy Agency (IRENA) (Reiche, 2010). The city is spread in the area of 6 kms and is in close vicinity of Abu Dhabi International Airport; is rising in the globe to become a place for dealing, promoting and exhibiting renewable vitality and manageability innovations.

The main research Institute present in this city is Masdar Institute of Science and Technology (MIST) which is devoted to generation of alternative energy sources, environmental sustainability, and making use of clean technology (Hassan, Lee and Yoo, 2016). Aircuity which is a superior solution for demand control ventilation (DCV) application has been implemented in the classes, conference rooms and library. It has been providing the university campus with solutions towards low energy and reduction in carbon emission followed by energy savings on a sustained basis (Ibrahim, 2016). A continuous monitoring is also done for the air in laboratory area so that outside air brought into the lab can be adjusted in such a manner for providing safe lab conditions and enhances the overall efficiency of energy. This has led to a saving of 55 percent of the total Heating, Ventilation, and Air Conditioning (HVAC).

Masdar city has further got a presence of Global Head Quarter of International Renewable Energy Agency (IRENA's) that has 32000 square metre of office spacing (Sharif, 2016). The place has been acting as a home to worldwide MNC’s, small and medium enterprises. The headquarter represents strategic energy hub and works beyond the concept of sustainable design and green building technology. The IRENA Head Quarter (HQ) will cater to the users that range from multi-national corporations to small and medium enterprises (SMEs). The HQ is a proficient, adaptable and naturally practical building which is supported through innovation and Internet of Things (IoT). The advances made through IoT are innovations for effective interfacing of each element in the HQ to boost operational efficiency, labelling, review and computerization of all items associated automatically.

The building further has a presence of 1,000 sqm of housetop photovoltaic boards that are there to generate power followed by solar thermal water warmers that fulfil 75 percent of the water demand in the building. The infrastructure has been created in such a manner that it demands 50 percent less water than similar such offices in Abu Dhabi. The air tight nature of the building reduces energy consumption while air conditioning system can recover 75 percent of the energy that has been released from exhaust followed by harnessing it to cool down the incoming fresh air (Evans, Karvonen and Raven, 2016).

In terms of corporate area, Masdar city provides a living laboratory, followed by corporate improvement openings as well as offers companies a domain by which they can work on their

advancements. It further acts as ground for new research and innovation followed by empowering the likeminded experts towards information sharing on a casual basis. The city is thus a home to many multi-national corporates (MNC's) who are listed in fortune 500 to new companies as well as innovation firms thereby allowing them to provide clean innovation as well as renewable-influence items and administrations to developing markets of middle east, North Africa and Asia (Jensen, 2016). Masdar City has provided the firms with a simple setup that is not in need of any support. There is a presence of developed laboratory in the Masdar Institute followed by a graduate-level research foundation that provides chance to undertake pilot projects and test the new thoughts and innovations. Its graduate college has laid a huge emphasis on renewable vitality as well as clean technology and has been providing quality graduate students (Elchalakani & Abu-Aisheh, 2014). The concentration of Masdar city will be on carrying out research activities in four areas being green building, solar oriented, water and power. Masdar City is likely to provide all the advantages as provided by Special Economic zone, however it will also focus on clean innovation and renewables in a corporate environment that offers;

- Quick and simplistic setup with a one stop focuses on enrolling, governmental relation as well as quick track visa handling.
- Absence of any import taxes and charges on firms and people.
- Absence of any limitation on capital development, benefits or quantities
- 100% remote possession
- No confinement with respect to money.
- Hiring the expatriate staff members.
- Acting as a gateway to energetic market in Middle East and Asia.
- A high calibre of life and sheltered, neighbourly workplace.
- Outstanding coordination's organize consolidating air, ocean, street and in the end rail.
- The chance to augment corporate social duty goals Strong IP security structure.

This section reviewed the three smart cities, examining the factors that contribute towards the success of the smart cities. In the next section, a review of disaster recovery frame will be made followed by an examination on the role of IT in strengthening DRP framework.

2.3 IT Disaster and Recovery

Through the ages of time, the human race has faced numerous events of natural calamities, making them accustomed to the phenomenon of natural disasters and hazards. It is through evolution and adaptability that the human race has found of ways to alleviate disasters and minimize their effects on the planet, using intellect, technology and superior acumen. These innovative measures stem from the socio-cultural and religio-magical features we have witnessed in people that are prevalent in the human race even today, since the dawn of humanity. However, with the integration of IT in the modern corporate world, the realm of disasters has expanded to included IT disasters.

Disaster can be specifically defined as an extreme and irreparable damage caused upon a region or a community, brining misfortune, harm to life and social structure as well as infrastructure. The affected community is often left crippled and unable to cope with the aftermath of the disaster, requiring strenuous hours of hard work and time in order to bring life back to normal. According to Emergency Events Database (EM-DAT), there are two different types of disasters – natural and technological – and are divided into 15 different categories, spanning over 50 sub-categories. The technological disasters are further categorized into three groups: (1) Industrial accidents which involve infrastructural collapse, explosions, fires, gas leaks, poisoning as well as radiation. (2) Transport accidents caused in air, rail, road or water transportation facilities. (3) Miscellaneous accidents: sudden fires and explosions, and collapse of domestic and non-industrial infrastructure and various erections.

In the current world, Information Technology resources such as important confidential data are the prime assets owned by organizations. Events such as IT infrastructure failure, server downtime, hackers, computer viruses, sabotage and terrorist attacks and others can cause major damage, in the case that this important asset is compromised or threatened. According to Paul Shread (2003) a study directed by Dynamic Markets Ltd. affirmed that innovative disappointment positions most elevated on the rundown of saw dangers. The main five most

basic saw dangers are equipment disappointment (61%), programming disappointment and infections (59%), terminate (56%), programmers (36%), and unplanned representative mistake (31%). Respondents trust the five undoubtedly outcomes of a fiasco without calamity recuperation arrange set up would be: information misfortune (64%), diminished worker efficiency (57%), harm to client connections (half), decrease in benefits (49%), and lessening in income (37%). The organizations should thus be able to respond and take swift action in the event of such attacks and catastrophes as their corporate survival depends on it. Various protocols and programs are set in place for quick recovery of data so as to protect the on-going function of the operations, securing the company's reputation. If the assets are lost however, the functioning of these companies will come to a standstill and cease to operate, resulting in them having to shut down their corporates indefinitely. Hence, IT disaster management is not an optional feature but a feature most vital to any company's protocols and a factor that can determine the success or failure of the organization depending on how effective their methods are.

To clarify this misunderstanding, the terms Disaster Recovery (DR) and continuity planning (CP) are important to consider. Although they are used interchangeably, there is a noticeable difference between them. DR refers directly to IT processes and is the process that a company will undergo when it faces a disaster or a crisis. In this process data recovery, access to important files, hardware and software rehabilitation and other activities become critical to the normal functioning of the corporate process and continuation of activities (Hoffer, 2001). With CP, an organization ensures that it can survive a crisis by taking on certain measures to minimize the impact of the crises. CP is generally carried out before the incident actually occurs, while DR is taken place after the occurrence of the incident (Menkus, 1994). CP is more strategic in its execution to responding to disturbances which cover company operations which involve the people of the organization, the infrastructure, the buildings as well as the company's core services and activities. The procedure for disaster recovery should relate the corporate procedures concentrating on:

Data recovery and availability: there is an increased accountability within the firms as to how the data is required to be managed, protected as well as safeguarded. There is an industry wise variation of policies and the technical requirements constantly grow with respect to complexity.

Increasing Availability Requirements: due to the increased dependence on electronic mail/messaging, Internet Protocol service, cross-platform governments applications is making a change in the manner by which corporates use and rely on the information. In many governmental firms, the usage of electronic mail has hidden the voice for carrying out communications, customer care as well as vendor dealings. This has resulted in the creation of stringent demand on operations in order to ensure towards service availability and functionality of plans (Budko, 2007). The presence of corrupted data in a few cases has resulted in bringing a stop to corporate e-mail services that then takes recovery time of 2 to 3 days.

Storage growth trends: there has been an increase in the overall storage requirements of enterprise operating settings on a yearly basis. The industrial growth rate for disk storage has ranged from 30 to 100 percent on a yearly basis (Vijayan, 2005). The emergence of technologies like image recognition, wireless applications, smart cards etc. will lead to an increase in the demand for highly sophisticated storage systems that are manageable, scalable and good in terms of management.

Storage management challenges: huge pooled arrays of disk and tape are accessed by the DR operating environments that are then maintained by central storage management. Storage costs were there to prevent decentralization that drove the requirement for usage of disk space in an effective manner. The tape is also used extensively for the purpose of backup; other than this, there is also an employment of hierarchical storage management (HSM) applications where files not used so frequently are moved to tape archives in order to vacate the disk space. The key feature of mainframe environments is its skill to logically partition (LPAR) an operating system environment. The LPAR system allows for sharing the hardware and network that have been connected locally (Mearian, 2005c).

Networking growth and availability: with the increase in the need towards storage management requirements along with the data volume, many clients have started deploying storage management solutions and devoted TCP/IP networks for recovery so as to provide solutions for TCP/IP bottle necking and overcrowding that arises on account of backup operations. In the present times, there has been a quick adoption of Storage Area Network (SAN) technologies for increasing the working, scalability, and adaptiveness of shared storage resources (Kumar et al.,

2008). SAN has thus been regarded as a devoted infrastructure for input/output storage on the basis of industrial standards for hardware constituents that have been adopted on a wide basis.

Capacity planning trend: having a continuous operations is dependent upon accessing the data followed by the ability to recover the same during the time of disaster (Postal, 2007). With an enhancement in storage consumption and development, there is an increased dependency of business on forecasts and capacity planning. If there is a poor or lack of storage planning then it causes the stoppage in operations due to overconsumption of storage or network resources. Some of the platforms, as well as technologies, support the expansion of resources in a dynamic manner while others may not do so.

2.3.1 Disaster Recovery Planning

As opposed to common thinking that disaster management often involves vigorous activities which include heavy gear and materials, it also involves co-operation among individual forces, work processes, learning bases, expanding methodologies as well as calling for reinforcements. Disaster management was a term which was passed on by PC sellers (Hawkins et al. 2000) around the 1960s and 1980s. It was during this period that DRP was used in order to maintain and centralize PC servers. By the 80s the process of disaster management and recuperation was properly embedded as part of the corporate process. Nowadays, only corporates that have a proper centralized server network can incorporate proper disaster management protocols between day to day corporate activities. Due to recent events in disasters, the need for disaster management protocols have been highlighted, making them an important feature to be present in most smart city programs and protecting the IT departments. To properly understand the various dynamics of the DRP, an enquiry into its definitions through alternate points of view should be considered.

According to Hawkins et al. (2000), the meaning behind DRP is considered to be an archive which is used to help in the rehabilitation and recuperation of information that had been subjected to natural calamities. This is done by re-establishing the information resource centres. As such, it is known that the DRP is supposed to consist of a “master dynamic report” that will be treated as a live report on the status of the servers and the operational state. The report is meant to use the available information to recognize different approaches and techniques to best

utilize them in order to maintain and preserve the data so that there is no loss incurred on the organization's side. But the DRP does not necessarily need to consist of such intricate details about the resource statistics. The setup can also be achieved by connecting the servers via hardwiring methods in order to ensure that the information is securely fastened and not lost during the transfer process.

DRP is primarily focused on the recovery operations of hardware and software applications in an organization (Elliott, & Swartz, 2004). It is merely a subset of the corporate continuity protocol whose primary aim is to move the corporate process to a backup facility. According to previously published literature, there are different procedures that are undertaken in the order of their respective phases to implement corporate continuity planning and DRP methods, based on the subject matter (Leong & Marthandan, 2013). The literature has also indicated numerous guidelines and measures to be undertaken but no implementation on the DRP front. There is also no mention of any tools used or supporting ideologies to help the DRP initiatives (Davies, 2000; Wood, 2006). The iterations made on the continued application of these methods have differed based on the users' understanding and experience in the field. There is also vigorous amounts of activities to be conducted which can overwhelm the users and the implementers which can cause confusion and ruckus at times throughout the DRP implementation.

According to previous DRP implementations, the focus has always included analysing the feasibility of progressing towards corporate continuity management (CCM) processes and towards a more strategic level of operation in order to maintain the corporates values and preserve the on-going activities of the organization (Karim, 2011; Herbane et al., 2004); identifying the key success factors for implementation of the CCM protocols (Kelly, 2012); creating assessments and forecasts for corporate impact and risk models (Shrivastava et al., 2012); minor disturbances and disruptions in service to outright catastrophes and their analyses and the preparation of contingencies for the respective modes of calamities. There have been 17 factors for success by Chow that help in developing a DR plan for four industries: financial services, manufacturing, trading and hotel in Hong Kong (Chow, 2000). 5 of the most successful factors were highlighted towards this cause, but based on the industry practicing them, the ranking may differ based on the priority and effectiveness. The top five factors are: top

management support, adequate financial support, appropriate backup side, off-site storage and training of recovery personnel.

Although DRP consists of numerous phases of processes, the processes themselves can be differed from researcher to researcher (Leong & Marthandan, 2013). There has been a book published based on the DRP for computer systems and in it, the author recommends a 10-phase DR project (Toigo 1996), 10 professional practices in CCM and DRP (Toigo, 1996; DRII, 2008); studies on a 7-phase CCM process approach (Gallangher, 2003), 6-phase CCM approach (BCI, 2008), 4-phase approach that involves a systematic planning program for prevention of certain risks as well as answering important emergency response questions, crisis management and restoration programs (Mainline Information System; Ketterer et al., 2007); as well as a case study which recommends a 3-phase approach for DR contingencies (Petroni, 1999). Considering all the numerous activities and phases proposed, the primary goal for DRP is to help organizations respond and recover from unplanned emergency situations such as natural calamities such that work is not interrupted and that there is no harm caused by the occurrence of unwelcome forces such as natural calamities.

During disasters, one of the most important ways of regrouping for a company is to first take on the essential resource reorganization processes. This will help organizations greatly in the post emergency situations and foster growth almost immediately as the significant resources are already allocated and allotted to their required positions. Other important activities include bringing the workforce on a singular plain unifying the organizational structure such that there is co-operation on all fronts and departments (Burritt, 2002). Eisendrath et al. (2008) had pointed out that when a corporate resumes its proper functioning, that is when the recovery operations take place. After the disaster has taken its toll, the disaster recovery management should be implemented almost immediately to keep normalcy in place and to establish the social, economic and political routines in a community (Lindell, 2011). Faulkner (2001) had also said that the recovery stage is when there is a certain amount of self-analysis made, healing undertaken and time absorbed for the healing process for reparation procedures such as rebuilding the affected parts of the city and infrastructure.

Spillen et al. (2011) had highlighted that there should be fluid communication within the relevant stakeholders of the recovery operations. This can be regarded as a good opportunity to effectively centralize the orders and protocols for all of the city's departments under a unified command (berke et al., 1993). Berke et al. (1993) had also mentioned that recovery procedures can provide numerous opportunities for benefits to organizations in methods such reducing the costs, increasing effective policies being passed as well as double the protection of the city and reduce the vulnerabilities of the organization and prevent further calamities from affecting it again. This can be possible by bringing in some physical changes and developments to the infrastructure, thereby making the framework more rigid and reducing the effects of disasters quite considerably. It is unfortunately escalated by Drabek (1986) that out of the four phases of dealing with a natural disaster, that the recovery phase is the least studied one of them all and therefore, it is the least understood phase among scholars and researchers alike.

Being one of the most important phases of the disaster management cycle, the recovery phase garners much attention in Roberts (1994), Fink (1986), Mitroff (1988), Pearson and Mitroff (1993) and Faulkner (2001). Emergency management can be measured in the recovery phase through the following ways: firstly, the speed at which the organization takes while recovering and continuing its day to day corporate operations; secondly, the degree in which the corporate is to recover from the disaster and presume its operations, despite having losses succumbing to the calamities; and thirdly, the resistance towards the disaster that has been taken on by the organization.

Ernst and Young/Computerworld Global directed Information Security Survey of 4,255 IT and data security directors, 84 percent of them said that their senior administration trusts that security administration is "imperative" or "critical". Surprisingly, 50 percent of the participants had stated that they do not have a disaster recuperation plan. Another review by Bahador & Danila (2005) 85 percent of the companies under the Fortune 1,000 organizations have disaster management plans in place. Only 50 percent of these organizations however, have plans that ensure the systems running the activities. This shows how numerous organizations disregard the importance of DRP protocols. DRP is considered as an insurance against factors that affect the corporate continuity. The most basic function of the DRP is the distinctive proof and the security of records that can prove to be invaluable in the company's existence. This is why stringent

measures should be undertaken in order to protect the IT department from assaults and damages. The safety measures ensure that the IT activities are recuperated in a way that they can continue with their corporate activities undisturbed. Such features are fundamental to the successful running of a smart city should there be an arrival of any unforeseen calamities.

2.3.1.1 Benefits of DRP for Organizations

DRP basically helps organizations in restoring lost data and recovering data that has been lost in the process of a calamity. There are seven benefits to this process. They are (Hawlins et al., 2000):

1. They eliminate confusion and human error. This can be done by giving only specific tasks to the responsible teams during the disaster. Other management teams can then focus on different matters at hand that are critical to the recovery operations. Managers are usually focused on customer service, company liabilities, vendor management, inventory, staffing and other legal issues at this time

2. They reduce corporate interruptions during operations. While a new corporate site can be established, the corporate can presume its activities almost immediately, with the appropriate team ready and capable for the task

3. This provides alternative options for mangers to consider. Before disaster strikes, the DRP can essentially provide different alternative scenarios for administrative teams to consider for recovery

4. It reduces dependence on certain key individuals. Supposing a LAN Network is destroyed in the disaster, the key personnel in-charge of handling the recovery task may be the only one who will have the knowledge in fixing the error. As such, if the personnel is not available, it can cause problems in fixing the error, which is why more than one person should be given the responsibility to handle such scenarios as one can cover for the other

5. It protects the data of the organization, which is the most invaluable asset of an organization. They are stored in numerous different forms such as databases, spread

sheets, documents and other means. They may also be more important information such as customer databases, financial documents, mailing lists, and EDI forms from vendors and customers. It is possible for users to store these data dumps in magnetic media such as tapes or hard drives and even on LAN servers. Especially for companies that are located in high-risk areas such as near water-bodies and other such environmental risks the DRP protocols become a fundamental need, with fail-safes such as elevated surfaces as well as wall-mounted racks for holding the necessary electrical equipment

6. In order to make sure that the personnel remain unharmed, the corporate offices need to be relocated to safer locations. DRP protocols can also accommodate for logistical needs to transport employees from one place to another when disaster strikes

7. DRP can effectively help in a more precise and orderly recovery since critical incidents can be taken care of faster and more efficiently, giving managers ample amount of time to focus on more stressing matters

2.3.1.2 IT integration and continuity

In IT, till about more than a decade ago, "systems integration" was unfamiliar terminology (Varney, 1996; Henderson, 1994; Wyse and Higgins, 1993). Essentially, systems integration deals with technical integration problems that can appear between numerous information resources and tools like operating systems; communication-networking standards; mono-functional systems and instruments; applications and data. All of these problems can be solved by creating proprietary hardware and software applications that serve these required functions and integrate the platforms with one another. Some of the functional areas are multi-purpose systems and devices, integrated desktop applications, and integrated enterprise-specialized structures such as supply chain management (SCM), enterprise resource planning (ERP), customer relationship management (CRM), integration protocols, corporate intelligence, middleware entities and integrated systems management entities.

Scholarly research papers on the topic of systems integration primarily broadens wither of both of the phases of data integration and application integration respectively. A generic summary of the principles, practices and perspectives pertaining to systems integration and systems

architecting was provided by Sage ad Lynch (2004). Furthermore a framework design was suggested by Irani et al. (2003), and it mainly focused on execution of enterprise application integration (EAI) solutions so that traditional life cycle shortcomings could get highlighted, and that EAI solutions could be recognized as the most well-known and recurrently utilized IS design methodology. Approaches of knowledge representation were emphasized upon by Rousset and Reynaud (2004) as they can be used to construct intermediaries for the purpose of information integration. A total of four integration areas are specified by Wainwright and Waring (2004). These are technical, systems, strategic, organizational, although just the first three are being incorporated in the research. Thus, a strategic model for implementation of integrated IS that is included in organizational domain was set up by them.

For the initiation of EIA in organization, Erasala et al. (2003) have established the following drivers: e-commerce, partnerships, and consolidations, ERP packages. Authors Peak et al. (2005) has discovered numerous aspects of integration that stress integration as being an ongoing process as the software and hardware of an organization gets updated and the corporate process gets transformed. The balanced scorecard method was used by Phusavat and Jaiwong (2008) that is used for linking as well as integrating the time lag effects as well as the bringing out of an effective strategy framework. A very special conceptual model was developed by Chen and Dwivedi (2008) that was based on the integration technologies taken up by Small and Medium Enterprises (SMEs) together with large-scale industries.

Gunasekaran and Ngai (2004) were the ones who came up with a framework that had the function that facilitated the study of information systems in supply chain integration and management of the systems. Coughlan et al. (2005) speak of the relationship that incurs between the corporate and IT departments. Oglesby (2005) claimed that there are six pillars of IT alignment. They are: strategy, organization, applications, infrastructure, projects, and governance. Proponents Bouwman and Versteeg (2006) provided a proper definition for the architecture of a corporate as being within domains that encapsulate a new paradigm and spectrum of relations that branch from corporate strategy and IT. Gulledge's (2008) take on the matter is far more holistic with respect to enterprise integration defined as architecture-driven. In this particular framework, corporate process management is regarded as the key element that constitutes achieving the total enterprise integration.

The best systems integrations always address the problems incurred by the IT system and the organization as a whole. An example of this is ERP, which is the most commonly used solution achieving integrated enterprise information system. There are numerous complex processes that need to be set up as prerequisites such as construction of master data, client-server setting, networking protocols, construction of master data, configuration of an ERP software, etc. But the most integral part of this system is the element of redesigning of the organization. Another scholar (Moon, 2007) had established parameters that help in receiving a successful ERP implementation. Aerts et al. (2004) have also brought up numerous different models of ICT architectures that have their respective roles in IS expansion and evolution. Thomson and Budgen (2003) also lay down some empirical proof that is relevant to computer aided software engineering tool evaluation.

There have been several engineers who have contemplated different methods of initiation of integration of information systems (IS) expansion and corporate process re-engineering/total quality management undertakings (Fok et al., 2001; Attaran 2004). Particular elements of IS moulding under ERP projects that were implemented by Nelson and Somers (2004) and Soffer et al. (2003). Brown and Ranganathan (2006) discuss of two varying types of organizational integration that are each related to information systems – in broader sense – and ERP systems as well. They merge technical integration as well as corporate integration. Jonkerr et al. (2006) have highlighted that an integrated approach to corporate and IT is invaluable. Enterprise architecture, according to them is a "structure with a vision". It provides a unified perspective of the systems being constructed or even being analysed.

A discussion by Goethals et al. (2006) purport that enterprises, invariably, are the same as living objects and they require to be consistently re-architectured so that they can be more agile, aligned, and integrated. In context of integration, Gulledge (2006) has also explicated in detail as to "what is integration?" – a question that is frequently asked, by presenting two variants of integration: one that is referred to as the "Big I" and the second one that is called to as the "Little i" in "integration" when considered as a whole term. Various other researchers have also proposed different perspectives of integration. Moon (2007) for instance, explores the different concerns with respect to selection and use of various IS methodologies and their design. Li and Chen (2001) have also investigated in the same. Furthermore, Peak et al. (2005), Marble (2003),

Bergeron et al. (2004), and Burn and Szetob (2000) have also meted out due significance to IT-corporate alignment.

2.3.1.3 Evaluation of IT DRP Components

An IT disaster recovery plan (DRP) is essentially a set of documents that describes the procedures which will be used for recovering the IT infrastructure of a corporate in the case of a disaster. Such a plan describes the procedures that the organisation will take for recovering its important IT elements. We evaluate the important DRP components here, which include the identification of disasters which affect IT components. We then discuss the IT services and describe how important company members should be involved in the recovery process. Other components include the ideal recovery process and employing offsite storage to provide alternate physical location for the important data. This storage needs to be serviced by regular backups. Maintenance activities are also covered in a comprehensive DRP (Wallace & Webber, 2010). A brief table 2.4 at the end of this section highlights how these components are evaluated according to the available literary sources. The figure 2.3 shares the key elements influencing the IT disaster recovery process, which initiates with IT disaster identification and notification and concludes with maintaining the system. Each of the elements is examined in the detail as follows.

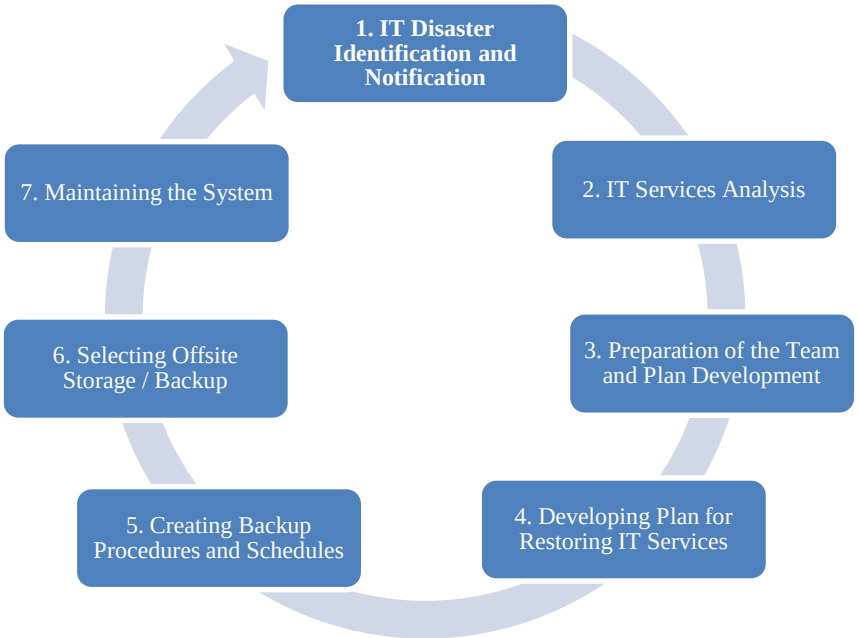

Figure 2.3: Elements influencing IT Disaster Recovery

2.3.1.4 IT Disaster Identification and Notification

The first dimension of a DRP is the identification and notification (Olshansky, et al., 2012). This element describes the procedures that are able to detect an IT disaster and launch the process of restarting the important IT services in an organization. There are three different sub-dimensions to this major element. The first section is that of detection. This is a sub-domain which describes the procedures that should allow the IT recovery team to classify a disaster and therefore ensure that the right mode of operation is selected for the recovery (Omar, et al., 2011). The second sub-domain is the warning phase. This is the phase in which the relevant recovery team members should be contacted and informed about the crisis at hand. The second phase should work as an alarm as well. It should signal the start of the required recovery process and ensure that the key stakeholders, such as senior management. All alarms and information processes must be included in this particular subsection for efficient IT disaster management (Snedaker & Rima, 2013). The third subsection is that of creating a communication channel. It is an important element, as ordinary communication methods may not be available during a disaster or IT problem (Pokharel, et al., 2010). Common phone lines and internet connects are not available during a crisis and the relevant team members should be contacted using an alternate method, such as using personal mobile phones and set addresses. Internet based services, and calling mechanisms can be used to provide this important option (Gustin, 2010).

2.3.1.5 IT Service Analysis

The next important dimension is that of IT service analysis. This element also has three subsections. The first explains the cataloguing of the IT services. This involves reviewing all the IT services that are on offer in an organization. It focuses on the core IT services on offer, such as email system, routers, servers and client based applications. The second sub-domain describes the process of prioritizing the IT services. It involves the ranking of the available services, which describes the order in which IT services should be restored after a disaster (Omar, et al., 2011). This can be done by carefully identifying the dependency of services of understanding their importance in relation to the main organizational functionality (Hentenryck, et al., 2010). The third sub-element is the identification of the risks to these IT services and their infrastructure. The focus needs to remain on the delivery of IT service, but not on the inputs. The main reason

behind this concept is that an IT service can still be delivered even when a few inputs are not available. An example can be presented in the form of a few servers being down, while still one available to offer the bare functionality (Wallace & Webber, 2010).

2.3.1.6 Preparation of the Team and Plan Development

The preparation of organizational members is another important element. This element describes the procedures that prepare key team members for performing activities that are required for decision making during the time of the actual need. This activity once again contains three subsections. These elements are disaster recovery team preparations, non-disaster recovery team preparations and decision making elements. The first sub-dimension of the preparations of the IT disaster management team consists of creating a team that will recover the required IT inputs and reinstall products wherever required (Omar, et al., 2011). The disaster recovery team may also include external elements, such as installation technicians, who are not part of the company. The team members need to be trained in order to ensure that they know their responsibilities, and will be able to quickly perform them when needed (Snedaker & Rima, 2013). The second element of this dimension addresses teams which are designed for preparing employees who are not part of the recovery team, but are important stakeholders. These people include senior management and key employees who work in the same premises. All key elements in the company need to understand IT disasters and learn how to perform in such cases (Saleem, et al., 2008). The final sub-dimension is proper decision making. This element requires that appropriate procedures should be set up, which should cover all aspects of important decisions. The authorities which are responsible for decisions should be clearly defined along with backups, as it is possible that a primary authority may be absent in the case of a disaster (Gustin, 2010).

2.3.1.7 Developing Plan for Restoring IT Services

The next dimension is the recovery process planning. This includes two clear elements of recovery processes and alternate IT facilities. The recovery processes need to focus on performing tasks that once again resume the basic IT services. This includes restarting the required inputs, such as servers, communication technology, physical facilities, data, human resources and applications. The facilities here refer to structures and HVAC units (Wrobel & Wrobel, 2009). The human resources include the labour required to resume IT services

(Pokharel, et al., 2010). The communication category includes resuming inputs that send data across in the organization. Servers on the other hand include the physical devices required for producing an IT network. Application systems on the other hand create the client end, which employees and company consumers can use to perform their functions. Data is a key element in this regard as it includes all files and unprocessed information (Gustin, 2010). The next sub-dimension is that of alternative services. These are the facilities that provide IT functionality, when the primary IT network is down. It also includes the planning which is required to shift operations to a secondary location in the case of emergencies (Hentenryck, et al., 2010).

2.3.1.8 Selecting Offsite Storage / Backup

A key element in this regard is offsite storage. It includes all the important actions that you need to take in order to ensure that your data and software remains safe in the case of an IT disaster. This dimension also has two sub-elements (Olshansky, et al., 2012). The first one in this regard is portability. Portability describes that an organization needs to create formats for all its data and software elements that can be easily moved if there is such a need (Heng, 2009). The second component is the actual off-site storage, which requires the setup of procedures for actually transporting the data and software to a remote location, in the case of an IT disaster (Wallace & Webber, 2010).

2.3.1.9 Creating Backup Procedures and Schedules

This dimension describes the routines, which are ideally required for creating the backups of all the key IT elements, such as software, data and other types of files. This component does not have any subcomponents like the other elements in the DRP (Saleem, et al., 2008; Heng, 2009).

2.3.1.10 Maintaining the System

The maintenance dimension has three subsections of testing, documenting and synchronizing processes. This element in fact describes all the procedures that are required for maintaining the overall IT DRP in an organization and improving it with the passage of time. The scope of the DRP needs to remain current in order to best describe the actual requirements of the IT structure. The first subsection is that of testing and updating DRP processes (Wrobel & Wrobel, 2009). It includes plans that continually test out the disaster recovery procedures. Tests are essential for

testing the recovery plan and it is essential to improve the problems found in the current plan (Pokharel, et al., 2010). The second element in this regard is the documentation needs of a DRP. It is essential to update schematics and manuals after each testing procedure. The documentation necessary is not part of the disaster recovery plan, but often helps employees and stakeholders to cover different elements during an emergency (Heng, 2009). No plan is capable of addressing every threat, and therefore it is always essential to keep modifying and improving the current set of plans and processes in a timely manner. Documentation helps in improving the plans (Snedaker & Rima, 2013). Synchronization is also a key element, as it helps in the disaster recovery and also allows the DRP to work with the overall continuity of the business (Saleem, et al., 2008).

IT DRP Components	Description and classification	Sources
IT Disaster Identification and Notification	Describes procedures for detecting IT based disasters and emergency communication methods. Also includes the warning mechanism for contacting key team members and stakeholders. Three sub-elements of detection, warning and method of warning	(Olshansky, et al., 2012) (Omar, et al., 2011) (Pokharel, et al., 2010) (Snedaker & Rima, 2013) (Gustin, 2010)
IT Services Analysis	Describes processes of recording and prioritizing the available IT services in the case of a disaster. Also describes the various threats that stop the reactivation of key IT services. Three sub-components of Identification, risk to services, and prioritizing services	(Hentenryck, et al., 2010) (Omar, et al., 2011) (Wallace & Webber, 2010)
Preparation of the Team and Plan Development	Describes procedures for training the disaster management team and other employees. Also describes the decision making structure during IT disasters. Sub-elements include preparing DRP team, preparing non-DRP team members and decision making processes.	(Omar, et al., 2011) (Snedaker & Rima, 2013) (Saleem, et al., 2008) (Gustin, 2010)

Developing Plan for Restoring IT Services	Includes procedures that restore the key IT service inputs and switch IT services to alternate facilities. Contains sub-elements of recovery procedures and alternative facilities.	(Wrobel & Wrobel, 2009) (Pokharel, et al., 2010) (Gustin, 2010) (Hentenryck, et al., 2010)
Selecting Offsite Storage / Backup	It includes all the procedures that describe how data and software will be kept in a portable form, as well as selecting the ideal offsite storage location. Includes subsections of portability and offsite locations.	(Olshansky, et al., 2012) (Heng, 2009) (Wallace & Webber, 2010)
Creating Backup Procedures and Schedules	Describes the routines for creating the necessary data and software backups to cover for an IT emergency.	(Heng, 2009) (Saleem, et al., 2008)
Maintaining the System	Includes procedures that allow for testing and updating the current IT DRP and produce supporting documentation. It also includes the synchronization of recovery activities to the overall organizational objectives. Includes subsections of testing and updating, documentation and synchronizing.	(Wrobel & Wrobel, 2009) (Pokharel, et al., 2010) (Heng, 2009) (Snedaker & Rima, 2013) (Saleem, et al., 2008)

Table 2.4: IT DRP Components classification

2.3.2 Process of IT Disaster Recovery Planning

There are many phases within DRP; however these phases differ amongst researchers (Leong & Marthandan, 2013). According to the author of '10 professional practices in corporate continuity management and DRP', which is a book on DRP for computer systems, there are 10 phases in a DR project (DRII, 2008) while a 7-phase BCM approach by the BCM Institute (2009) as well as Gallangher, (2003) along with a 6 (BCI, 2008), and 4 phase approach has been suggested which include emergency response, program management, crisis restoration and risk prevention (Mainline Information System; Ketterer, Price, & McFadden, 2007) . In a case study, a 3-phase DR contingency plan has also been suggested (Petroni, 1999). In spite of the phases as well as activities that are suggested, the main aim of DRP is to ready the organization to be able to avert,

respond and recover from any kind of corporate interruptions via a planned structure of actions grouped into a number of phases. There are many studies which have discussed at length the components of DRP (Herbane, 2010), however very few have actually analysed the vital factors of success of DRP. The critical success factors of DRP were studied by a researcher in 4 industries which included trading, banking, hotel industry and manufacturing, in Hong Kong. The researcher came to the conclusion that there are 17 factors which influence DRP (Sahebjamnia, Torabi, and Mansouri, 2015; Chow, 2000). In the conceptual paper, a total of 27 critical success factors were identified which could be used for the implementation of corporate continuity management, which needs further study and validation (Kelly, 2012). The key factors that are found to primarily influence IT DRP are presented as follows.

2.3.2.1 Implementation

DRP is governed under the governance of IT since it is an IT function. In order to achieve the IT objective within the IT sphere, the governance framework is developed by including system development lifecycle along with project management methodology. The main aim of project-management method is to create a basic arrangement using which those people who work together, their behaviours can be managed (Smith, 2012; Johns, 1995). It is vital that there is an initiation of projects to create the DRP for communication along with computer resources (Toigo, 1996). It was concluded that is vital to formulate a well-planned project management approach and adopt it so that there are more successful projects in IT processes (Johns, 1995; Pink Elephant, 2006). The success rate of IT projects will improve (Skulmoski, 2001) upon maturity as well as competency of project management methodology within a corporation. In order to be relevant to the ever growing organization and to ascertain that it is effective whenever required, it is essential that the DRP is maintained, updated and tested regularly (Gibb & Buchanan, 2006; Sahebjamnia, Torabi, and Mansouri, 2015; Cegiela, 2006; Bank Negara Malaysia, 2004; Emmanuele, Damiano, Sandro, & Marco, 2007). Further suggestions include development of regular audit programs to make sure that DRP of the corporation is in line with the IT and corporate governance always.

2.3.2.2 Continuity Management

The main focus of IT service management (ITSM) is to provide good quality IT services which help to reorient IT with the corporate objectives (Cater-Steel, Tan, & Toleman, 2007). ITSM is a process-oriented service which includes employment of software tools by companies to support as well as automate all the process (Kuamoo, 2006; Sahebjamnia, Torabi, and Mansouri, 2015). It is important to note that IT service continuity management (ITSCM) which is a process of ITSM, is nothing but an extension to the DRP (Kuamoo, 2006; OGC's Authorized Authors, 2001). It is an important technical component of BCM and it constitutes of some of the vital BCM phases which are then incorporated within the DRP functions (Wallace and Webber, 2010; Loftness & Drapeau, 2007). The goal of ITSCM is to support BCM and also make sure that the corporates have the needed IT systems to get back quickly after experiencing a disruption. The four core components of ITSM during the development of the 3rd version were, people, partner (also called vendor) and product (tool). It is all about formulating procedures and processes for the management of IT operation situation with the proper vendor, product, & people. This also includes paying attention to the IT services recovery by employees along with the vendors who are there to provide the needed support. Since then, individual components have been introduced which depict the value of people and partner within process development.

2.3.2.3 People

When it comes to innovation, it is a rather broad concept which includes processes, people and technology by creating scales which help in the measurement of the ability of new acquisition (Gaynor, 2002; Sahebjamnia, Torabi, and Mansouri, 2015). It was discussed as a practice or a set of practices something that is noted by a person (Rogers, 1995). In the promotion of innovation, people play a very important role and the competency of people directly influences the effectiveness of the organization. Competency in this regard was initially defined in terms of skills, knowledge and attitude (Gregory, 2011; Yang, Wu, Shu, & Yang, 2006). However, this was later changed and connected to many other elements that have a relation with job superiority and outstanding achievement (Gregory, 2011; McClelland & Boyatzis, 1980). When looked at it from the perspective of IT DRP, people factor forms the core of the process development. The aim of this research is to examine the importance of people factor in IT DRP adoption for the

Smart City framework. They are mainly considered in order to encompass the IT DRP from the environment, technology and organization to technology, environment, organization and individual framework.

2.3.2.4 Technology

Technology is termed as the means through which systematic knowledge is being transformed into tools. It considered to be important in gauging the efficiency of those elements within the society that helps to accomplish tasks (Gregory, 2011; Drejer, 2000; Tornatzky & Fleischer, 1990). Depending on the kind of trade being carried out, its requirements with respect to technology and its strategic direction, different corporations make use of different kind of technology (Phoommhiphat, 2011). The focus of DRP is on the accessibility of services as agreed during the service hours ; however, in case of any outage, there are well designed process and procedures which have been tested and they help in the recovery of services inside the time frame that has been decided (Lawler & Szygenda, 2007). Technology readiness does not only refer to the physical assets of the organization but also the availability and accessibility of resources that assist the services (Teo, and Tan, 1998). Furthermore, they should also be dependable in order to execute their functions as required (Tipton and Nozaki, 2012; Lippert & Govindarajulu, 2006).

Behaviour related to disaster is very complex since it may occur at different times within different communities (Quarantelli, 1999). In the opinion of many people, there are overwhelming tasks for the implementation of DRP process, along with the handling of the daily trade activities. To be able to recover smoothly as well as efficiently, the technology recovery constitutes of a sequential and systematic recovery which starts with the hardware and software recovery, network, data and backup technologies (Snedaker, 2013; Dirtadian, 2008; Serrelis & Alexandris, 2007). Implementation of DRP process is complicated as well as costly (Tipton and Nozaki, 2012; Gallangher, 2003).

Recovery of technology includes many efforts for recovery of hardware, software, physical assets, network, data and backup technologies which are IT services the base (Serrelis & Alexandris, 2007). It is vital to note that backup technologies shouldn't be only affiliated to the equipment but instead, there should also be a focus towards building where the technological

assets are kept along with the facility which supports the IT services (Gallangher, 2003; Dirtadian, 2008; Ling, 1997).To be able to further fortify the competitive advantage of an organization, the technology readiness of the organization helps to improve the corporation's performance by reducing the recovery time period; thus having more satisfied customer service function with lowered costs of operations (Oliveira & Martins, 2010).

2.3.2.5 Organizational

The main objective of implementing the DRP process was to have service quality which is readily acceptable (Snedaker, 2013; Gronroos, 1984). All customers are looking out to experience uninterrupted services and the processes, services and products are continuously updated and improved so that it can satisfy the ever changing needs of the customer (Teo, Lin, & Lai, 2009; Snedaker, 2013; Ramdani, Kawalek, & Lorenzo, 2009). Organizational compatibility discusses the implementation of DRP in congruence with the values of the organization, its culture and practices. The existence of organizational policy as well as framework will lend assistance in the DRP implementation (Wallace and Webber, 2010). Some of these policies include, internal and external communication policy, learning and development policy, technical blueprint, management risk policy and technology process framework such as System Development Life Cycle (Chang, 2015; Chau & Tam, 1997; Ramdani, Kawalek, & Lorenzo, 2009) or Project Management Methodology (Ifnedo, 2011; Teo et al., 2009).

One of the important construct in the organizational context is top management assistance and decision-maker characteristics that help in diffusion of technology within the organization (Ifnedo, 2011; Ramdani et al., 2009). Mitroff (2005) further stressed that without the presence of quality leadership within an organization, it is impossible for any corporation, organization, firm or an institution to survive for a long period. Furthermore, it was established that it is the senior managements responsibility for the implementation of DRP which includes robust development of plan which is not only tested but is also communicated properly to the stakeholders (Mitroff 2005; Woodman, 2008).

2.3.2.6 Environmental

One of the vital environmental factors that influence the selection of IS innovation is external pressure for the survival as well as growth of an organization (Chang, 2015; Iacovou, et al., 1995). Extraneous pressures maybe further classified as competitor pressure, information intensity, government support, industry competition and regulatory requirement (Kuan & Chau, 2001 Zhu, Xu, & Dedrick, 2003). Physical as well as technological infrastructure underpin IT services. These include location of the building, location security, protection equipment which includes fire alarms, fire detectors, location monitoring systems theft alarm, along with data center utilities such as hardware rack, cabling management, and cooling systems (Wiboonrat, 2008; Khalil & Elmaghraby, 2008; Wadekar, 2007). Based on the discussion raised above, the six key elements of the IT DRP process are shared in the table 2.5 below.

Element	Description	Sources
Implementation	In order to be relevant to the ever growing organization and to ensure that it is effective whenever required, it is important that the disaster recovery plan is maintained, updated and tested regularly	Sahebjamnia, Torabi, and Mansouri, 2015; Emmanuele, Damiano, Sandro, & Marco, 2007; Cegiela, 2006; Gibb & Buchanan, 2006; Bank Negara Malaysia, 2004,
Continuity Management	IT service continuity management (ITSCM) which is a process of ITSM, is an extension of DRP .It is an important technical component of BCM and it constitutes of some of the vital BCM phases which are then incorporated within the DRP functions	Wallace and Webber, 2010; Loftness & Drapeau, 2007; OGC 's Authorized Authors, 2001
People	In the promotion of innovation, people play a crucial role and the competency of people directly influence the effectiveness of the organization. Competency in this regard was initially defined in terms of skills, knowledge and attitude	Gregory, 2011; Yang, Wu, Shu, & Yang, 2006

Technology	Technology is termed as the means through which systematic knowledge is being transformed into tools. It considered to be very important in gauging the efficiency of those elements within the society that helps to accomplish tasks	Gregory, 2011; Drejer, 2000; Tornatzky & Fleischer, 1990
Organizational	Organizational compatibility discusses the DRP implementation in congruence with the organization's value, culture and practices. The existence of organizational policy as well as framework will lend support in the DRP implementation.	Wallace and Webber, 2010
Environmental	One of the critical environmental factors that influence the decision of adopting IS innovation is external pressure for the survival as well as growth of an organization. External pressures maybe further classified as competitor pressure, information intensity, government support, industry competition and regulatory requirement	Chang, 2015; Iacovou, et al., 1995

Table 2.5: Key Elements of IT DRP

2.4 Information Technology as Enablers for Corporate Continuity

IT has recently been hailed as being the primary source for corporate continuity enablers. Since its inception, IT researchers and personnel alike have all contributed towards improving the corporate processes in numerous ways to facilitate corporate continuity. As any amount of downtime results in losses, the IT operations can convert that downtime into profitable means of communication by increasing uptime through various efficient processes, thus effectively securing the financial stability of a company. The prerequisite for any corporate plan nowadays stems from a proper continuous computing solution. "Corporate Continuance" has thus been described as a term that allows for emphasis on continuing the corporate operations despite external factors that can affect the organization negatively. In order to keep the corporate up and running, there are numerous corporate technologies being developed to ensure that there is no downtime in the process.

Servers play a major role in ensuring that there is no loss of data. Selecting the right server operating system ensures that the company has the most optimum levels of availability, reliability, scalability, and security. Corporates today are thus entirely IT-dependent and data driven. This is the evolution of IT in today's world. The competition has to keep up with the corporate acumen of the biggest names and IT is the most decisive factor (being both adaptive and flexible). All corporates which want to be continuous and uninterrupted require strong IT platforms that are "25x7x365" functional and available with data readily. This is because any amount of downtime with regard to corporates' applications/ functions/ services can translate to instant losses of customers, corporate opportunities and lost revenues.

One of the best supporting causes for the 2006 British Standard (BS 25999) is the organization-wide culmination of the stakeholders, strategy and the durability-centric crisis management approach for corporate continuity that has accumulated over three decades of development for the sake of recovering from interruptions and prevention of the same. In essence, corporate continuity management is but a figment of the much wider spectrum of crisis management literature that has been in existence since the 1970s that focuses on prevention, swift decision making as well as numerous social and technical perspectives. Corporate continuity can be traced back to the methods adopted in the form of contingencies and disaster recovery programs that were first enabled by organizations back in the 1970s. It was in numerous studies (Pitt & Goyal, 2004; Gallagher, 2003; Swartz et al., 2003) that crisis management operations and planning have been identified that consist of multiple distinct phases of development. Each of these phases was attributed a decade since the 1970s and can be easily distinguished as being the most influential methods in the development and implementation towards newer, modern approaches in crisis management planning. The main differences are the use of technology, emergent compliance as well as value.

With the introduction of the IBM 360 in 1965 and the model 370 in 1970, which served as cutting edge technology that served for corporate processing by offering a solution for corporate management and storage of important information into a single system, risks had risen as to the safety of the data and so it led to the eventual realization of what is now commonly referred to as corporate continuity management. As more information technology came to be developed, more and more corporates focused on safety and security of these systems and thus focused their work

towards the weaknesses of these systems during the process of their electronic data processing (EDP) features. They tracked the causes of hardware failure as well as the response to such incidents by the organization as well as the experience of the operator or lack thereof (American Bankers Association, 2005). The planning of the contingencies took place at the facilities which housed these systems, such as in data centres (Namel & Ward, 1983). At this point of time, the main methods of contingencies adopted were to have standby systems and data backups in place should there be an instance of emergency.

There was no method developed to remedy the situation or to prevent failures of the systems' functioning. It was when the Automated Clearinghouse Association was founded that seven banks from Philadelphia had set out to together establish stringent protocols for the development of disaster recovery planning after their own companies had suffered losses due to information systems (InnoVest 2003). Electronics began taking over more of the corporate dealings, especially after the 1980s and the 1990s when information technology was fluent in financial services as well, being integrated into the stock market despite concerns for deregulation (known as 'The Big Bang'). The move to electronic stock exchange happened first in the year 1986 in the London Stock Market and thereon first, direct telephone insurance (Direct Line) grew in popularity in 1990, then came telephone banking (First Direct) in 1991, followed up by internet banking in 1999 (Herbane, Elliott, & Swartz, 1999a).

After being embedded into the technology of the 1980s and the 1990s, the next step in crisis management was carried forward during the invention of the personal computer (which resulted in more computer operators in the organizational sphere). This resulted in more connections being formed, such as the interconnection of systems and data, as well as the rate at which transactions and processes were being automated and assumed. It was in the 1980s that compliance began to take form. The 'auditing mindset' that organizations are known to have, influenced organizations to initiate crisis management activities (Swartz et al., 2003) since it had become a legal compliance under certain corporate regulations set by the government (but the actual need and necessity for this kind of enforcement only happened during the 1990s and the 2000s). Being one of the key strategic access points for organizations, computer systems were the first to incur any planning for crisis management protocols, but owing to previous failures in implementations, companies could no longer afford to create recovery options, and so they

decided to create more preventive measures instead. There was suddenly, the appearance of a disaster recovery industry (one that can supply emergency recovery tools and centres that involve telecommunications, data backup as well as restoration, salvaging and other services). Despite the emergence of such an industry, many organizations still lacked DRP in more cases than not.

DRP was also not considered to be popular at the time and numerous calls for question were made surrounding the viability of such a methodology during the 1980s. It was in 1986 that Dugan suggested that DRP teams located within the IT function resulted in limited number of managers who were involved in the process of planning and testing. Banks were the first-adopters of the DRPs but the user experience was not favourable enough for users and so they pushed for better implementation of the delivery of user-driven needs over the importance of the generic system functions when deciding on transferring to an emergency facility (Burger, 1988). Although the above-mentioned incidents are still meagre in number, it does emphasize vulnerability of these systems at a time when important information and data was lost, owing to the third-party infrastructure. During the early days of corporate continuity, the outcome defined the corporate continuity process as opposed to there being a set plan of action or methodology (Gallup, 1989; Moretz, 1989). After a series of terrorist activities appearing in the 90s decade (like the London Stock Exchange (1990), World Trade Centre (1993) and the London financial district (1992 and 1993)), a need for crisis management planning and support was realized and was given more priority in the form of a process-centric approach that became more important than IT-based and function-specific disaster recovery planning.

A few minutes of downtime in today's corporate landscape can result in thousands and millions of dollars in lost revenue. Hence, down-time has now become an unacceptable feature that is not usually tolerated by big enterprises especially. This is why there is a need for systems that are reliable, secure, and can be scaled afar. Fault tolerance, corporate continuity and Disaster Recovery (DR), data access being fluid and fast; these are just a few of the demands that can be found in today's corporate world (Gartner Group, 2002). The ramifications of downtime can be easily defined in financial lingo and are also bound towards the company's financial results. "Economics of availability" and "economics of uptime/downtime" have thus become very important keywords to establish a corporation's affinity towards success, especially when they

deploy information systems routinely. At present, it is possible to evaluate exactly how much money a company can lose, form a mere minute to even up to an hour of stoppage in activity. The losses can differ and fluctuate, based on the kind of corporate being started (examples: airline reservation systems, online banking systems, call centers, dispatching systems, online shops, point-of-sale systems, e-mail servers, amongst others).

In the view of Graham and Sherman (2003), an hour of downtime for a company can cost up to $44,000. According to that number, moving from an availability level of 99.99 percent to 99.999 percent availability is considerably low compared to the $435,600 that is incurred over five years of losses due to downtime. E-commerce based companies must therefore be capable to address the requisites for a proper "25x7x365" functioning. Hence, the operating system platform is most important as the prerequisite. A system like this should be able to take on the possibility of downtime and overcome it, tackling issues such as daily glitches relating to the hardware and the software, upgrades to system and hardware, partial disasters as well as full-scale disasters, corporate mergers and acquisitions and other such issues. The organization should have an information system in place that ensures that all of the corporate processes run smoothly despite the interruptions made available that can match the customers' needs. The technology can be used for providing cost-effective means of production as well as service delivery.

In the last few decades, Information Technology literature has focused on the fact that a well-developed organization will have an advanced IT disaster recovery contingency (DRP) to elevate it from collapse (Marshall and Schrank, 2014; Green and Olshansky, 2012; Al Badi et al., 2009; Benton, 2007). In fact, many legislative and regulatory bodies have now made it mandatory for companies to include this feature in their corporate plans. In the United Arab Emirates (UAE), banks are not allowed to have a DRP, but corporate practices that are successful, will be able to mandate a plan such as this. Many modern corporate setups are fully independent on their IT systems and are integrated not only internally, but also externally to vendors and other external modules of the organization. Organizations are required to include one or more of the industry practice approaches (ITIL, ITSM, COSO and COBIT) into their corporate plan so that they can ensure the continuity of their activities should a disaster take place.

In the given literature, numerous terms are given to define and discuss planning that is related to keeping a corporate alive and continuing despite a disruption. An organization should critically analyse and define the plan of contingency that it is setting out to practice. Corporate recovery, disaster recovery, emergency management, crisis management or emergency response are all used in the same plain when it comes to the prospects of corporate continuity. In the following section, an evaluation will be considered between the various researches undertaken on IT disaster recovery planning. These will be narrowed down in order to come up with important research questions and further scrutinized for evaluation.

2.5 Significance of Findings from Literature Review

The review of the literature conducted in this chapter led to various significant findings, but the most important significant finding is the identification of the factors that contribute to the development of the IT DRP for smart cities. In the literature review, a comprehensive analysis of past research in the area of smart city and its prominent factors, along with IT disaster recovery was conducted. The aim of this review was to identify the most important factors that can lead to the development of a comprehensive framework leading to a state of the art model which encompasses both smart city and IT DRP elements in a harmonious pattern. From the review of the past literature on the smart city concept, it was found that smart city characteristics are classified into six essential components that determine its operations and overall success. Amongst the six components, the role of people, process and technology was found to be prominent. IT was found to link the development of smart cities with future sustainability thereby allowing smart government services to embrace smart city developments and services, and lead to enhanced security, safety and availability of government services. On the other hand, the review of IT DRP literature lead to the identification that there are six components that lead to successful IT disaster recovery planning. The six components were noted as implementation, continuity, people, technology, organizational and environment. Amongst these factors, the factors that were found to have cohesive behaviour with smart city factors were noted as people and technology, while implementation and continuity were identified as the core elements driving IT DRP success. In the section 2.6, the factors identified in the literature review will be subjected to further evaluation to identified the relationships that exist between the factors of smart city and IT DRP. At this stage, the factors for the framework for smart city IT DRP are

considered in general applicable for smart cities around the globe and not specifically for Abu Dhabi Smart cities. However, upon the validation of the model from data generated from Abu Dhabi based smart city participants, the model will be confirmed for application by other smart cities too.

2.6 Conceptual Framework

In today's competitive corporate landscape, any new corporate model should be able to work continuously and maintain its data at all times, especially when it needs to access and share the relevant data. Information technology has improved over the years and the rise of e- corporate and internet technologies, corporate continuity has become a more prevalent need than ever before as continuous computing (CC) technologies have become popular models of corporate infrastructure. At the same time, while IT is given tremendous focus on the corporate development front, there needs to be a plan put in place in order to establish the availability ratios of an information system. The methods put in place here are mostly interdependent, requiring a more integrated approach, which would be more favourable in the case of a smart city model. The following sections will feature reviews on the systems integration, system development as well as corporate continuity along with discussions on significant issues relating to systems integration such as downtime and disconnection issues. A framework on the development for IT continuity drivers for enterprises is also presented.

2.6.1 Factors influencing Smart Government Services in Smart City

With the review of the pertaining scholarly writings on the subject, characteristics of smart city attributed to the smart government services have been classified into the following: Technology, Processes, People, Organisational, Financial Resources and Security and Privacy.

Technology (IT and Skills) - The chief technological requisites for the execution of the smart government services pertaining to the IT infrastructure and skills is the increased usage of ICT, increased dependability and correctness of data. However, researchers have showcased some of the deterrents like a shortage of IT proficiency and a deficiency of dependable networks and communication. Some of the risk perils to be kept in mind when executing the smart government

services include the chance of the new technologies failing and the disintegration of the services (Abdallah & Fan, 2012; Matavire, 2010; Nkohkwo & Islam, 2013; Mundy & Musa, 2010).

Processes – Some of the challenges associated with implementing the smart government are the poor service quality, a lack of control over information and corruption, which is even more in case outsourcing is done for the front office. On the other hand, if it is executed effectively, it ensures competent delivery of the services, reduced chance of errors, increased transparent operations, a reduction in corruption, makes the process much more expedient and time-saving. There are a number of factors which have an unfavourable effect on the execution of e-governance are a lack of maintenance and reliability, a lack of awareness, reduced benchmark for the resources used and the strategies governing the communication architecture (Weerakkody*et al*, 2013.; Abdallah & Fan, 2012).

People – In order to provide credible e-learning to workers, having people skills are an indispensible attribute, alongside endorsing sharing of information amongst them, employees and to come up to the expectations of the citizens. Research has shown that some of the conflict of the staff, the lack of faith and approval as some of the other factors. Additionally, a few of the risks are due to the employees and relational confidentiality e.g. checking background credentials, lessening of human capital and augmentation in joblessness (Lam, 2005; Liu &Zhou, 2010).

Organisational (Culture/ Structure) – The element of organization is based on structural framework and cultural settings. Some of the advantages of the execution of smart government are the effectual change in the administration and communication activity among the various governmental bureaus and incorporation of government activities. Other issues showcased are the variations in institutional precedence, issues in the socio-economic and cultural paradigm, the deficiency of an organisational structure and headship failures. Researchers have highlighted the organisational risks as concerning the misunderstanding and mistreatment of e-Government services along with an increase in censure by other agencies and citizens (Abdallah & Fan, 2012; Almarabeh & AbuAli, 2010; Ghapanchi*et al*, 2008).

Financial Resources – The accessibility of financial resources can pave the way for financial and monetary incentive and favourable worth for money when the cost-benefit (CBA)

assessment of the services is done. However, review of the research literature showcases on the impediments to the execution of the smart-government services in relation to deficiency of resources, their proper allotment, the expenses of training and the development. Research has shown that a reduced capacity to fund the services, especially through the execution phase and the monetary sustainability are the major risks in the execution are some of the implementation risks (Nkohkwo & Islam, 2013; Abdallah & Fan, 2012; Liu & Zhou, 2010).

Security & Privacy – Research literature showcases that the security precautions and privacy concerns can work as incentives or as obstacles in the working of an organisation. The advantages are the increased security, secrecy, discretion and the trust in the dependability of the information as it is shared and stored electronically. Some of the threats are those to the safety of the stored data against loss and attacks from virus, malicious attempts as securing access (internally as well as externally) and the need for increased security arrangements. In the execution of smart-government services, the risks include identity theft and online attacks (Hector, 2012; Kessler, 2011; Nijaz & Moon, 2009).

An overview of the factors influencing the smart government services in smart cities is shared in the table 2.6. The table illustrates the benefits and obstacles of each factor in the smart government services along with the sources. In the next section, the past research in the domain of information technology disaster recovery planning is examined in detail.

Factor	Description	Sources
Technology	Benefits: Endorse the utilization of ICT in society, added Promote the use of ICT in the society; Increase dependability, constancy and accurateness of data sharing; Portability across systems and applications **Barriers:** Allows access to the information to other agencies; New technologies - peril of failure; reliance on foreign technological know-how; Service fragmentation	(Nkohkwo & Islam, 2013; Abdallah & Fan, 2012; Mundy & Musa, 2010; Matavire, 2010; Martin & Reddington, 2009; Hamed*et al*, 2008a; Lam, 2005)

Processes	Benefits: Competent service delivery and lessens inaccuracy; Increases transparency and lessens corruption More expediency and saves time **Barriers**: Decreasing control over information; Poorer service quality e.g. late service; Increases corruption if front office jobs are passed on to intermediaries;	(Weerakkody*et al*, 2013; Abdallah & Fan, 2012; Eddowes, 2004)
People	Benefits: Option of e-learning to the employee; Encourages information sharing between employees; Personalization: meets citizens' expectations **Barriers:** Relational privacy e.g. background checks; Decrease in manpower; More joblessness	(Liu & Zhou, 2010; Lam, 2005; West, 2004)
Organizational	**Benefits**: Change management becomes more effective; Enhances communication activity between overall government outlets; Amalgamation of government facilities and activities **Barriers:** Misapprehension and abuse of smart government facilities and services; Could be criticised	(Almarabeh & AbuAli, 2010; Buccolieroet *al*, 2008; Ghapanchi*et al*, 2008; Hu et al, 2006; Anderson, 2006)
Financial	**Benefits**: Better value for money in terms of cost-benefit analysis (CBA); Fiscal incentives	(Abdallah & Fan, 2012; Nkohkwo & Islam, 2013 ; Liu & Zhou, 2010; Ebrahim &Irani, 2005)

	Barriers: Reduced funding particularly during implementation; Monetary sustainability	
Security and Privacy	**Benefits**: Encourages discretion and correct information sharing; Electronic storage of large data **Barriers**: Environmental information which includes theft of identify Cyber- attacks, internet infrastructure attack	(Hector, 2012; Kessler, 2011; Nijaz & Moon, 2009; Beynon-Davies, 2005; Joia, 2004; Solove, 2004; Sanchez *et al*, 2003; Lambrinoudakis*et al*, 2003)

Table 2.6: Elements of Smart Government Services

2.6.2 Past Research in IT DRP

It is not easy to formulate a plan for an IT disaster recovery. The increased complication of current IT systems and the swift rapidity with which technology evolves makes it hard to make sure that the adequate measures are put into implementation (Retelle, 2008). The mainframes execute and process comprehensive transactional activity every day. There is continues development, modification, integration and retirement of internal applications. There is need for the maintenance of the desktop computers. The presence of neck-to-neck competition makes the customers desire and ask for the latest services. All of this ensures that development of an IT disaster recovery plan is tough. In this section, a detailed analysis of the past scholarly research in the domain of IT DRP and smart cities is conducted. The main purpose of this evaluation is to enable the researcher to identify the components essential towards the development of IT DRP for smart cities, specifically for Abu Dhabi Government.

IT DRP does not get consideration as a preference or alternative anymore. Efficient IT services are now an essential part of all the processes. In order to certify the sustained provision of IT, companies need to indulge in IT disaster recovery planning. However, there is not enough research done on the subject. It has not been completely looked into in IT research. Research by

Mohamed (2014) conceptualised an IT disaster recovery planning guide. The Recovery Plan is designed to ascertain that the furtherance of critical corporate processes in case a disaster occurs. The research was intended to come up with an effectual answer to recover all fundamental corporate processes inside the requisite timeframe by making use of the important records that are accumulated offsite. It was one of the numerous plans that aims to give processes to tackle emergencies and talks about the improvement, continuation and testing of the Disaster Recovery Plan.

In another study by Mansoori et al. (2014), the planning and execution of a disaster recovery in the healthcare system was investigated. The study focussed on radiology and picture archiving and communication system (PACS). The authors investigated the need for seamless operation of the system while maintaining integrity of the system, continuous access to data and ability to cope from a failure of the system. The DRP focused on structural design with a couple of servers, one in each site (local/disaster recovery (DR) site) with four altered situations to go on running and uphold end user service. While this research is related to healthcare, it is reviewed as healthcare is an active part of the smart city framework and to keep such service up and running, focus should be made on each element of the smart city model.

The significance of DRP is irrefutable particularly after the 9/11 terrorist attacks and the numerous natural disasters all over the globe; as a result a lot of work labor has been put in to uphold a set of practical DRP. Nevertheless, although a lot of resources is assigned for IT and DRP, there still are IT service outages which have disrupted operations, hampered the functions and affected the largely organizational long term strategic plan. Hoong and Marthandan (2014) put forward that the vital factors affecting the growth and upholding of DRP process, particularly to recognize the dimensions which put in to a thriving DRP that intends to diminish the effect of IT service outages. This research made use of an academic framework, technology-organization-environment model (TOE) to observe the adoption and implementation of DRP processes in economic bodies of Malaysia. The ensuing IT service management notion, individual constituents that encompass of trade collaborator willingness, personnel capability, functions and responsibilities were incorporated in the research. This research highlighted that the eight dimensions had been significant for the execution of DRP, and 2 out of 3 separate constituents being reviewed were included on the lists. The aforesaid 8 dimensions might be utilised for

giving direction to subsequent and successful DRP rollout and upholding; with the eventual aim to diminish outage period of IT services that sustain decisive operations.

As the reliance on corporate processes increases for the electronic and conventional services, it has become almost obligatory for every institute to also make preparations for Continuity (CP). Studies by Prazeres, and Lopes (2013) showcase a project to manage Disaster Recovery and support corporate connection was examined. The researchers paid attention on how the numerous virtualization technologies are influenced to restructure servers, network and storage supplies for the significant functions based on precedence. Additionally, the preparation of a project was conferred to manage the sensible solution execution in a key Portuguese association.

In the research by Kadlec and Shropshire (2010) the authors hypothesize that to make sure the sustained condition of information technology, companies need to invest in IT disaster recovery planning. The scenario is such as IT recovery planning has not been studied using a traditional IT research approach. This three-part analytical study present in detail the establishment and growth. Focus is given to how the domain definition came to be formed followed an attempt to understand the by the analytical growth and review of IT disaster recovery planning. For survey purposes, a corroborated structure was designed in advance to generate the 7 dimensions. A total of 34 items were assessed to calculate the reach and magnitude of IT disaster recovery planning. A sample of 153 financial and banking institutes were utilized to affirm the understanding. This research is a guide to IT disaster recovery planning; scholars might make use of the measure to contrast preparation activities among firms.

The Table 2.7 presents the overview of the discussion raised in this section, outlining the past researches in the area of IT DRP. In the next section, a framework for smart cities (primarily targeting the Abu Dhabi Government in UAE) is proposed.

Source	Study
Mohamed (2014)	A study to develop a guide to approach IT disaster recovery planning. The Plan is intended to make sure that the continuation of imperative operations in case a disaster occurs. The study aims to build up an effectual resolution which can be utilised to recover all essential corporate processes inside the required time frame by making use of crucial records that are stored off-site.

Hoong and Marthandan. (2014)	A study to analyse the vital dimensions which affect the development and upholding of the DRP process, particularly to get an understanding of the dimensions that play a part in the successful DRP which intends to reduce the effect of IT service outages.
Mansoori, Rosipko, Erhard, and Sunshine, (2014)	A study into the framing and execution of a disaster recovery in the healthcare system. The study concentrates on radiology and PACS (picture archiving and communication system). The researcher explores the requirement for flawless functioning of the system while upholding reliability of the system, constant access to data and capability to cope from a system outage.
Prazeres, and Lopes (2013)	A study that investigates the project plan to manage Disaster Recovery and hold up corporate continuity. The research focuses on how different virtualization technologies are influenced to rearrange restore servers, network and storage resources for the significant applications based on precedence.
Kadlec and Shropshire, (2010)	A study on the best practices in IT disaster recovery planning was conducted by the authors, for the banking industry. Though the study was not aimed at a smart city, it was able to outline a series of actions needed by firms to counter IT disaster and achieve effective recovery.
Tijan and Kos (2009)	The study evaluated the disaster recovery procedures specifically in corporate perspective, while focussing on the role of IT and ICT in strengthening the recovery operations.

Table 2.7: Past Research in IT DRP Area

2.6.3 Proposing a Framework for IT DRP in Smart Cities

There is the clear requirement to build a theoretical structure essential for recognizing IT DRP for smart cities. This is due to the literature and research review and view put in the chapter. The vital aim of the IT disaster recovery plan for smart cities is to build, review and document a reasoned and easily comprehensible plan which will aid the smart cities in recovering swiftly and efficiently form the unanticipated emergencies which act as a deterrent to the functioning and operations of the city. It also enumerates the role, process and the list of requirements that shall

be utilised to organise and regulate the circumstances after a disaster has occurred. The theoretical structure comprises of the components that recognise the major smart government service factors in a smart city and IT DRP aspects from the pre to post execution phase. Studies highlight the need for a necessary and essential structure that will include technology, procedures and people which have an effect on the IT DRP for the smart cities. The IT disaster recovery solution that will be particularly deal with within the purview of the smart cities is the inability to access IT services and the data processing abilities and the connectivity of the network. Though a loss of admission to the facility is more likely, the IT Disaster Recovery Plan shall look into the revival of the vital systems and crucial communications only. The situation also conceptualises that the hardware in the IT network cannot be recovered and that there is a compete loss of all the essential communications. The model is showcased in figure 2.4, and the main hypothesis to validate the framework below:

Hypothesis 1: There is a significant relationship between IT DRP components and Smart City Systems components in Smart Government Services leading to an efficient and effective integrated Smart City IT DRP Model

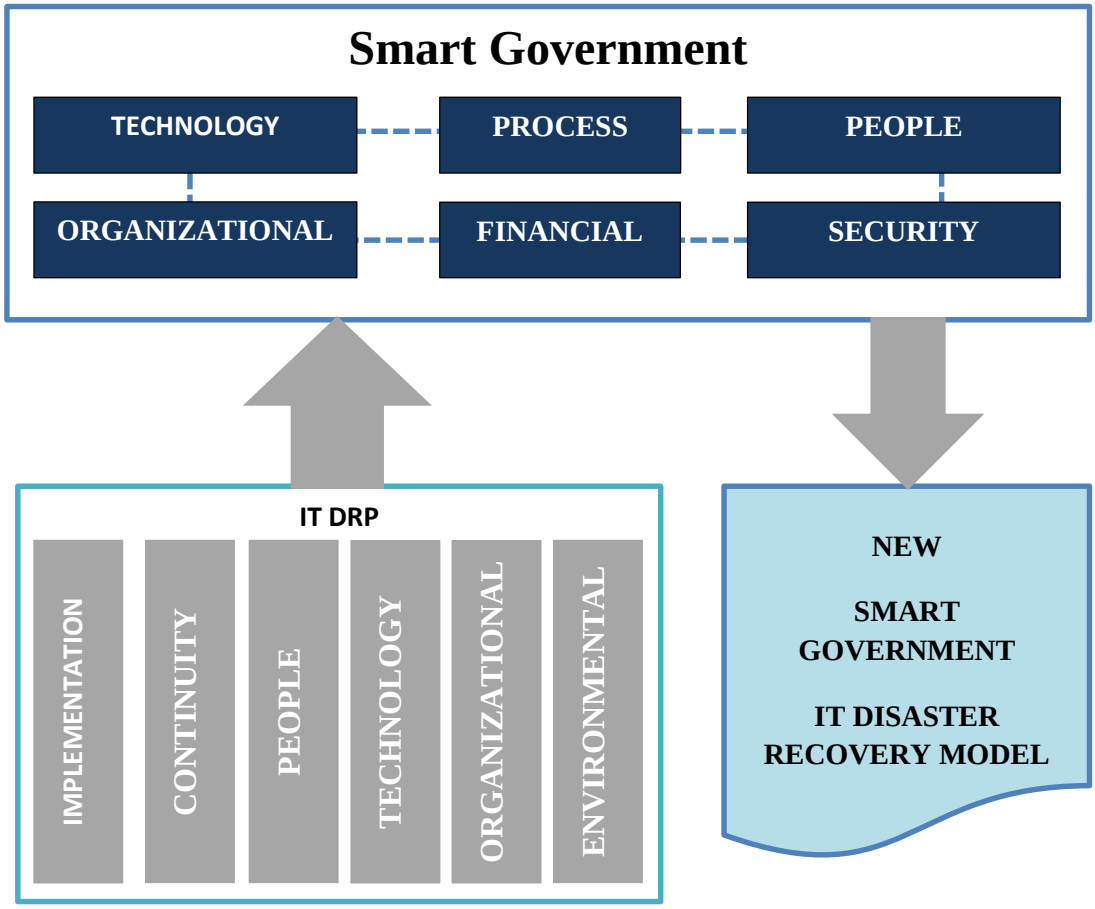

Figure 2.4: Framework for Smart Government Services IT DRP

2.6.3.1 Role of People and Technology in Smart Government Services IT Disaster Recovery

In the event of a disruption, corporations have become a lot more technology savvy and have developed corporate continuity plans which help to safeguard the systems as well as critical infrastructure (Rodger et al., 2015). Two of the important aspects of IT DRP as well as Smart government services are the people and technology factor. In the opinion of Rodger et al. (2015), it is important that the workforce be adept with what is present at hand which includes the use of right technology and corporate processes in order to keep the risks at minimum. While people maybe documenting their security policies as well as DR plan, they are not fully aware of the real issues that are plaguing the organization and thus assess the critical systems which will help

to make the smart city organizations ready to deal with disaster. Increased workload with reduced staff may be a major issue during the data recovery process. Furthermore, workforce may be forced to take up new roles and responsibilities for which they have little training. This therefore calls for the need to provide training to the workforce for continuing DRP operations during time of disruption.

Just as IT DRP is dependent on people, the role of human infrastructure is critical in smart government services (Albino, Berardi and Dangelico, 2015). It is the presence of smart people in smart government which makes use of technology to significantly transform life and work. The availability as well as quality of technological infrastructure are important for smart government services (Giffinger et al., 2007). Information and communication technologies (ICTs) along with other related technologies form the main facilitators for information revolution; they facilitate the smartness in government (Scholl and Scholl, 2014). Malfunction of technology can cause a lot of problems for the functioning of smart government services, to the point that al processes may halt. This phenomenon is true for IT DRP too; as pointed out by Gardner (2016), there is an increased dependency on technology (information systems) by organizations in order to survive during and after a disruption or an outage. Smart city organizations have a large number of employees which includes management as well as IT staff for handling technological responsibilities for disaster recovery. It is important to note that information technology is being updated and is evolving constantly, and therefore the solutions to past problems are not applicable to disruptions today (Koech, 2016). This therefore points to the need of setting up standards and benchmarks which help to achieve a sufficient level of survivability. Koech (2016) suggests making use of resources efficiently and adopting frameworks that ensure IT service continuity after a disruption. Furthermore, technologies for disaster recovery will differ based on the organizations layout, network, applications and the complexity of the information security. Based on the need and risk of the organization, DR security technology can be adopted by the organization. It can be safely assumed that in the absence of both the factors i.e. people and technology, smart government services as well as IT DRP cannot function. Thus in time of crisis, people and technology factors play critical roles (Gradner, 2016).

The above literature clearly builds an outline of smart government services and IT DRP with people and technology components, pointing out its importance and requirement. In the past discussion in the study, these factors were discussed independently which showed that these factors overlap each other which gives rise to the smart government services IT DRP framework. The present discussion, with reference to present literature further identifies these factors. The above literature thus confirms our hypothesis as follows:

Hypothesis i: The information technology, People and Process components of Smart City in Smart Government Services has an effect of IT DRP Implementation Component

Hypothesis iv: The technology knowledge and practice of Smart City Components in Smart Government Services is related to the Education and Experience level of the IT personnel

Hypothesis v: The technology knowledge and practice of IT DRP components is related to the Education and Experience level of the IT personnel

2.6.3.2 Role of Organization and Process in Improving Success of Smart Government services IT DRP

Projects are majorly affected by management and organization factors, these factors include organizational diversity, project size, compliance to change and alignment of organizational goals (AlAwadhi and Scholl, 2013). Smart government services outcomes are based on the laws and codes along with the governance structure of the city (AlAwadhi and Scholl, 2013). In the absence of such organizational factors, smart government services cannot function successfully. Institutional arrangements are critical components of smart government services (Gil-Garcia, Pardo and Nam, 2015). Furthermore, as stated by Yigitcanlar and Velibeyoglu (2008), it is vital to establish an administrative environment that supports a smart city initiative. In the same manner, IT DRP framework requires a robust organizational administrative environment that will support the IT DRP efforts. This refers to an environment and organizational policy that supports the implementation of DRP (Hoong and Marthandan, 2014). In order to be able to implement the necessary IT DRP framework, certain organizational changes are necessary. According to Shaw (2016), many institutions are able to implement the necessary changes very quickly. Furthermore, the researcher asserted that a time of crisis gives the perfect opportunity to bring in

organizational changes; it is the disaster that creates the necessary context for the organizational changes to take place quickly (Shaw, 2016).

As mentioned earlier, functioning of various processes in a smart city are based on ICT. ICT has helped to redefine and redesign formal processes and structural organization in smart government services (Scholl and Scholl, 2014). Smart government services constitute of completely novel processes which when aligned, help to achieve smart government services objectives effectively (Lee, Phaal and Lee, 2013). IT continuity plan is written for specific organizational processes and it includes DRP. DRP is able to gauge the important corporate processes and accordingly with the help of ICT comes up with continuity plans that will ensure continuity of processes even during disruption (Alshamma and Alwan, 2016). This will also require identification of application systems that support the processes and similarly identifying host systems that support the application. In this manner, critical corporate processes can keep running amidst a disaster.

IT Continuity Management is the planning process and the identification of potential external and internal threats, which may lead to losses (Choudhary, 2016). This may be due to a disaster, a disruption or due to loss of key corporate process. During the implementation of Continuity Management, there are essentially two phases that have been identified by Alshamma and Alwan (2016). The first phase is the knowledge of issues and allocating of resources for effective implementation. The second phase is the creation of a plan according to the needs of the organization, people, and processes including the key parameters. This process of IT continuity management is vital for the application and implementation of IT DRP. According to Choudhary (2016), the main processes of IT continuity management lifecycle include; understanding the organization, defining the continuity management strategy for the specific corporate process, development as well as implementation of the continuity management strategy, and exercising and reviewing the strategy. All these processes within the IT continuity management cycle, strengthen the plan and make its implementation effective. A critical analysis of the above literature helps to conclude the following hypothesis:

Hypothesis ii: Information technology, People and Process components of Smart City in Smart Government Services has an effect of IT DRP Continuity Management Component

2.6.3.3 Role of Security and Privacy & Financial Resources in the Success of Smart Government services IT DRP

The concept of smart government services is based on information technology and communication (ICT); it forms the main component of a smart government services. The components of a smart government services include online transactions, urban dashboards and performance management systems along with disaster recovery systems (Kitchin, 2016). Central to smart government services is the generation, processing and sharing of large amount of data with respect to citizens, government, infrastructure and services. Therefore smart government services is about making processes technology driven wherein services are able to act upon real-time data (Kitchen, 2015). This thus results in the production of large scale data which is produced continuously. Furthermore, Kitchin (2016) also points out that all the data available is linked data which allows all the documents to be linked and termed as data. Smart government services links all the available data with the underlying technologies to enable better coordination of government systems (Elmaghraby and Losavio, 2014). This generation of big data results in severe consequences; the smart government services strategy offers technological solutions which are not customized according to the need of the smart city (Greenfield, 2013). Furthermore, the urban systems which are a part of the smart government services are hackable and there can be serious breach of privacy if proper precautions are not in place (Cerrudo, 2015). Some of the common form of privacy breaches include watching or listening and recording of activities of an individual due to information collection; linking information to people due to information processing; threat of disclosing personal information due to information dissemination etc. (Kitchin, 2016). Thus this clearly shows that smart government services is vulnerable to many security braces and data leaks when proper security and privacy processes are not in place.

IT DRP processes in smart city for smart government services are directed towards averting crisis with respect to data recovery. The crisis disaster that may hit an organization maybe a physical disaster such as a cyclone, tornado etc. or it may be a virtual disaster such as virus attack or phishing attempts. An IT DRP framework helps to safeguard the information while ensuring that all the processes are working in accordance. While there is a lot of literature discussing security and privacy with respect to cloud computing, very few researchers have

studied IT DRP framework with respect to big data. Governments need to identify the need for data security by means of a robust IT DRP framework which ensures timely back-ups (Hawkins, Yen and Chou, 2000). Furthermore, Snedaker (2013) states that a DRP strategy that is designed to safeguard the smart government organization is built in a manner that provides full back-up at continuous interval along with privacy features so that the information of citizens and big data is not leaked or lost. Data breaches cause identity thefts which further lead to financial crimes such as credit card frauds, phone frauds etc. (Snedaker, 2013). It is therefore essential that the smart government services utilizes and implements important data breach controls along with DRP framework that will minimize the data breaches and data thefts.

Smart government services need to collaborate with organizations in order to take in new opportunities which are presented (Maheshwari and Janssen, 2014). In smart government services, interoperability is extremely important since relationships are changing constantly and organizations work within the organizational ecosystem (Scholl and Scholl, 2014). However, this interoperability and the overall functioning of a smart government services can be severely jeopardized due to financial constraints. Smart government services are not only focussed on providing technologically driven solutions but is also about many other aspects such as smart waste management, smart water, smart transactions etc. While a smart government service presents many opportunities for infrastructure, these are long-term commitments. Usually the government is the financer of such infrastructure projects in a smart government services implementation process (Covell, 2016). It is not only responsible for the finance and implementation but also for operation as well as maintenance of these projects. However such projects require large scale investments, long periods of gestation and high capital initially. Such funding requirements may not be fulfilled by governments alone. Therefore various steps are taken to acquire private funding along with other modes of finance. Many indulge in Public Private Partnerships (PPP), infrastructure financing institutes, commercial borrowing, foreign investments etc. (Maheshwari and Janssen, 2014). It is believed that robust financing helps in robust infrastructure development for smart government services. Financial constraints experienced by the government are fulfilled by alternate methods. It is observed that finance is readily made available by corporate houses for huge infrastructure projects as it offers maximum gain. Furthermore, technology, which is the basis of smart government services is financed by

technology driven companies to offer the required ICT components for the development of a smart city in smart government services.

IT DRP, which is a component of a smart government services too faces financial constraints. The increasing frequency of natural disasters, cause many losses to organizations and in order to combat such disasters, DRP systems have to be set in place (Vidar and Medalla, 2015). The resources available with the government are usually insufficient to address the losses made. However, as pointed out by Vidar and Medalla, (2015), it is important that governments take into consideration the loss of vital data and information along with customer service which have to be faced by organizations. Therefore it is imperative that there is better access to finance for DRP, taking a much needed approach towards risk financing. Snedaker (2013) points out that surprising number of organizations are do not have any IT DRP mechanism in place nor are any finances allotted to this aspect. Thus it clearly depicts that there is lack of education regarding the importance of having a robust IT DRP plan in place. The lack of this understanding it detrimental to the smart government services implementation and thus, it is vital that the government re-enforces the importance and as mentioned by Vidar and Medalla, (2015), set aside essential finances for a well-developed IT DRP strategy.

Therefore we can conclude that financial constraints can be a major constraint in the development of a smart government services infrastructure which has IT DRP components that safeguard the government and organizations from disasters. Without a robust DRP framework in place, smart government services cannot function effectively since the basis of smart government services is ICT and in the absence of a sound IT DRP strategy due to financial constraints, the loss of data can be a major factor for failings in smart government services infrastructure. As Covell (2016) has pointed out, the need for finance has to be fulfilled mutually by the government, people and the stakeholders in order to ensure that the smart government services infrastructure which includes IT DRP is implemented. The above discussion on the available literature helps us to conclude the following hypothesis:

Hypothesis iii: ITDRP Implementation Component is effected by Smart City Financial Resources Component and Security and Privacy Component in Smart Government Services

2.7 Conclusion

After literature review and a detailed discussion on the factors of smart city and smart government services along with ITR DRP components, this chapter drew out a conceptual framework for IT DRP Framework for Smart City in Smart Government Services which considered critical factors of both the components and proposed a new framework. In order to do so, these factors were researched and relevant, recent references from literature were discussed to determine whether these factors would formulate a suitable Smart City IT DRP framework. Upon review it was determined that the components are suitable for a new framework and therefore based on these hypothesis as discussed above, a new Smart Government services IT DRP framework was developed. The framework consisted of all the important components which covered both, smart government services as well as IT DRP and thus presented a new perspective.

3 METHODOLOGY

3.1 Introduction

This chapter is has been developed to focus on those issues that pertain to research methodology used in this present study. The main aim is to define, describe and then select while also providing a justification to the selected methods as well as research approach for the study. Firstly, a summary of the underlying research philosophies has been presented and later on relevant justification is presented for selecting the mentioned research methodology. The chapter further chooses the survey quantitative design as the preferred research strategy while also providing a justification for this choice of technique. Later, a discussion has been established regarding the major two research methods, i.e. quantitative and qualitative while providing a rationale regarding the chosen quantitative approach. After this a research approach is presented for conducting empirical work. This approach reports about the research design and also gives information with respect to different methods of data collection along with data analysis for a better understanding. Finally, the survey protocol is provided as the proposed action plan to collect the relevant data from those respondents who have been selected for the study.

3.2 Research Philosophy

The main issue that needs to be considered when planning and designing the research design of a study is the main philosophy for conducting that study. The research philosophy is often termed as paradigm and is nothing but a set of philosophies, notions and presumptions regarding certain facets of the world (Oates, 2006; Collis and Hussey, 2009). Keeping these assumptions in mind, the researcher is able to decide upon the research strategy which is most suitable along with the methods that become part of the given strategy (Saunders et al., 2012). Mainly, there are 2 main types of assumptions: epistemological assumption and ontological assumption (Collis and Hussey, 2009). Epistemology addresses and studies the methods of acquiring knowledge while ontology studies the nature of reality (Saunders et al., 2012). Epistemology is an extremely important philosophical assumption which provides guidance for the study (Myer, 1997). Epistemology is an important aspect of research since it helps in selecting the right research strategy along with the methodology for the accumulation of empirical information (Saunders et al., 2012; Orlikowski and Baroudi, 1991).

In Information Technology (IT) field and disaster recovery there are 3 main types of epistemologies which can be utilized by researchers; these are positivist, critical and interpretive (Straub et al., 2005). Under the positivist theory, it is assumed that reality is presented objectively, it is thus described in terms of properties that are measurable instruments of the researcher. In case of critical researchers, they evaluate everything critically and alter the social reality which is being investigates (Orlikowski and Baroudi, 1991). Lastly, interpretivist has the assumption that the social reality is subjective since it is in our minds and there are multiple of such realities (Collis and Hussey, 2009). Subsequent sections in this chapter will provide additional clarification regarding all the three epistemologies and how each of them is relevant to the research presented in this study.

3.2.1 Positivism

The principal idea which governs the theory of positivism is that externally, there exists a social world and it is the properties of this social world which need to be measured by means of objective methods and not be deduced in a subjective manner by sensation, intuition or reflection (Easterby-Smith et al., 2008). Thus, as put by Orlikowski and Baroudi (1991), the studies under the positivist outlook are "premised on the existence of a priori fixed relationships within phenomena which are typically investigated with structured instrumentation". According to this theory, the researcher is an objective analyst who builds detached interpretation of the data serenely. The data is collected by the researcher in a value-free fashion. According to this framework according to Saunders et al. (2012), the researcher has worked independently and has not been affected or influenced by the research. Since a positivist is of the belief that social phenomenon can be measured, it gets linked with quantitative analysis methodology which is founded on the statistical analysis of the research data acquired though quantitative (Collis and Hussey, 2014). The present study explores the requirements that are needed for the development of an IT DRP framework which will help support the Abu Dhabi Government for the evolution of smart city services for the continuity of its systems. For this purpose, the study intends to identify the main factors of the framework of smart city services along with the barriers which will not allow for the transformation of the city into a smart city. Thus, this study has opted for a positivist approach for conducting its research and for identifying as well as examining the critical factors.

3.2.2 Interpretivism

Interpretivism is a phenomenon that is founded on the premise that in our minds, social reality exists and therefore by nature, it is subjective as well as multiple. Therefore, when investigated, the most affected is social reality (Collis and Hussey, 2009). The notion that there is a need for a strategy which is able to differentiate between people and objects of natural science and therefore social scientists need to take into account the subjective meaning of the social science is bought about by this paradigm (Bryman and Bell, 2007). Assumption by interpretive researchers is that humans have a tendency to go about creating as well as associating their own personal subjective and intersubjective views while interacting with everyone and everything around them. The purpose of these researchers is to comprehend the phenomenon by means of accessing the meanings which have been attributed by the participants (Orlikowski and Baroudi, 1991). Interpretivist researchers make use of qualitative methods of analysis to be able to comprehend the social phenomenon. With respect to this study, the interpretive approach is not suitable since it emphasizes on the exploration of social phenomenon complexities for achieving interpretive understanding. On the other hand, measuring the social phenomenon is the main focus of the positivist approach (Collis and Hussey, 2014). Since the main concentration of the present research is on the measurement of the social phenomenon, which includes empirically validating the conceptual model, it is not ideal to use the interpretive approach for this study.

3.2.3 Critical

It was observed by Orlikowski and Bourdi (1991) in previous studies of IT literature that 96.8% of studies in the field have opted for the positivist approach while 3.2% with an interpretive approach and 0% opted for the critical approach. When previous IT studies were examined in the later years by researchers, it highlighted the fact that 75% studies opted for the positivist approach, 17% opted the interpretive approach while merely 5% opted for the critical studies approach (Mingers, 2003). Thus it can be easily concluded from these findings that positivist approach has been the most preferred option for studies in the IT field. Critical researchers examine and evaluate critically while transforming the social reality which is being investigated. It critiques the social system that is existing currently and sheds light on the conflicts which may exist within the present construction (Mingers, 2003; Orlikowski and Baroudi, 1991). From the

critical perspective view, people produce as well as reproduce social reality. While social and economic circumstances can be purposely changed by people through certain acts, critical researchers identify that the ability of people to do so is restricted by different types social, cultural, social and political domination (Orlikowski and Baroudi, 1991). For this study critical approach is not well suited as it does not correlate to critical evaluation or opposition; it in fact observes and studies the background of public value and what consequences it has on e-government services. Thus, a thorough research of all the three defined research epistemologies has aided the current study to select the positivist approach as it is the most suitable of all the three epistemologies for the present study.

3.3 Research Design

The process in which a researcher will choose to answer the research questions is termed as research design by Saunders et al. (2012). On the other hand, Collis and Hussey (1997) defines it as the art and science of planning those procedures which are used in conducting studies so that it leads to the most accurate and well-grounded findings. The researcher makes use of a detailed plan that acts as a guide and helps to focus on the study. This plan includes the objective of the study which have been sourced from the research questions, the data collection sources have been specified and an analysis of the acquired data ahas been detailed out long with a description of the ethical issues is described. There are 3 basic stages in the plan of the current study, these are: research design, followed by data collection and data analysis. In the present study, in the research design phase, a detailed literature review is conducted with respect to IT DRP and its framework along with its application in a disaster situation that may affect the Abu Dhabi Government smart city IT continuity. For the present study, the research strategy that has been selected is the survey method whose justification has been provided in the above section. The second stage entails data collection wherein the researcher carried out a pilot study and questionnaire was checked for reliability and validity. The researcher made necessary amendments to the study based on the previous checks and prepared the final questionnaire. The last stage of the research constituted of an analysis of the results and a discussion regarding the same by means of Statistical Package for the Social Sciences (SPSS). At the end, the plan helped to achieve the thesis' aims and objectives which were set in chapter 1. To understand better, an overview of the research plan has been presented below in Figure 3.1.

3.4 Research Approach

Research approach is an enquiry strategy that revolves around the underlying assumptions based on which the research design as well as data collection is developed (Myers, 2009). As per the most known classification, there are mainly two approaches to research: Quantitative and Qualitative. While at one level, these two approaches differ based on the knowledge nature; on the other level, they are distinguished by the way to collect and analyse the data leading to data generalizations/ representation. In the following section, the two approaches are reviewed and the selection justification for choosing a quantitative method is presented.

3.4.1 Quantitative Approach

When objective theories are tested by means of examining the relationships amongst the variables it is termed as a quantitative research (Cresswell, 2013; Myers, 2009; Bryman and Bell, 2007). When it comes to quantitative research, the best approach to be adopted is the deductive approach wherein the research is guided via the theory (Collis and Hussey, 2014). In case of deductive approach, the researcher first studies the theory which helps in the formulation of the research hypothesis. In the next phase, collection of data takes place and its findings help in either the confirmation or rejection of the hypotheses. Based on this, revisions are carried out within the theory (Bryman and Bell, 2007). Quantitative approach has been linked with positivism which aims at testing the theory that has been developed so as to have a better understanding of the phenomena (Saunders et al., 2012). Collis and Hussey, (2014) are of the opinion that experimental and survey research strategies are included in quantitative studies. Survey is conducted via means of structured interviews, questionnaires and even structured observation of actions and decisions (Saunders et al., 2012).

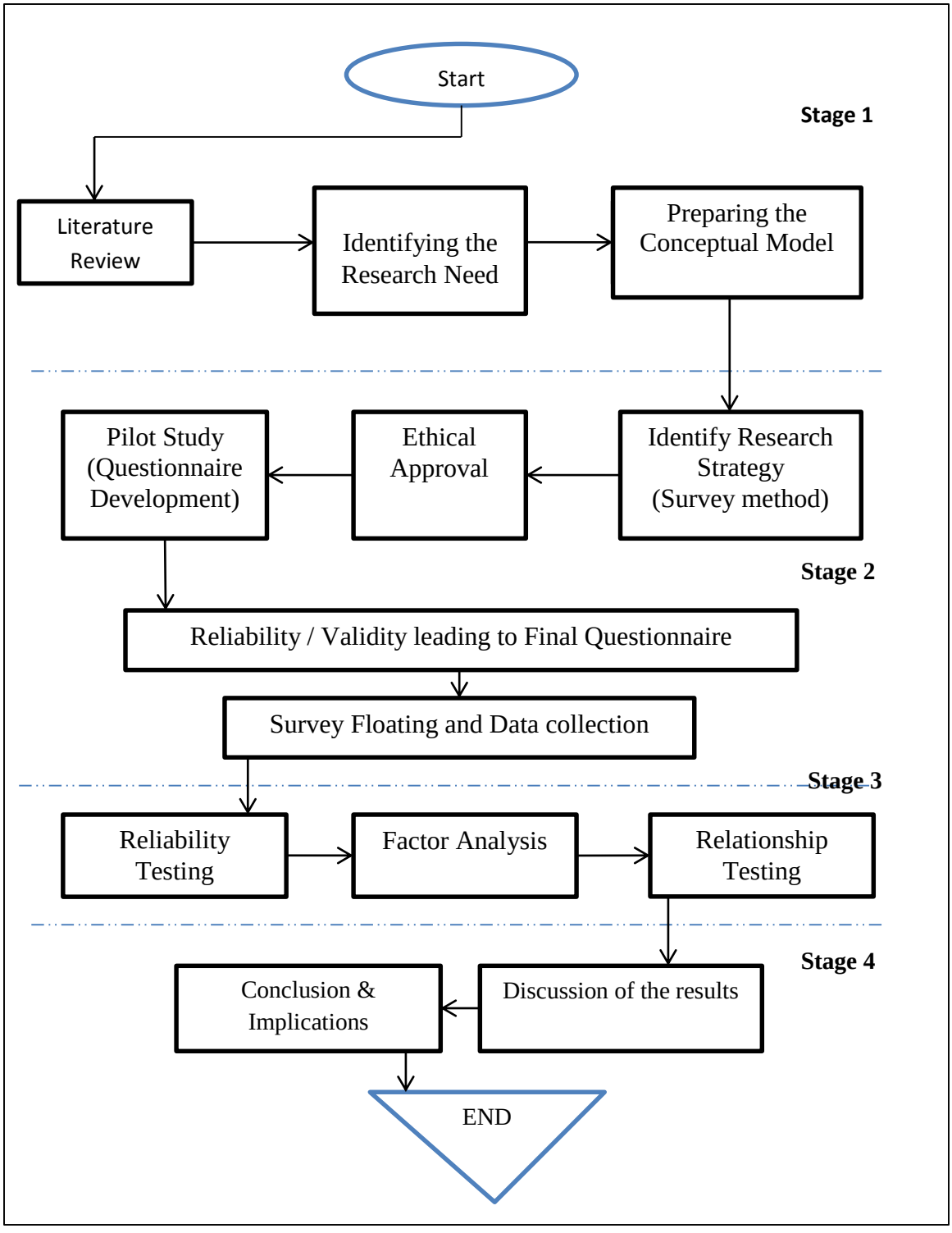

Figure 3.1: Research Design

3.4.2 Qualitative Approach

Qualitative research is the approach for exploration as well as grasping the meaning which groups and individuals assign to a social or human problem (Cresswell, 2013). In qualitative research, the emphasis is on the collected words followed by an analysis of the data (Bryman and Bell, 2007). The approach adopted is inductive approach in qualitative research wherein the outcome of the research is the theory (Collis and Hussey, 2014). In an inductive approach, the researcher draws inferences from the findings and observations that are generalizable in order to develop a new theory (Bryman and Bell, 2011). Interpretive philosophy uses the qualitative approach wherein the topic is studied by the researcher while being within the context and makes use of the emerging design wherein during the process, categories are identified (Bryman and Bell, 2011; Collis and Hussey, 2014). Qualitative approaches can make a choice from a number of research strategies such as narrative theory, grounded theory, ethnography and case studies (Saunders et al., 2012).

Features	**Quantitative**	**Qualitative**
Characteristics	The relationship between variables is examined and a numerical value is derived along with statistical analysis.	Making use of a number of data collection methods, the participant's meanings and the relationships are studied for the development of a new theory.
Role of theory	It is deductive in nature (testing of hypotheses based on which the principle is either accepted or rejected).	It is inductive in nature (a generalizable inference is drawn by the researcher based on the observations and findings for the formation of a new theory).
Research philosophy	Positivist Approach- Testing of theory in order to better the predictive understanding of the phenomena.	Interpretivist Approach- The topic is studied by the researcher within the context and makes use of the emerging design wherein categories are acknowledged during the process.
Research strategy	Surveys	Grounded theory, narrative theory, ethnography and case studies

Table 3.1: Quantitative vs Qualitative

In Table 3.1, a very clear differentiation of the qualitative and quantitative research has been made by Saunders et al., (2012) with respect to 4 main factors: characteristics, research philosophy, the role of theory and research strategy.

The present study has made use of the quantitative research approach that opts for the deductive approach wherein 1 main hypothesis and 5 sub-hypotheses are empirically tested to establish if they are rejected or confirmed. Qualitative approach is not suitable for this study since it does not collect data in the beginning and develops the theory later. Additionally, this study's epistemological orientation is a positivist approach that mainly aims to investigate the proposed conceptual model for IT DRP framework smart city in Abu Dhabi Government, in UAE which has fixed priori relationships; thus, the best suited approach for this study is the quantitative approach. Measurement instruments have been developed by this study for every constructions under IT DRP that are used for the purpose of defining the IT value role within the framework of DRP for smart cities that have been mapped out from the former studies to formulate the questionnaire and to analyse the results statistically. This therefore calls for the need to use the quantitative approach for the study. With respect to the research strategy, the quantitative approach provides the preference of making use of experimentation and surveys, the subsequent section will provide details regarding the selected research strategy along with justification for the choice.

3.5 Research Strategy

The plan drawn out by the researcher regarding on how to respond to the research questions is termed as the research strategy. It is the methodological association between the philosophy that has been chosen and the methods chosen for the collection and analysis of data (Saunders et al., 2012). When it comes to research strategies, there are a number of them to choose from; survey, experiment, grounded theory, case study, archival research, ethnography and narrative inquiry (Saunders et al., 2012). Quantitative research is associated with surveys and experimental studies according to Collis and Hussey (2014). As mentioned in the earlier sections, the current study has adopted the quantitative approach and therefore the chosen research strategy for the same is the survey method. The following section provides a summary of surveys and also provides a justification for selecting it as the preferred choice of research strategy for the present study.

3.6 Data collection Methods

The data collection outlines the method adopted for collecting the information required to meet the research aim and address the research problem. The process of data collection is divided into three stages, with the first stage being the sampling method identification, the second stage as the sampling size finalization and the third stage as questionnaire method adoption. In the following sections, the above three stages for data collection are discussed in detail.

3.6.1 Sampling Methods

Sampling is referred to the choosing and picking out a portion of a population, making and recording observations on the group, and lastly generalizing the findings on a larger population (Burns 2000). Any part of a population is termed as sample, whether it may or may not be representative. On the other hand, population is defined as the entire cases from the midst of which sample is taken (Saunders et al., 2012). With respect to the present study, the population are the government entities, IT managers and IT technology consultants which are a part of the UAE's smart city development. These individuals are responsible for the development of continuous services in smart city and bring value to the current research through their inputs. However, a review of the role of the participating population will be conducted to assess if they fit the following requirements: 1.Manage IT and computer systems, 2.Plan, organize, control and evaluate IT and electronic data operations, 3.Ensure security of data, network access and backup systems, and 4.Recommends strategies for information technology, procedures and policies by means of evaluation of the organization outcomes; evaluating trends; identifying problems and anticipating requirements. It is not common or easy to collect data and analyse it from every group member; this process is known as census. For the present research also, it was not viable to survey the entire population especially since everyone does not contribute effectively towards the smart city development and understand what role IT in DRP framework plays. Furthermore, other factors such as time and budget constraints along with difficulty in access played a major role. By making use of a smaller number of cases, it is possible to achieve better accuracy and also more time can be allocated towards designing as well as piloting the means of data collection. Thus, in the present study the researcher has the choice between two available sampling techniques; probability or representative sampling and non-probability sampling.

In terms of probability sampling, each case which falls under population gets an equal chance to be seleccted, in other term, their probability is equal. Such a kind of probability sample is not only simple and systematic, but also a stratified kind of sampling (Saunders et al., 2012). In case of non-probability sampling, the probability is unknown for each case which has been chosen from the entire population (Saunders et al., 2012). There are a number of non-probability sampling such as convenience sample, quota sample and snowball sample (Bryman and Bell, 2011). The current study has made use of the convenience sampling since it is cheap, a lot of time and effort is not required for conducting and is also easily collectable. Convenience sampling includes acquiring access to the easily accessible subjects in order to finish the survey. Since convenience sampling meets the purposeful sample selection criteria which are relevant to the research aim of the study, this technique was chosen for the study. Furthermore, the convenience issues are what motivated the researcher to choose this technique for the present study.

The sample was divided into three main groups from the Abu Dhabi Government based Smart City initiatives: Abu Dhabi Municipality, Masdar Smart City and Abu Dhabi Police along with other private bodies which formed an essential driver of the smart city initiative. The initial aim was to get at least 400 responses for the study.

3.6.2 Sampling size

Once the sampling technique was selected the next issue that needed attention was to determine the sampling size. The sample size needs to be adequate in number. It is important as a large enough sample size would aptly represent the population in general (Hussey and Collis, 2014), and more importantly the research issues would be addressed. Thus, in order to generalize the obtained results it is vital that the research chooses a sample size that reflects the population. Many times, a small sample size does not make it possible to conduct imperative statistical analysis tests between the suggested dynamics or hypothesis (Hussey and Collis, 2014). Since the current study makes use of SPSS for analysis of the suggested conceptual model and it examines the effect of various factors on the efficiency of IT DRP, therefore a larger sample would be required for that. Sampling technique in SPPS can be characterized as; 100 represented

as poor, 200 represented as fair, 300 as represented good, 500 represented extremely good and 1000 represented as excellent (Tabachnich and Fidell, 2001; Comrey and Lee, 1992).

3.6.3 Questionnaire method

Questionnaires are the most popular tool for gathering data since designing it is easy. The present study has adopted questionnaires for collection of data since it is a low cost approach in terms of money as well as time. Additionally, it is easier to code the questions, thus making the analyses simple and less time-consuming (Gray, 2014). Rather than interviews, this research has made use of questionnaire since it can be dispatched to hundreds and even thousands of participants within a short span of time and at a little cost. Furthermore, interviews can pose to be difficult to get by since the respondent may not find the time and thus may delay the process. Such limitations are easily overcome by questionnaires as respondents can select an appropriate time to answer the questionnaire according to their convenience. Thus, this research opted for the questionnaire method for collection of primary data. The researcher needs to carefully conduct the analysis of the questionnaire design as it will change the response rate and also the consistency and legitimacy of the data (Saunders et al., 2012). Depending on the method of delivering and collecting the questionnaire, its design would alter.

There are two main methods of collecting data from questionnaires which are referred to as self-completed and interviewer completed. Self-completed questionnaires are wherein the respondent has completed and answered the questionnaire himself while in case of interviewer completed it is the interviewer who records the responses of each respondent. Interviewer completed approach is usually telephonic or structured interviews while in case of self-completed ones, it is usually online questionnaires, mail or postal questionnaires, delivery and collection questionnaires or intranet mediated questionnaires. For the present study, the researcher has opted for online questionnaires since many services are available for accurately creating the questionnaire which is not usually unavailable in the conventional paper formats of questionnaires (Gray, 2014). Some of the online survey tools comprise of drop down menus, pop-up instruction boxes, font color and size choice etc. Additionally, with respect to this research, web based surveys would benefit the research immensely with respect to ease of access to large samples and convenience (Gray, 2014).

When large sample data requires to be gathered, then web-surveys are utilized so that the collected data can be analysed statistically and a generalized result according to the population can be derived (Collis and Hussey, 2014). When large amounts of data need to be extracted from a large portion of population, then surveys are an economical choice. Furthermore, the researcher can contain the overall research procedure in a suitable manner (Saunders et al., 2009). Survey strategy and deductive approach are linked with one and another. The latter commences with the theory of research and causes the development of the research hypothesis, leading to the confirmation or rejection of the hypotheses (Bryman and Bell, 2011). Positivist approach is linked with surveys as the approach mainly tries to test theory in order to enhance the phenomena's understanding in the predictive context (Collis and Hussey, 2014). As far as survey strategy is concerned, there are multiple data collection techniques which can be deployed: internet self-completion questionnaires, postal, direct interviews and telephonic interviews.

Survey questionnaires are mainly divided into two important types- analytical surveys and descriptive surveys. An analytical survey questionnaire determines the relationship between variables or even a pair of variable while a descriptive survey provides a precise representation of the phenomena at a certain point or in various times (Collis and Hussey, 2014). Before one goes about conducting a survey, thorough understanding of the overall steps and phases involved in a survey is most important. There are 5 main stages involved in a survey process; designing the survey, pilot testing of the designed survey, altering and modifying the questionnaire and sample, data collection followed by data analysis (Czaja and Blair, 2005). Neuman and Robson (2014) recommends a survey should be conducted using three key steps; sampling, data gathering and instrument development. Definition of sampling describes it as choosing a part of population and formulating an observation on the chosen population and then generalizing the findings to apply on a larger population (Burns, 2000). In case of data collection, it is choosing from the various methods such as internet self-completion questionnaires, postal, direct interviews and telephonic interviews, the most suitable method. It is vital that the instruments are well developed so that it helps to raise the quality of information with the purpose that the study's research questions are answered in a credible manner.

The research has made use of a quantitative approach for the research area examination as is identified in chapter 1; it will therefore need huge amounts of quantitative data collection along

with statistical analysis of the collected data. Surveys are an appropriate tool for the purpose as they are not only cost effective but are also fast and the data from such a large population of respondents is easily collectable (Hussey and Collins, 2014). Additionally, the present study has chosen the positivist methodology combined with a deductive approach and therefore survey methodology is the most suitable approach for the present study. As pointed out earlier, three main stages of survey were followed by this study; sampling, followed by data gathering and lastly instrument development (Flower, 2002). The following segments will provide details regarding each step.

The following Table 3.2 depicts the research matrix for the study that includes; research questions, objective, data collection and lastly data analysis. The data collection area depicts the methods that have been used for the collection of data with respect to every objective while the data analysis column provides details about the preferred methods used for conducting data analysis.

Research Questions	Research Objective	Data collection	Data analysis
1. What is the existing IT DRP framework used for Smart City in Smart Government Services in general and Abu Dhabi smart city in focus?	1. To review and compare the existing frameworks in relation to IT DRP and their application in a disaster situation affecting the IT continuity of Abu Dhabi Smart City services	Survey Questionnaire	SPSS
2. What are the factors that limit the application of the current IT DRP framework of Abu Dhabi Smart City, in terms of safety and efficiency?	To identify, analyse and evaluate the prime factors in the IT DRP framework of Abu Dhabi government for smart city system in terms of security and IT continuity in even of an IT disaster	Survey Questionnaire	SPSS
3. How can Abu Dhabi Smart City switch to a reliable IT DRP framework without affects its current IT continuity?	To suggest improvements in the current IT DRP framework adopted by Abu Dhabi governments to support its Smart city System through the development of IT DRP plan that can ensure reliability and security of the highest level even during a disaster	Survey Questionnaire	SPSS

Table 3.2: Research matrix

3.6.3.1 Instruments

As depicted in the table 3.3, the employed measures for the study have been drawn from literature. For the purpose of this study, the Likert scale (Bryman and Bell, 2007) has been used in order to rate the questions or for the collection of responses from the participant. Additionally the questionnaire designed for this study makes use of both, positive as well as negative questions so that the respondent thinks properly while answering each question and gives proper weightage to each answer (Saunders et al., 2012). Questionnaires are without a doubt one of the essential wellsprings of acquiring information in any examination try. Be that as it may, the basic point is that when planning a survey, the analyst ought to guarantee that it is "legitimate, solid and unambiguous" (Johnson and Christensen, 2008).

Overall, surveys can be used in three forms: 1-closed-end (or organized) survey; 2-open-end (or unstructured) survey and 3-a mix of closed-end and open-end. Closed-end survey gives the inquirer quantitative or numerical information and open-end surveys with subjective or content data. In such manner, Neuman and Robson (2014) partition surveys into seven fundamental question sorts: amount or data, class, list or various decision, scale, positioning, complex lattice or table, and open-finished. By and large, a survey may make utilization of one or a few sorts of these question shapes. The truth of the matter is that every type of survey has its own particular qualities and shortcomings. Christensen et al., (2011) are of the conclusion that closed-end surveys are more proficient on account of their simplicity of examination. Then again, Gillham (2008) contends that "*open inquiries can prompt to a more prominent level of revelation*." He too concedes the trouble of investigating open-end surveys. In such manner, Johnson and Turner (2003) recognize the value of subjective information however express that "their open-finished nature made it hard to look at reports of discourses and meetings." The imperative issue in open-end inquiries is that the reactions to these sorts of inquiries will all the more precisely reflect what the respondent needs to say (Sexton et al., 2006). In this way, it is better that any survey incorporate both closed and open-end inquiries to supplement each other. In this research study, the researcher employed only closed-ended questions given the complexity of the elements utilized in the study. Option based responses allows the researcher to capture more productive responses due to their simplicity of investigation. In the study, different types of scales were employed, with the most commonly used was the 5 point rating scale wherein 1= Very

important, 2 = Important, 3 = Moderately Important, 4 = Less important, 5 = Not Important. Care was ensured to include both positive and negative questions. The table 3.3 shared the different types of measurement scales utilized in this research study.

	Factors	Code	Measurement
Core Components of Smart City	Information Technology Components (ITC)	ITC1	Please select the applicable data feed sources mentioned below that you have worked with
		ITC2	From the following sectors, what is the priority level of smart city technologies which represent for your community?
		ITC3	Currently, what is your community's level of engagement with respect to smart city technologies?
	Process Components (PC)	PC1	How important are the following benefits in encouraging government to implement use of smart city technologies?
		PC2	Which of the following processes have been optimized for Smart government initiative?
	People Components (PEOC)	PEOC1	What type of IT training do employees receive at their workplace for smart government services in smart city implementation?
	Organizational and Structural Component (OSC)	OSC1	How will your organization/community implement the smart government initiatives? Select the most relevant.
	Financial Resources Component (FSC)	FSC1	What is the widely adopted financing mechanism for Smart Government Services in Smart City implementation?
	Security and Privacy Component (SPC)	SPC1	How much importance is given to security and privacy during and after implementation of the initiatives?
IT DRP Components	Implementation Component (ITIC)	ITIC1	What is the DR implementation strategy for your organization? Choose from below
		ITIC2	Alternate Location
		ITIC3	When disruptions are caused by the following third-party components, what specific steps are taken by the organization?
	Continuity Management Component (CMC)	CMC1	Does your organization have a continuity plan in place?
		CMC2	How often is the IT DRP reviewed in your organization?
	People Component (ITDRP PC)	PC1	Employee Readiness /IT recovery team / Employees along with the Stake holders are aware of what to expect in case of an IT disruption / Employees participations in emergency preparedness workshops
	Technology Component (IT DRP TC)	IT DRP TC1	In order to protect your organization from data loss identify if the following steps are followed

		IT DRP TC2	Are the following components for IT Services incorporated?
	Organizational Component (IT DRP OC)	IT DRP OC1	Organizational identification and notifications for IT disasters. Answer Yes or No
	Environmental Component (IT DRP EC)	IT DRP EC1	Are regulations followed binding the IT DRP for Smart government?

Table 3.3: Questions Type and Measurement Scales used

3.6.3.2 Pilot Testing

It is vital to first conduct a pilot test of the prepared questionnaire prior to utilizing it for collection of data. The main idea behind a pilot test is to perfect the questionnaire and allow the researcher to gain an understanding regarding the validity and reliability of the questions which have been asked (Saunders et al., 2012). The process of validity comprises of asking an expert or a group of experts regarding their views on the representativeness as well as usefulness of the questionnaire, on the other hand, reliability is linked to the consistency in responses to the questions asked (Saunders et al., 2012). At first, the existing study's questionnaire was put through a validation process by a group comprising of IT professions that were experience and had expertise in DRP in smart city projects for Abu Dhabi Government, UAE. Each participant was solicited offer an opinion regarding the clarity in the provided instructions, their views and if layout was appropriate, that is was clear as well as attractive (Saunders et al., 2012). Afterwards, based on the revised questionnaire, a pilot study was conducted.

In totality, 50 responses were collected to dwell upon whether the questionnaire had a clear layout and instructions. This study has made sure that the respondents do not face any problems in understanding as well as answering the questions during the pilot phase. Afterwards, based on the same construct the reliability of the items was tested by making use of internal consistency. Internal consistency is developed for the measurement of the proposed question's consistency. For this purpose the most frequent method used is the Cronbach's α. Cronbach's α makes use of the basic rule that a figure of ≤0.90 is considered excellent reliability, while 0.70-0.90 is high reliability, 0.50 - 0.70 is moderate reliability, and ≤ 0.50 is low reliability (Hinton et al., 2004). For the purpose of this research's testing for the pilot study, Cronbach's α has been used and successfully achieved a high reliability of 0.76 (Hair et al., 2010).

3.7 Data Analysis

3.7.1 Data Cleaning

The initiation step for data analysis is data cleaning so as to ensure that no data has a missing value or an outlier. Data cleaning will be through manual screening. In order to code the available data, SPSS version 20 was utilized after which screening was done to clean the data. As missing data can lead to lower reliability score, responses with missing fields were eliminated. Also, care was taken to observe the data collected for possibility wherein the respondent didn't read or understand the question. Responses wherein similar patterns such as selection of negative or neutral options such as 'not important, no, etc' on a continuous basis were excluded from the data. The main data collection received a total of 219 responses through the survey, out of which 200 responses were finalized after data cleaning.

Post data cleaning, reliability tests were conducted so as to ensure that the measurements' consistency was maintained throughout. Post measuring internal consistency in the variables, parametric tests were conducted using regression analysis including the descriptive statistics.

3.7.2 Descriptive Statistics

Descriptive statistics are coefficients summarizing a data set, represented for a sample population or an entire population in representation. These can further be divided into central tendency measures (mean, median and mode) or variability/spread measures (kurtosis, skewness, standard deviation, minimum and maximum variables). The two measures make use of graphical representation, tabular formats, and general discussions so that individual can comprehend the data meaning that is to be analysed. These statistics aid in describing and comprehending the properties of specific data set by summarizing sample and data measures in short.

3.7.3 Correlation Analysis

Correlation is the strength of the relationship that exists between 2 variables. The presence of the strong relationship between two variables showcases strong, or high correlation while less relation between two variables depicts weak or low correlation. Correlation analysis is thus a technique by which strength of relation in the available statistical data can be studied. SPSS (a

statistical software) can be applied to find out as to if there is a presence of the relation between two variables or not and how strong is it. In this regard, Pearson r is the most commonly used correlation coefficient which is based on an assumption that the 2 variables to be analyzed are measured on increasing value range. The Pearson coefficient of correlation has a range from -1 to +1. It is calculated through the measurement of covariance of the variables under study and dividing it with their product (as per their standard deviation). Here -1 showcases perfect negative correlation where values of one variable increase while the other decreases. On the other hand, +1 showcases perfect positive correlation where the value of both the variables increases or decreases simultaneously.

3.7.4 Regression Analysis

It is a predictive modelling technique which assesses the relation that exists between dependent (i.e. smart city) and the independent (IT DRP) variable where former is the target while latter is the predictor. The regression analysis is utilized for the purpose of the forecast, identifying causal effect relation, for time series modelling and data analysis. The benefits of regression analysis are as follows;

- It showcases important relation between dependent and independent variable.
- It indicates the impact strength for the independent variables against the dependent.

Many forms of regression techniques exist by which predictions can be made. The present research study has applied a linear regression which is the most common modelling technique with wide usage. Linear Regression creates the relation between dependent (Y) and 1 or more than 1 independent variable (X). Linear Regression can further be divided into simple linear that has a presence of just one independent variable and multiple linear regression that has more than 1 independent variable.

3.7.5 Reliability

One of the principle necessities of any examination procedure is the unwavering quality of the information and discoveries. In the fundamental, unwavering quality manages the consistency, trustworthiness and dependability of the outcomes acquired from a bit of research (Nunan 1992).

Acquiring the comparative outcomes in quantitative research is somewhat clear on the grounds that our information is in numerical frame. Nonetheless, in subjective ways to deal with research accomplishing the indistinguishable outcomes are genuinely requesting and troublesome. It is on account of the information are in story frame and subjective. To this end, Christensen et al., (2011) call attention to that as opposed to acquiring similar outcomes, it is ideal to consider the trustworthiness and consistency of the information. For this situation, the reason for existing is not to achieve similar outcomes rather to concur that in light of the information accumulation forms the discoveries and results are predictable and tried and true.

The study has made use of discriminant validity in order to make sure that the constructs' measurements represent the concept of interest properly. Discriminant validity is conducted by doing comparison of the values of the average variance pulled out for any of the two constructs with the square of the correlation estimate between the chosen two constructs. Discriminant validity is defined by Hair et al., (2010) as "*the degree to which two conceptually similar concepts are distinct*". In order to test the internal reliability of the instruments, Cronbach's alpha (α) is utilized. Internal reliability assesses whether the indicators which are the scale are consistent or not. In conformity of the rule of Cronbach's alpha, any figure of ≤0.90 is termed as having excellent reliability, 0.70-0.90 is high reliability, 0.50-.70 is moderate reliability, and ≤0.50 is low reliability (Hinton et al., 2004). The reliability test which is conducted on the data collected through the aid of the quantitative questionnaire led to a Cronbach alpha score of 0.65 which is termed to be acceptable.

3.8 Ethical Considerations

Ethics deals with the principles and moral values which make the base for the code of conduct, while research ethics refers to the way the research for the study was regulated and the manner in which the results were reported for the same (Collis and Hussey, 2014). Few of the important ethical considerations that concern research ethics include; avoiding any harm to the participants of the study, right to confidentiality, right to anonymity and voluntary participation (Collis and Hussey, 2014). All the ethical requirements were taken into consideration while conducting research for the study. Participants were advised about the aim of the study and reasons for their participation were made clear. It was also ensured that the participation in the study was voluntary and they had a choice to withdraw at any stage of the study and survey. Furthermore, each participant was assured that their anonymity and confidentiality will be protected at every phase. The code of conduct for this study purpose was guided by the University's ethical guidance. Following the guidelines, the researcher as well as the researcher's supervisor is under obligation to sign the research ethic form which was then submitted to the office of academic program. Only after receiving an approval from the committee was the research conducted.

3.9 Research Limitations

The idea of IT DRP for smart city in smart government services is constrained; few measure of research is consequently accessible about ITDRP for smart city. While this gave the researcher the opportunity to investigate a wide range of parts of IT DRP for developing a comprehensive framework for smart city IT DRP, the absence of expert audited research may perhaps have traded off the legitimacy of the presumptions under which the researcher worked. Furthermore, the outcomes with this research study demonstrate that urban communities held distinctive understandings of what IT DRP reflects as for smart city idea within the boundaries of smart government services. Within the scope of research presented in the chapter 1, the IT DRP for smart city in smart government services is effectively being connected in a few urban projects; the researcher constrained the degree to just incorporate the firms associated with the smart city projects in Abu Dhabi, UAE. Along these lines, a few discoveries were identified, especially in the form of the financing structures, which may not have any significant bearing to different components of the smart city in smart government services.

The main impediment in this research study originates from the information gathering approaches selected i.e. quantitative. An impediment of having a survey questionnaire may not have been the right choice as it limits the response of the participants to a specific set of answers. Also, presenting numerous choices may befuddle the respondents and does not give researcher a clear outlook on whether the respondent really comprehended the question being inquired or not.

Time management acted as a major limitation on account of full-time job for the researcher and other job commitments. The need here was to assess the challenging nature of the study and carry out proper planning for different research phases. This was as the researcher has to travel in the emirate for introducing herself as well as the purpose of research so that maximum responses can be collected. A lot of attempts were made to connect with the participant through email but it led to the generation of minimal responses during first 2 weeks. Hence a reminder was then sent to participants for completing the survey through a phone call or email. This acted as a limitation for study as highlighted by Davies (2000) in his study. The researcher in the present study thus made an attempt to reduce the impact of these limitations and has even recommended to correct them while conducting future research studies.

3.10 Summary

The chapter aim was to clearly outline the research design of the thesis. A scrutiny of the various research philosophies was done that led to the conclusion that the positivist philosophical approach was the most applicable and suited to conduct the given study. According to positivists, the reality is given objectively and is its description is in measurable properties which are dependent on the instruments of the researcher (Collis and Hussey, 2014). Thus, for the purpose of this study, the positivist approach for conducting research was adopted since the main focus of the study is to develop and create a frame for IT DRP for smart cities in Abu Dhabi smart government services in the UAE. After that, the chapter made clear distinctions between the various research approaches and zeroed in on the quantitative approach rather than the qualitative approach. Quantitative research helps in the testing of objective theories by probing the relationship between the variables (Cresswell, 2013). For the present study, a quantitative research approach is chosen since it makes use of the deductive approach wherein 1 main hypothesis and 5 sub-hypotheses are empirically tested to deduce whether to confirm them or

reject. For this study, qualitative study is not suitable since it does not collect data first followed by development of theory.

Thereafter, the chapter focuses on the different research strategies and zeroed in on the survey strategy that would be used for the present research. Research strategy which is connected with quantitative approach makes use of experimental studies and surveys (Cresswell, 2013; Collis and Hussey, 2014). Since the in the present study, quantitative approach has been adopted for examining the factors which are acknowledged in the literature review, it became necessary to collect large amount of quantitative data to conduct statistical analysis. Therefore surveys were the most appropriate methodology for this purpose since they were quick, easy and cost effective option for collection of data from a large number of participants. Furthermore, the chapter talks in detail about the sampling techniques, data collection methods and sample size. This chapter has also discussed what the ethical issues in data collection along with the data analysis methods. In the next chapter, a discussion about the results obtained using SPSS of the data that has been collected will be conducted.

4 RESULTS & DISCUSSION

4.1 Introduction

In this chapter, the results generated through the aid of IBM statistical package are presented along with a detailed discussion of the findings. The data captured through the aid of a survey instrument was analysed and interpreted in a systematic way to identify key patterns and trends. The chapter outlines the demographic profile of the respondents that participated in the study, followed by a detailed review of the core components of smart city and information technology disaster recovery planning. In Section 5.2.4, the key relationships between the independent and dependent variables are examined to test the hypothesis, identified in chapter 1. The goal is to examine the relationship between the components of smart city and IT DRP in order to test the framework developed in the chapter 4 to achieve continuity of IT services in smart cities in event of an IT disaster.

4.2 Results

In this section, the quantitative data analysed through the statistical package is presented.

4.2.1 Demographic Profile

The table 1 presents the demographic profile of the respondents that participated in this research study. As observed in the table, the largest group within the sample (n = 200) comprises of system engineers (26%) followed by IT Managers (24.5%). Out of the 200 responses received, 169 responses attributed to males (84.5%) while 31 (15.5%) as females. The highest age group corresponded to 31 – 40 years (n = 111; 55.5%). Similarly, when inquired about the total years of experience, a majority i.e. 36.5% (n = 73 out of 200) were found to hold 11 – 15 years of experience, followed by 24.55 with 8 to 10 years and 20% with 20 years and above. With respect to the years of experience the respondents held in Abu Dhabi Government services, in UAE, it was observed that the highest group help 5 to 6 years of experience (n = 64; 32%) followed by 7 – 9 years (n = 51; 25.5%) and 10 years and above (= 45; 22.5%). Out of the 200 respondents, a total of 105 (52.5%) held a Master's degree while 71 (35.5%) had a Bachelors and 21 (10.5%) held a Doctorate degree.

	N	Mean	Std. Deviation
1. Position	200	2.98	1.475
IT Manager	49	24.5%	
Systems manager	26	13.0%	
Systems Engineer	52	26.0%	
Operations Manager	27	13.5%	
2. Gender	200	1.16	.363
Male	169	84.5%	
Female	31	15.5%	
3. Age	200	2.21	.848
20-30	34	17.0%	
31-40	111	55.5%	
41-50	34	17.0%	
51-60	21	10.5%	
4. Experience Years	200	2.35	1.059
8-10yrs	49	24.5%	
11-15yrs	73	36.5%	
16-20yrs	38	19.0%	
21yrs and above	40	20.0%	
5. Exp in Current Position	200	2.51	1.051
2-4yrs	40	20.0%	
5-6yrs	64	32.0%	
7-9yrs	51	25.5%	
10yrs above	45	22.5%	
6. Education	200	3.72	.666
Diploma	3	1.5%	
Bachelor	71	35.5%	
Master	105	52.5%	
PhD	21	10.5%	

Table 4.1: Demographic Profile of the Respondents

4.2.2 Core Components of Smart City

The core components of a smart city, as identified in the literature review, are technology, process, people, organizational/structure, financial and security/privacy (Nam and Pardo, 2011; Chourabi et al., 2012; Al-Hader et al., 2009). These six core components are the driving forces that determine the way operations are held and executed within the smart city framework. In this section, each of the six components of the smart city system is examined in detailed, with a review of the responses received against each component.

4.2.2.1 Information Technology Components

Smart City Applications need to integrate different "technological silos" and various technologies involved. To identify these technological properties, the respondents were asked to share their response towards the following questions contributing towards the technology component of the smart city system.

Q1. Please select the applicable data feed sources mentioned below that you have worked with:

The question was aimed to identify the applicable data feed sources that the respondents have familiarity in terms of professional usage. As seen in the figure 4.1, six data feed sources were provided as options to the respondents. Of the six options, high usage was found for cameras, GPS systems, traffic data streams, disaster prevention data stream and security data steams with each receiving more than 140 responses out of 200. Only energy saving data stream received 50:50 response indicating an apprehension within the respondents of its application.

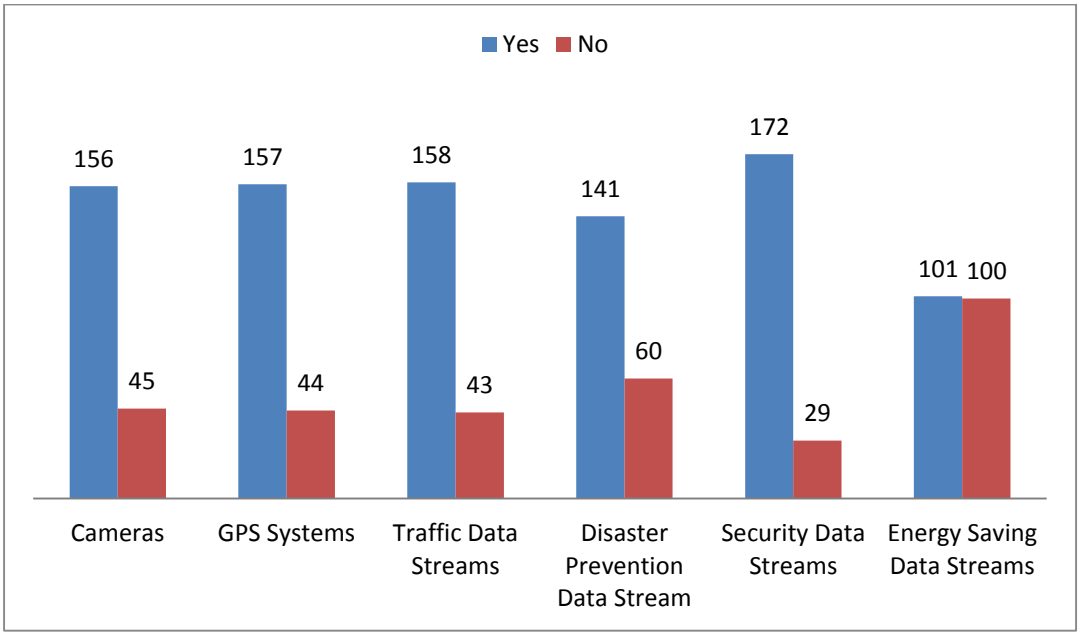

Figure 4.1: Familiarity in applicable data feed sources usage

As highlighted by Zanella et al. (2014) and Al Nuaimi et al. (2015), seamless integration within the components of smart city is achieved through a well-developed and connected architecture which includes a variety of devices including data feed sources. Various channels of data feed

enhance the quality of data utilized by the smart city system to improve the services and achieve improved decision-making (Mitton et al., 2012; Zanella et al., 2014). However, given the financial constraint involved, the technical architecture of smart city systems are restricted, as identified from the type of devices chosen by the respondents that they have familiarity using within this respective organizations.

Q2. From the following sectors, what is the priority level of smart city technologies which represent for your community?

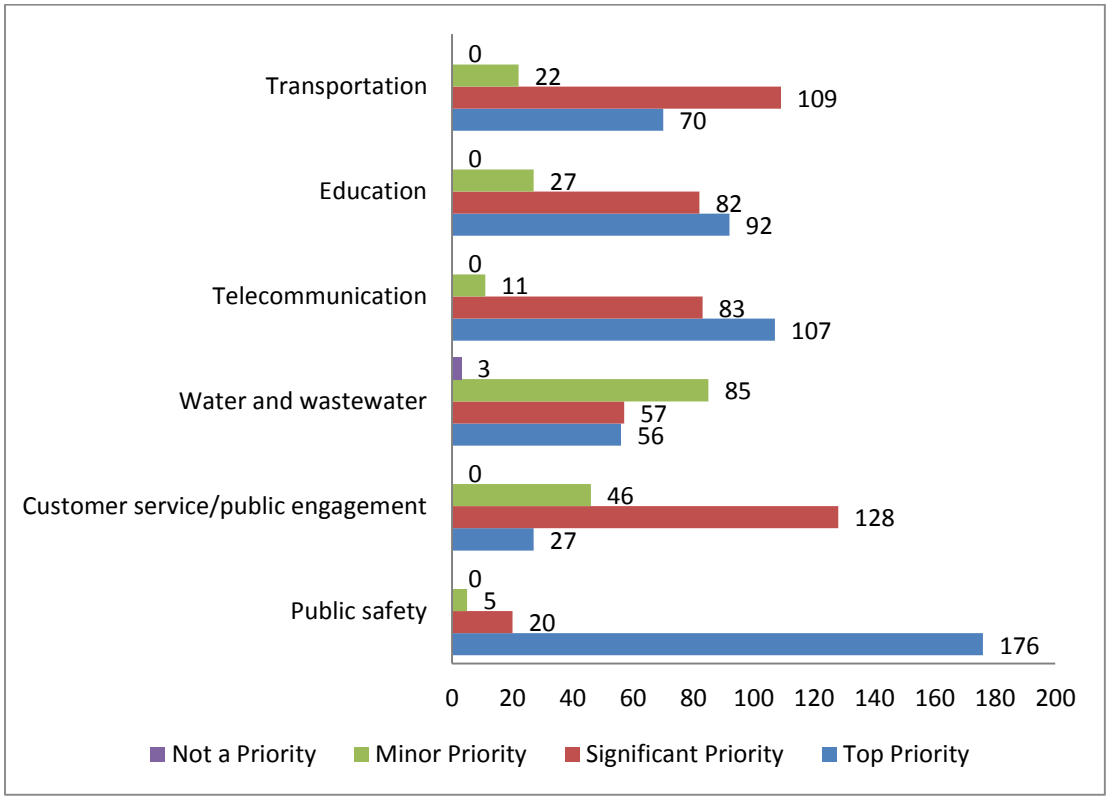

Figure 4.2: Priority level of smart city technologies

The smart city activities are priority for the larger communities as opposed to the smaller communities, and hence require complex and well-integrated technology architecture. When asked to share the priority level of various smart city technologies with the respondents community, the highest responses was received for public safety (n = 176; 88%) [See figure 4.2]. The information supports the positive relationship between the prioritization of smart city activities and population size, as identified by past researchers (Nam and Pardo, 2011; Naphade et al., 2011). Overall, the respondents to the survey identified the activities 'public safety',

'telecommunications (n = 107)' and 'education (n= 92)' of the smart city as top priority. Similarly, significant priority was found to be associated with customer service and public engagement activities (n = 128) and transportation (n= 109). Lower priority was allocated towards water and waste-water activities (n= 85). A point to note is that none of the six dimensions were listed as 'not a priority'.

Q3. Currently, what is your community's level of engagement with respect to smart city technologies?

This question related to the level of engagement of the respondent at the community in the usage of smart city technologies: smart payment (finance), water and wastewater, customer service (engagement), telecommunications and energy. As seen in the figure 4.3, a majority of the respondents active deployment of smart payment services (n = 137) with the remaining activities receiving a lower vote. Similarly, in pilot stage of the programs, the activities identified are water and wastewater (n=90), telecommunication (n= 106) and energy (n= 90). Customer services and engagement within smart city technologies was identified to be in the planning stage (n=73).

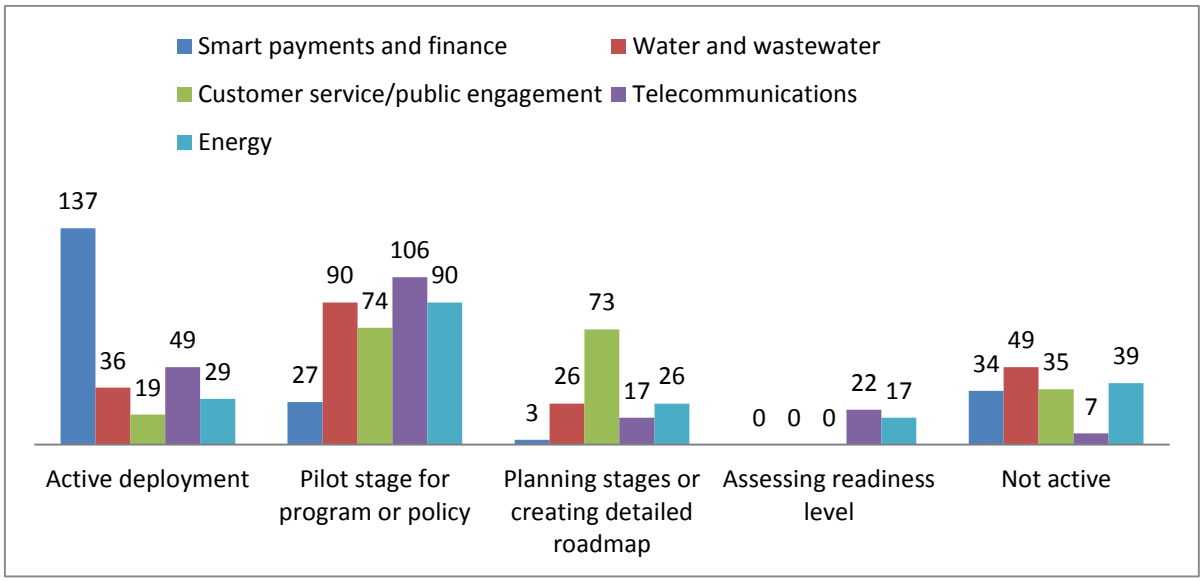

Figure 4.3: Technology Level of engagement at community level per service

As highlighted by Sahebjamnia, Torabi, and Mansouri (2015) and Herbane (2010) smart city strategies should be based on innovation and engagement that breaks the nexus for development and brings in public engagement. A lack in engagement of the public in smart cities raise a question on the technology readiness of the overall system or the specific service offered.

4.2.2.2 Process Components

The smart city process components comprise of the effective integration of the smart city technologies within the system through seamless integration. The processes of a smart city system are action oriented and hence, are required to be reviewed, monitored and updated on a regular basis.

Q1. How important are the following benefits in encouraging government to implement use of smart city technologies?

When asked to share how important are economic development, safety & security, capital (operational) cost savings, resilience towards critical operations and enhanced services, a clear set of responses were received [See figure 4.4].

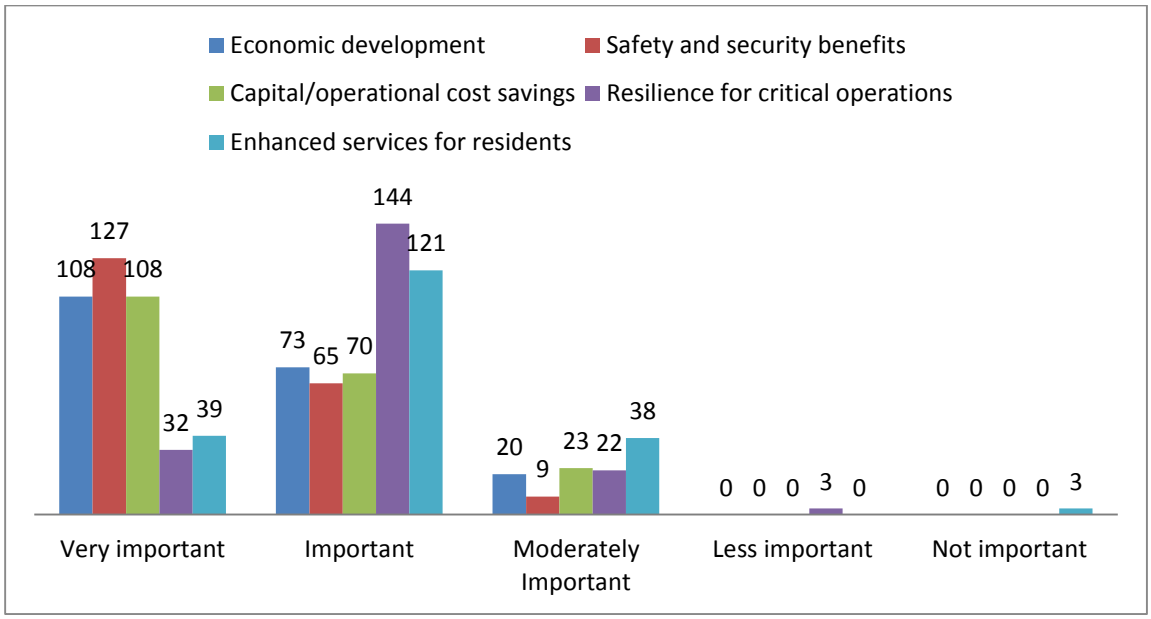

Figure 4.4: Ranking encouraging government to implement the use of smart city technologies

As seen in the figure, high important for implementing the Smart city Technology was given to safety and security benefits (n = 127), economic development and capital/operational costs savings (each with n=108). Resilience towards critical operations (n = 144) and enhanced services for the residents (n = 121) also received the vote of importance of the respondents. This indicates that safety and security is the prime benefit that users view from smart government services while also considering resilience in critical operations and improved services to the users.

Q2. Which of the following processes have been optimized for Smart government initiative?

When asked which processes were optimized as part of the smart government initiative, a majority of the respondents indicated new IT architecture plan and organisation (43%), followed by new organization model (33%). Only 24% responses were received for new interconnected management positions.

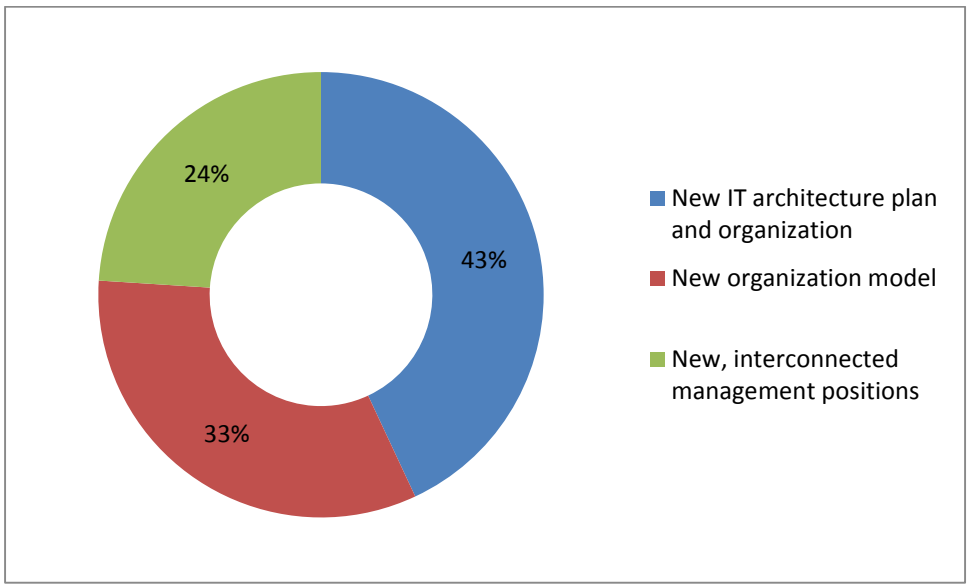

Figure 4.5: Processes optimized for smart government initiative

4.2.2.3 People Components

For implementation of Smart Government Services in Smart City project, people skills play a crucial role (Gregory, 2011; Yang, Wu, Shu, & Yang, 2006). In the absence of proper training to the people involved in the operations, smart government services implementation may be effected.

Q1. What type of IT training do employees receive at their workplace for smart government services in smart city implementation?

In order to review the current scenario of the IT training rendered to the staff involved in smart city services, the respondents were asked to share their response for a series of attributes, as seen in the figure 4.6.

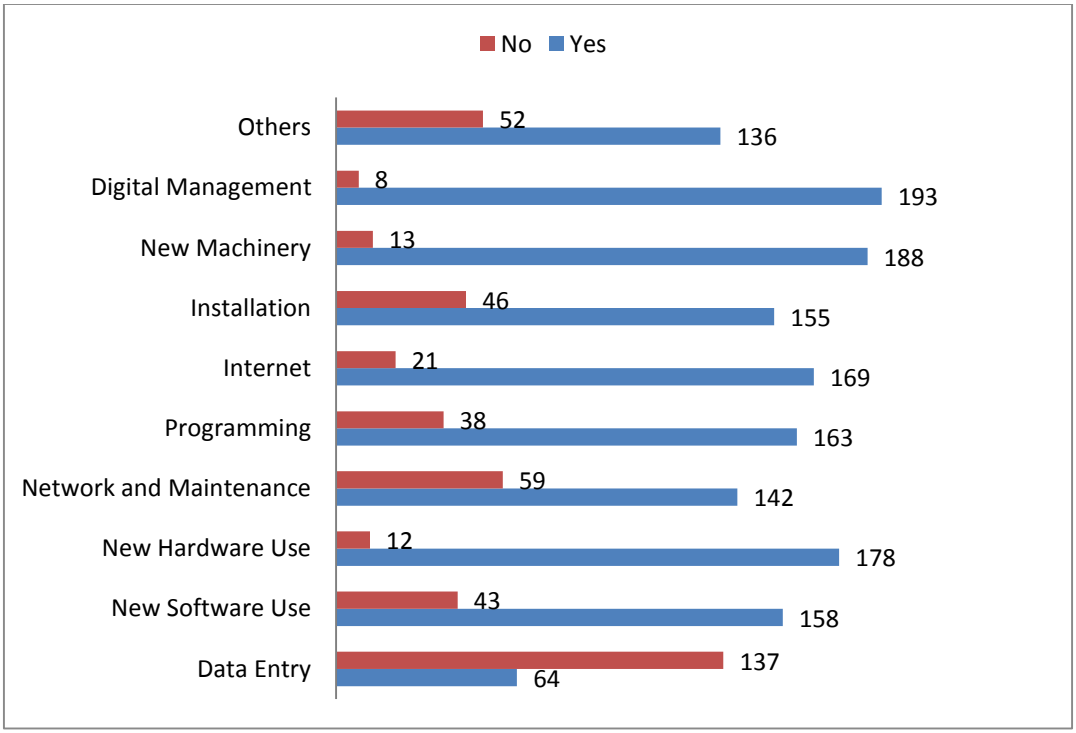

Figure 4.6: IT training received by staff of smart city services

A total of 10 attributes of training were listed as options of which the highest response was received for digital management (n=193) followed by new machinery (n = 188) and new hardware use (n=178). Other high ranking attributes include installation, internet, programming, network and maintenance, and new software use. This indicates that the employees of the smart city services are provided with effective IT training in almost all aspects of the system operations and provision of the smart city services.

4.2.2.4 Organizational and Structural Component

Q1. How will your organization/community implement the smart government initiatives? Select the most relevant.

The respondents were asked to choose the most relevant aspects to implement smart government initiatives, as seen in figure 4.7. As observed in the figure, the highest response was received for acquiring long term solutions from consultants (n=133, 20%) followed by building and operating systems internally and operate consultant advised system (together n = 123, 19%). Also, 17% responses were received for outsourcing operations and development to consultant while other solutions received 12% vote.

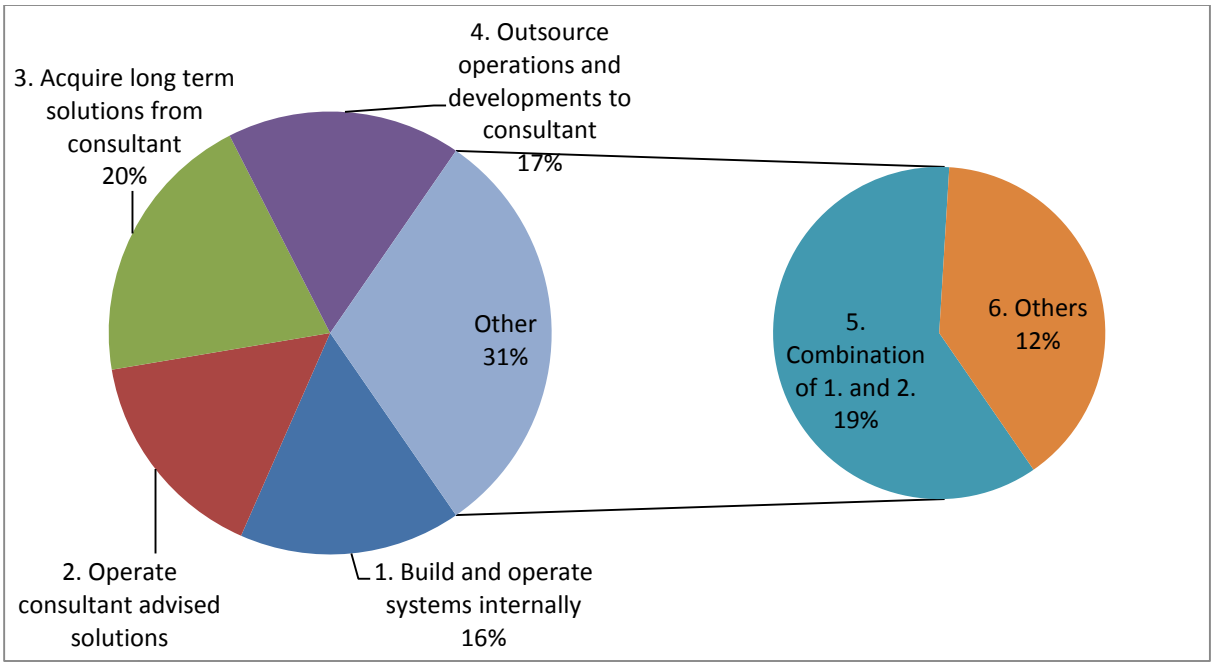

Figure 4.7: Organizational – structural components needed for implementing the smart government initiatives

4.2.2.5 Financial Resources Component

Q1. What is the widely adopted financing mechanism for Smart Government Services in Smart City implementation?

The widely adopted financial mechanism for the Smart Government Services in the Smart City implementation was identified as the use of strategic partners (n=187), a seen in figure 4.8 below. It is followed by public private partnership (n=184). Other widely adopted financial mechanisms include Government funding (n=159), private investment (n=155) and use of financial instruments (n=138).

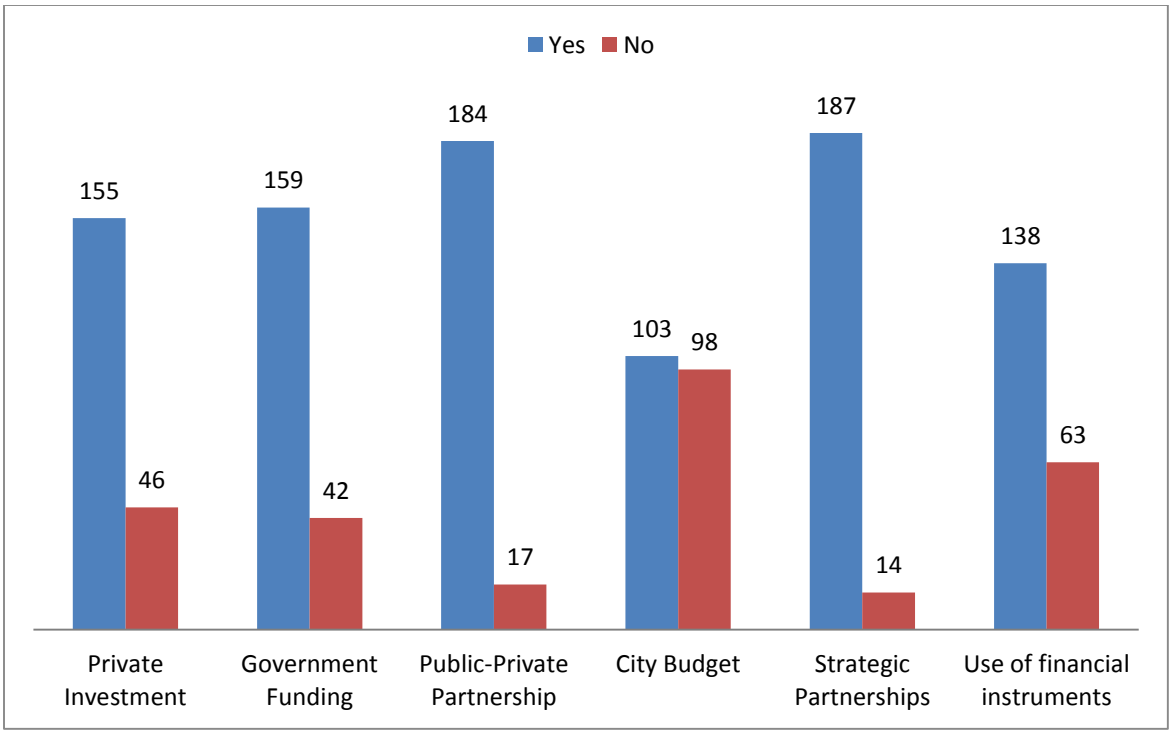

Figure 4.8: Wide adopted financial mechanism for the Smart Government Services

4.2.2.6 Security and Privacy Component

Q1. How much importance is given to security and privacy during and after implementation of the initiatives?

The level of security and privacy, as indicated by Nam and Pardo (2011) and Al Nuaimi et al., (2015) is one of the most vital characteristics of a smart city system. As seen in the figure 4.9, importance of security and privacy in the implementation of the smart government in smart city initiative received a strong agreement (n= 194). Highest vote of importance was received for the need to carry out security evaluation for the products that are acquired for smart government implementation. Moderate to nil negative responses were received from the respondents.

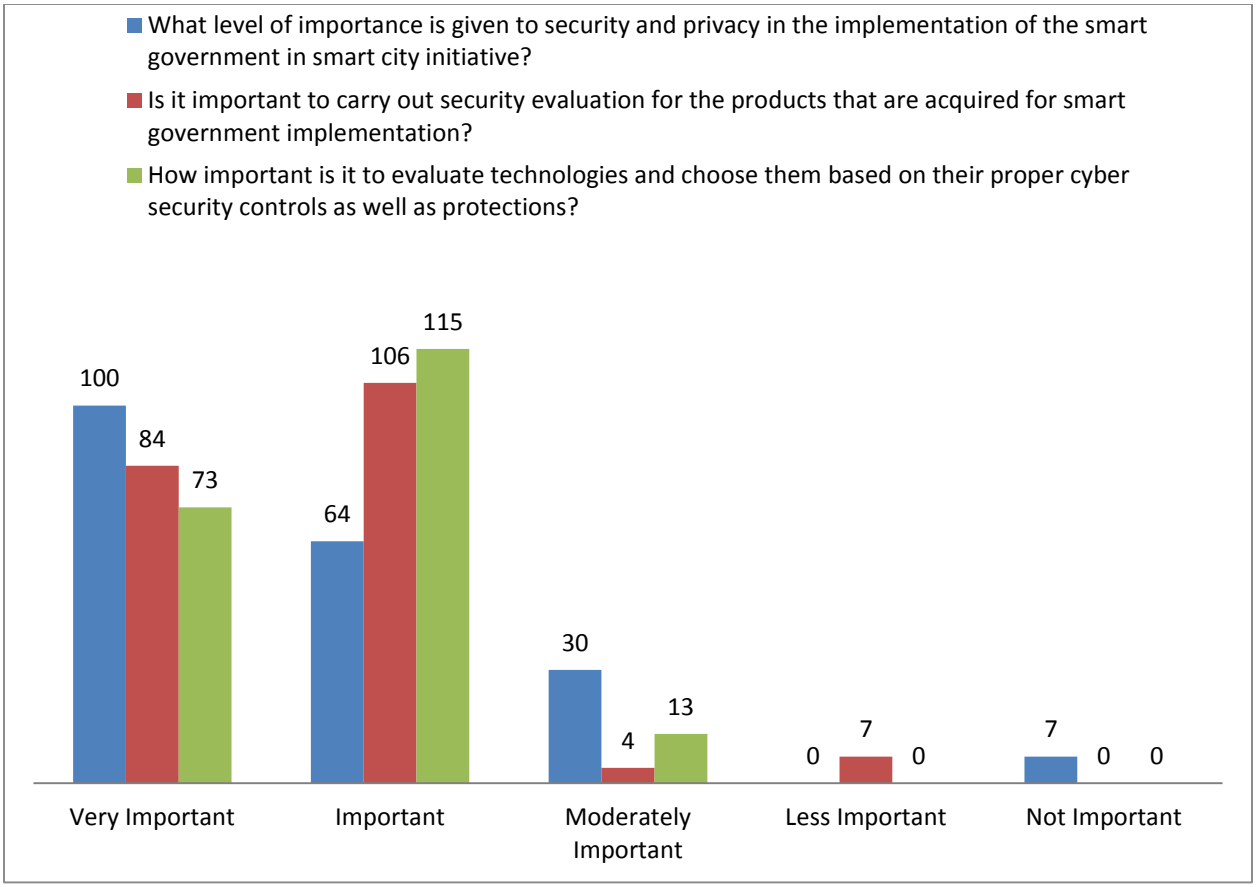

Figure 4.9: Importance towards security and privacy during and after implementation of the initiatives

4.2.3 Identifying IT DRP Components

4.2.3.1 Implementation Component

Q1. What is the DR implementation strategy for your organization?

To examine the current level of the disaster recovery implementation strategy with the firms of the participants, they were asked to share their response towards a set of DR attributed, as seen in figure 4.10. As observed, the highest response was received for 'making use of software based replication for DR (n=127, 17%)' and a hosted or Managed Service Provider (MSP) environment (n= 112; 15%)'. Similarly, Secondary site that mirrors the primary site and Secondary site, but does not mirror the primary site each received 12% responses. Others include hardware array-based replication (13%). The responses indicate the IT professionals in UAE collaborating for smart city projects understand the need for disaster recovery strategy and the elements involved to achieve it.

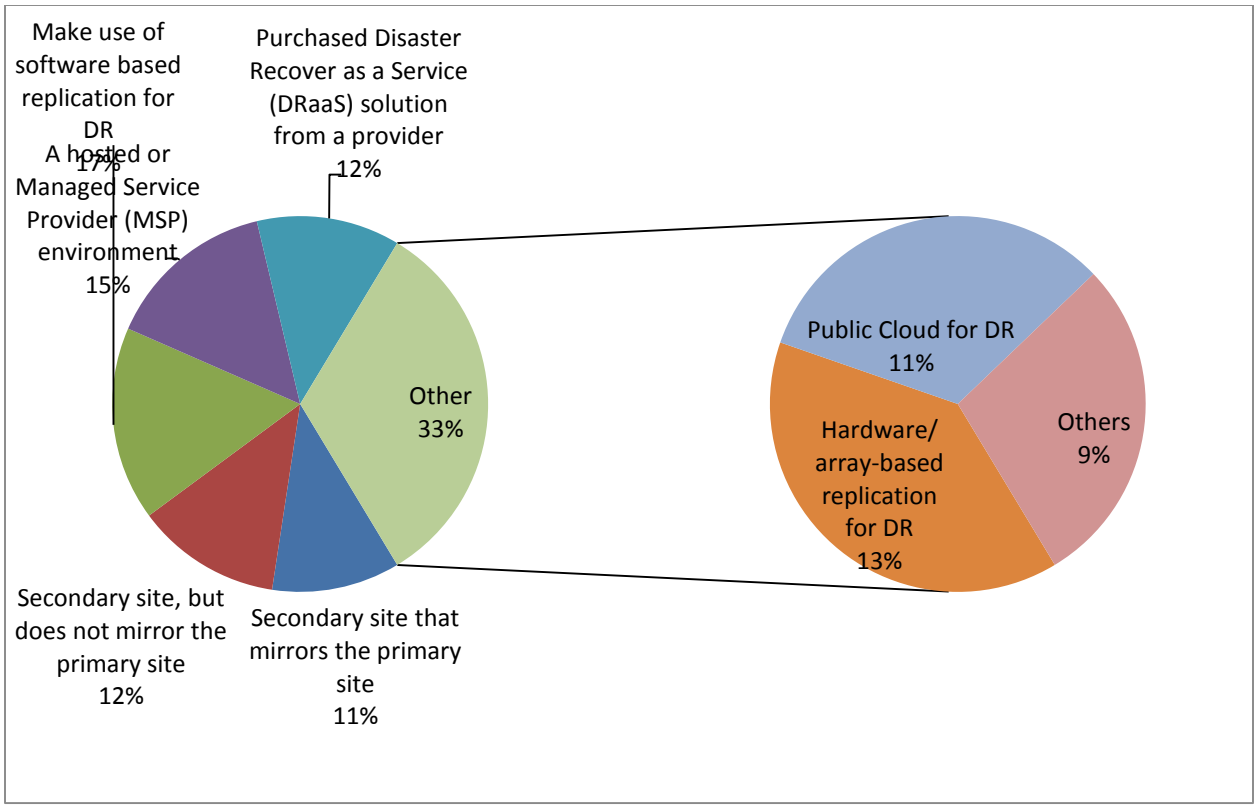

Figure 4.10: Current DR implementation strategy

Q2. Alternate Location

The respondents were asked to select the Alternate location Options and their use in DR implementation strategy for your organization. As seen in the figure 4.11, when asked if the respondents organizations have an alternate location for their respective organization, 149 out of 200 replied in affirmative, while 32 denied. Similarly, when asked if their organization has backup facilities in a separate geographical location, 110 positive responses were received (signifying the acceptance of the firms to rely on an alternative location in case of an IT emergency). However 81 respondents replied in negative which accounts to 40.5% firms that do not have an alternate site for data protection and emergency operations in event of an IT disaster. If the backup facilities pointed by the respondents made use of a separate telecommunications provider, 106 respondents replied in negative while 83 agreed to the question. A similar observation was made for the question 'Are the system resources portable, i.e. can they be easily transported to backup location?' A total of 112 out of 200 (56%) respondent denied that their organization has potable system resources during backup operations. This signifies that firms

though having knowledge of IT disasters and IT operations lapse, still do not have the needed provisions to adapt to any IT emergencies that may face.

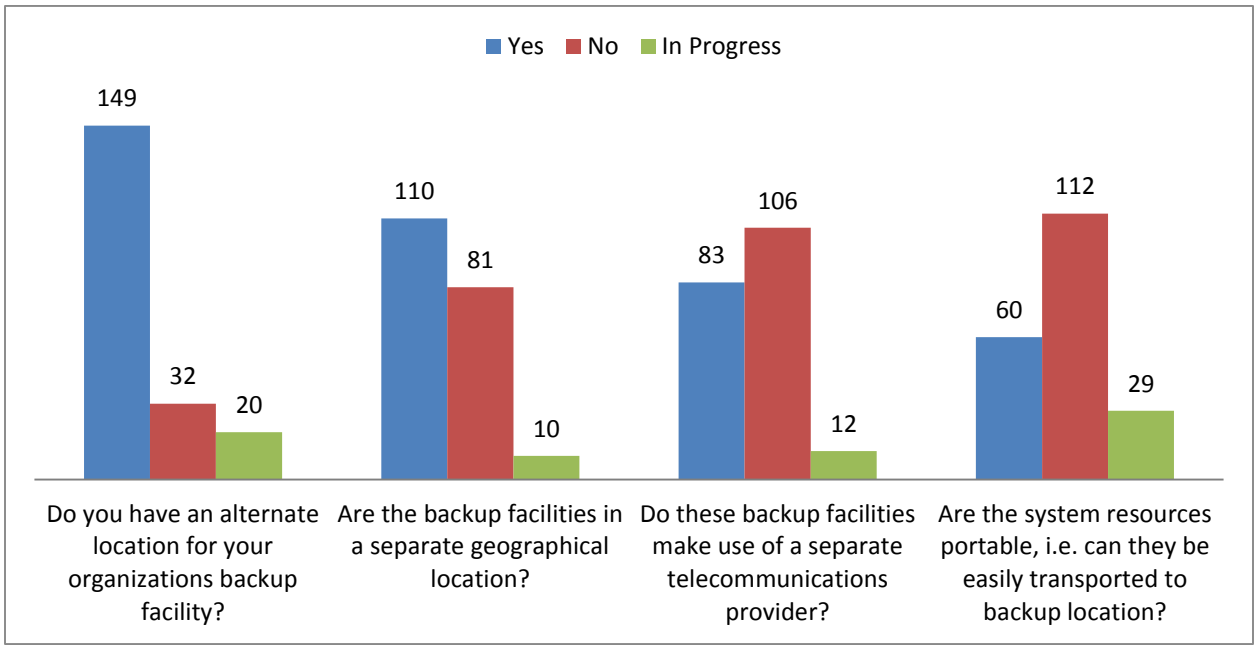

Figure 4.11: Alternate location Options and their use in DR implementation strategy

Q3. When disruptions are caused by the following third-party components, what specific steps are taken by the organization?

To examine the actions taken by the organizations when disruptions occur, the respondents were asked to share their responses on the actions taken. As seen in the figure 4.12, highest number of actions were accounted for service providers such as Etisalat and Du (n=147; 24%) followed by data providers (21%). Other third parties and disaster management firms account to 20% response each, while banks received 15% response. The responses indicate the high priority given to service providers such as the telecommunication firms to restore the service disruptions and ensure continuity of the operations.

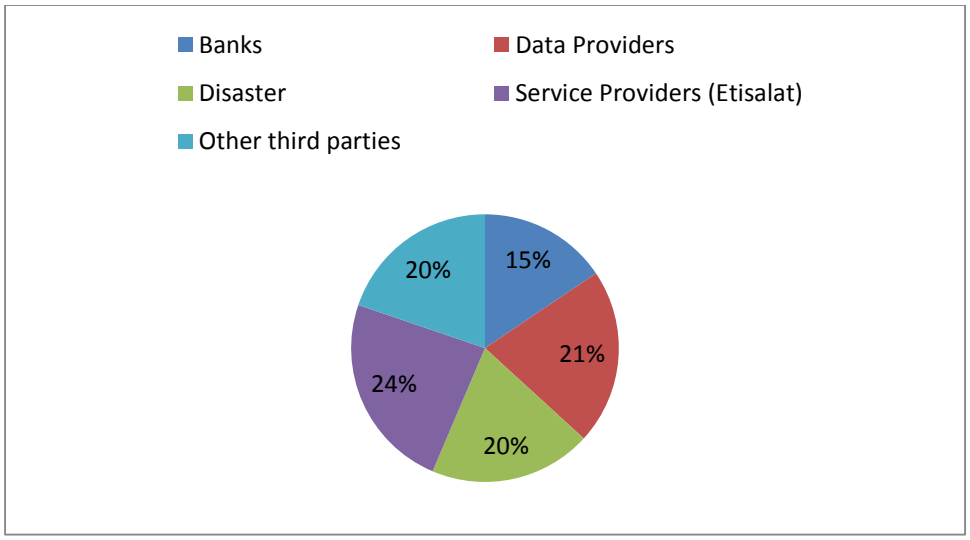

Figure 4.12: Percentage of Actions Taken per Third party

4.2.3.2 Continuity Management Component

Q1. Does your organization have a continuity plan in place?

To examine of the respondents' organization's had a continuity plan in place to protect their operations in the event of an IT Disaster, the respondents were asked to share their view. A total of 127 out of 200 respondents indicated that their organization is in progress to develop a continuity plan, while 71 replied in affirmative. This indicated that current status of the firms in the transit stage wherein they move their strategy to accommodate IT continuity strategy and become resilient and ready to respond in case of an IT disaster.

Q2. Which are the most important functions of your organization and how soon can they resume after a disruption?

A set of five to six attributes were provided to the respondents as options to specify which are the most important functions and the time period to respond post disruption. As observed in the figure 4.13, the most important functions of the organisations (based on the respondents) were identified as customer service, production and procurement, and IT research and development. The three functions of the participating organizations resume within 1 week post IT. Other functions such as IT development and deployment resume in 2 weeks (n=115). It can be seen the IT functions are given prominence during recovery operations to streamline the operations and resume services at the earliest. Other operations such as finance and accounting are prioritized lower.

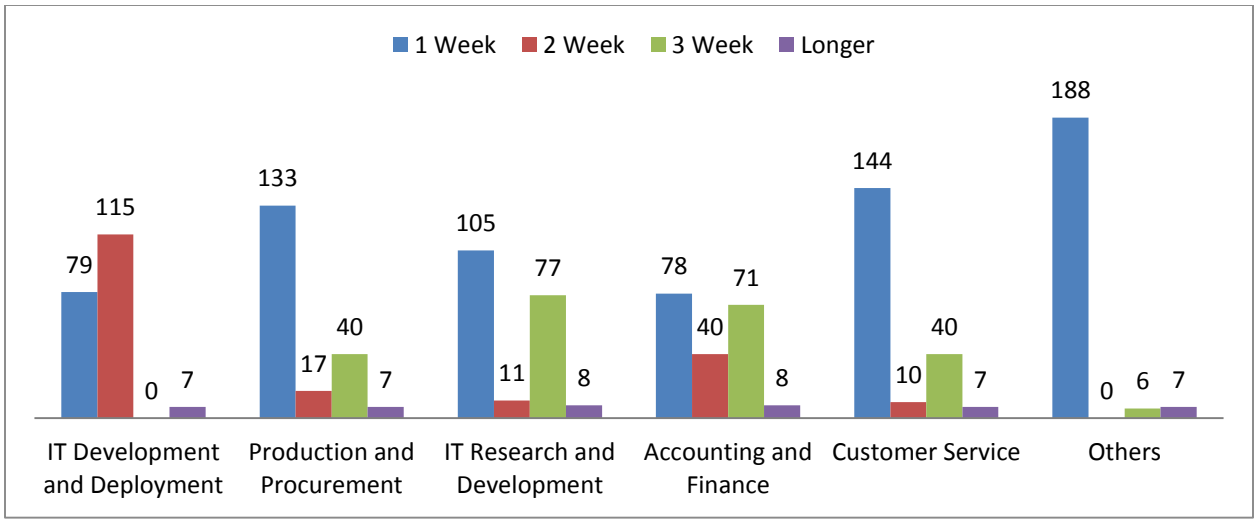

Figure 4.13: Most important functions and Response Time in Event of IT Disaster

Q3. How often is the IT DRP reviewed in your organization?

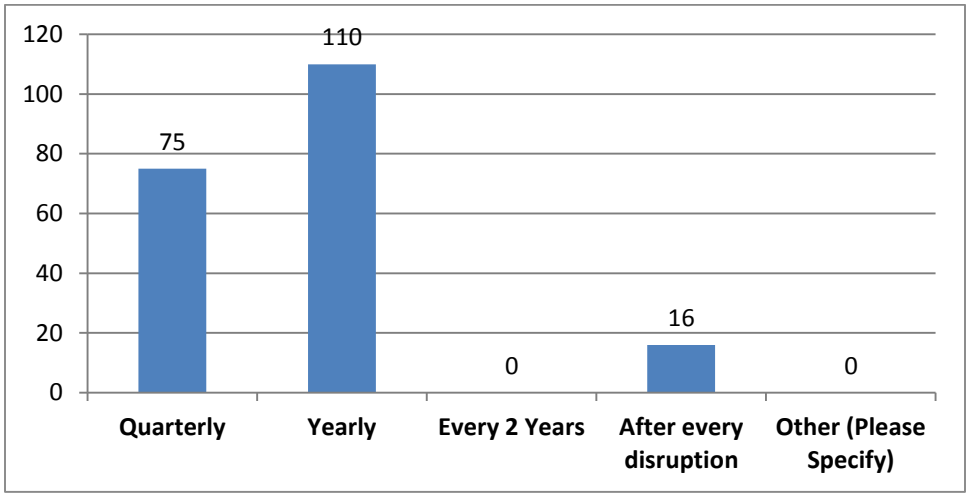

Figure 4.14: Frequency of review for IT DRP

To respondents were asked to share how often their organization reviews their respective IT DRP. As seen in the figure 4.14, a majority of the respondents pointed out that the IT DRP is reviewed yearly (n=123) while other high level responses indicated quarterly (n=75). This indicates that the frequency of review for IT DRP within firms associated with smart city operations is rather stretched. It is important that these firms update their strategy to increase the frequency of review of IT DRP, enabling them to launch effective action in case of an event. The relaxed frequency of review also reflects the outlook of the management in prioritizing IT DRP within the organization.

4.2.3.3 People Component

The respondents were asked to their response towards the people component comprises of a series of questions to examine the technological readiness, and awareness to maintain continuity of smart city services. As observed in the figure 4.15, a majority of the respondents indicated that their firms have an IT recovery team (n=122), are aware of IT disruptions and what to expect in such an event (n=144) and have participated in emergency preparedness workshops (n=137). A total of 25% of less respondents indicated that their firms lack behind in technology readiness, indicating the failure of the firms to successfully manage their people component in achieving continuity during IT disasters.

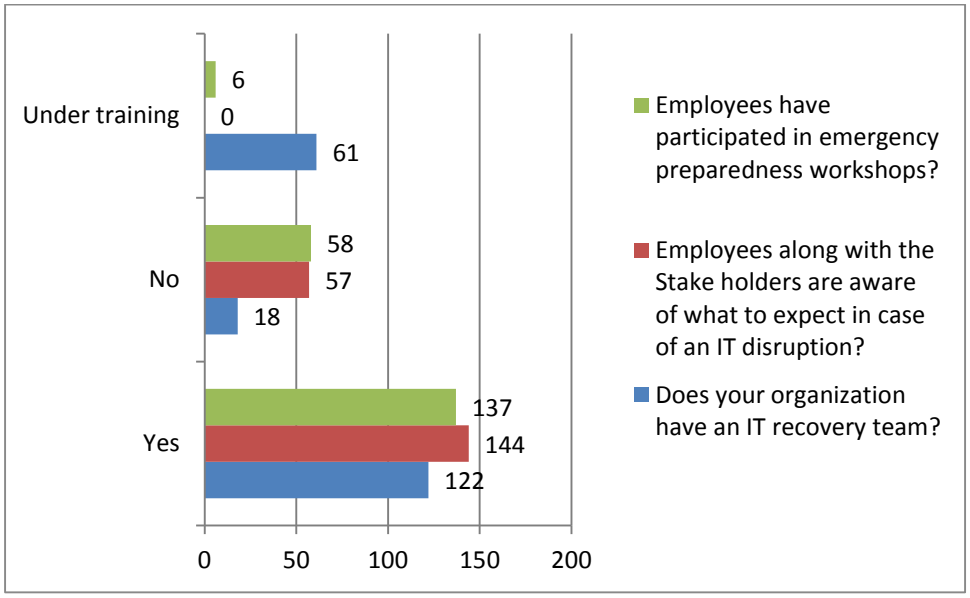

Figure 4.15: People Component of Smart City Firms

4.2.3.4 Technology Component

Q1. In order to protect your organization from data loss, please share your response if the following steps are followed.

The aim of this question was to examine which data loss protection attributes of IT DRP are effectively management by the participating firms. As observed in the figure 4.16, the respondents indicated that their organizations are fully to somewhat prepared for data loss protection in event of an IT disaster.

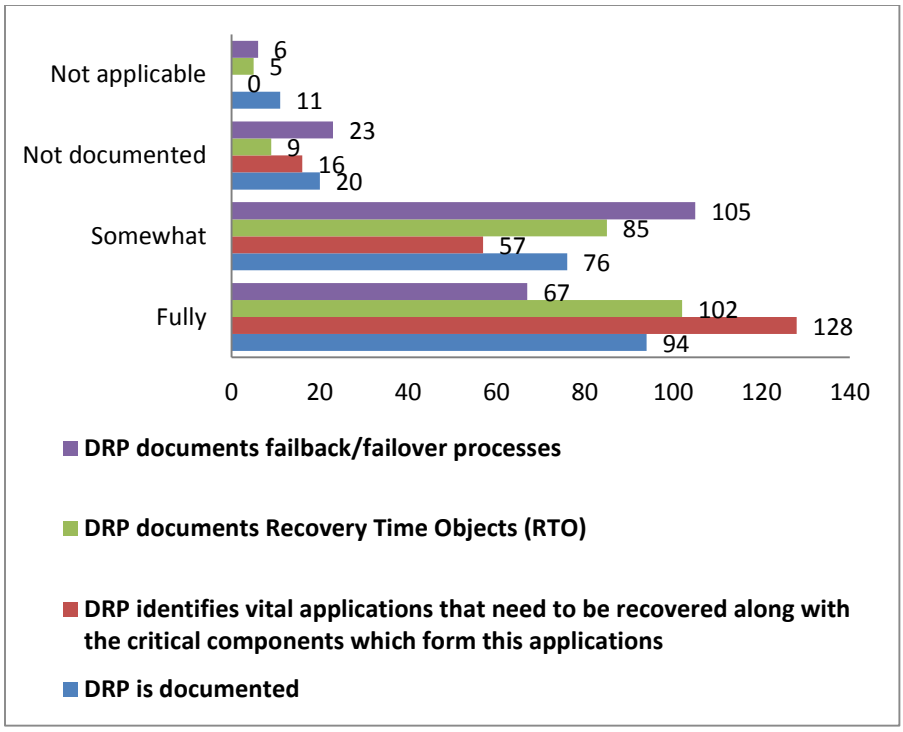

Figure 4.16: Prevention against data loss

A total of 94 out of 200 respondents indicated that their firms have IT DRP documented, whereas 128 respondents confirmed that DRP identifies vital applications that need to be recovered along with the critical components which form its applications. Similarly, 102 respondents indicated that DRP documents Recovery Time Objects (RTO) are followed and met within their firm. A point to note is that 105 respondents indicated that their firms may not be fully prepared for DRP documents failback/failover processes, which may affect their overall IT DRP strategy.

Q2. Are the following components for IT Services incorporated?

The aim of this question was to identify which components of the IT services are incorporated within the participating firms. As seen in figure 4.17 below, a total of 194 out of 200 respondents indicated that all IT services offered by the IT department have been identified, while 158 respondents confirmed that assessment has been done regarding risk to IT services and infrastructure. Similar response was received for 'all system requirements have been identified to provide IT services' and 'all system requirements have been identified to provide IT service'. However, the latter components received slight negative responses too.

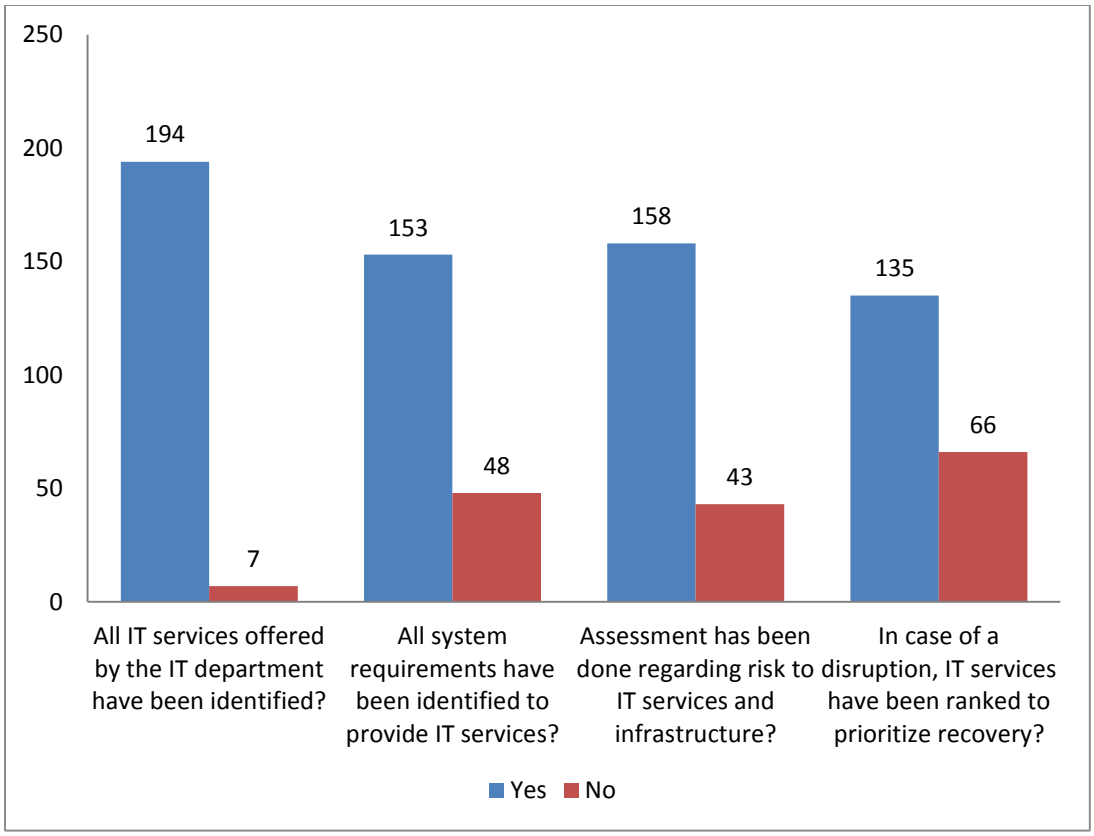

Figure 4.17: Incorporation of IT components

Organizational Component

Q1. Organizational identification and notifications for IT disasters. Answer Yes or No.

When asked to share their agreement or disagreement on whether their organizations have protocols for organizational identification and notifications for IT Disasters, a majority of the respondents replied in affirmative.

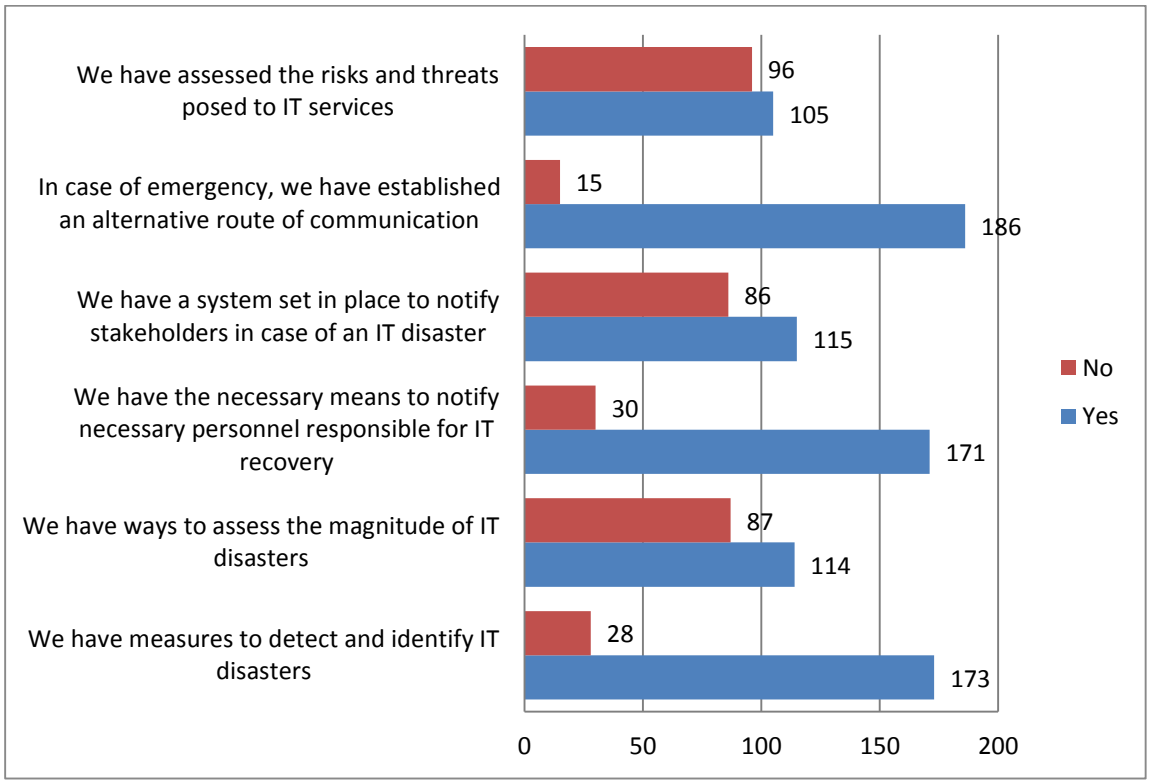

Figure 4.18: Organizational identification and notifications for IT disasters

As seen in the figure 4.18 below, the highest positive responses were received for protocols set for alternative communication in case of an emergency (n= 186). It was followed by 'having measures to detect and identify IT disasters (n=173)' and 'having the necessary means to notify necessary personnel responsible for IT recovery (n=171)'. The other options such as 'protocols to assess the magnitude of IT disasters', 'a system set in place to notify stakeholders in case of an IT disaster' and 'having assessed the risks and threats posed to IT services' too received positive responses (n >100). This indicates that the participating firms have a clear outlook towards IT disasters and recovery by having identified measures to restore systems, operations and communications.

4.2.3.5 Environmental Component

Q1. Are regulations followed binding the IT DRP for Smart government?

When asked if there are any regulations that bind the IT DRP for smart government activities or projects, a majority of the respondents (n>100) replied in affirmative.

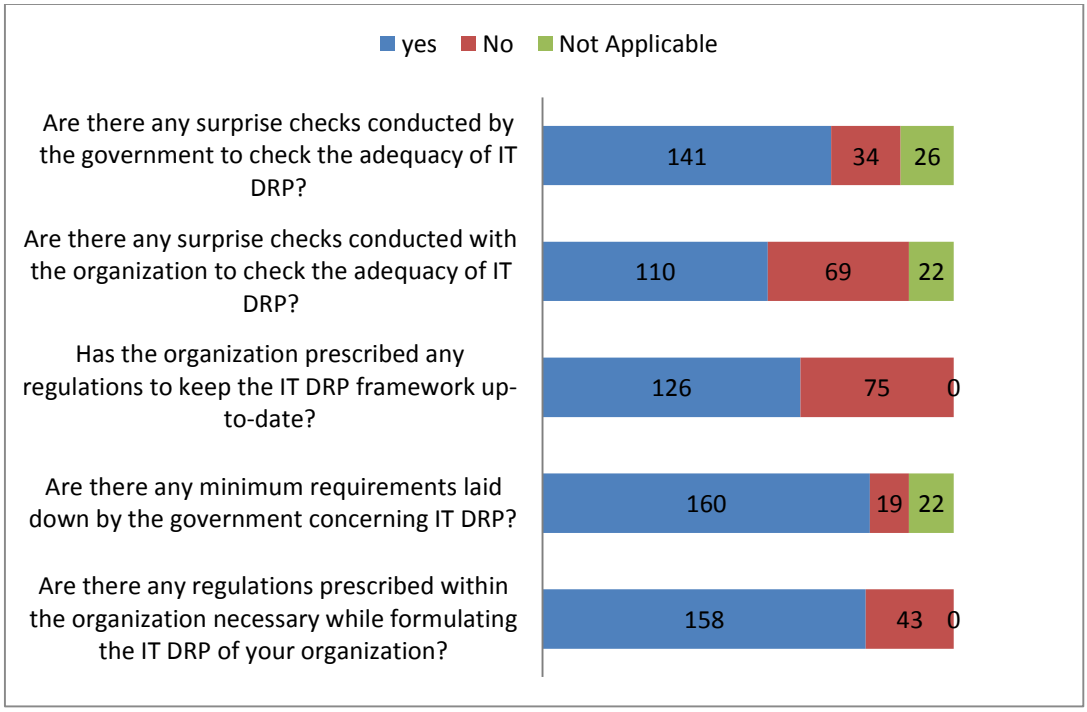

Figure 4.19: Regulations followed binding the IT DRP for Smart government

As seen in the figure 4.19 above, the highest positive affirmation was received for 'minimum requirements laid down by the government concerning IT DRP (n=160)' followed by 'regulations prescribed within the organization necessary while formulating the IT DRP in the firm (n=158). Only 30% or less negative response was received, with the highest (n=75) being for 'regulations prescribed to keep the IT DRP framework up-to-date within the firm'. Similarly, a total of 69 negative responses were recorded for 'any surprise checks conducted with the organization to check the adequacy of IT DRP.' This indicates that the firms that are a part of the Abu Dhabi Government smart city projects in UAE are imposed to regulations and protocol that binds their working environment to meet IT DRP standards. However, there is still is a gap with the existence of low surprise checks and regular update of the IT DRP requirements as per the framework.

4.2.4 Examining the Key Relationships between the Variables

An examination of the key relationships is essential in order to understand how the variables are related to each other and the effect one has on the other. In this research study, the aim was to develop a framework that integrates the elements of IT DRP and Smart City, to be a comprehensive framework effective in managing IT continuity in case of IT disasters. Before proceeding with the examination of the relationships (based on the hypothesis presented in the chapter 1), a correlation test was conducted to measure the coefficient (strength) of the relationship. Pearson correlation test was utilized to measure the strength of the relationships.

		Smart City					
	Pearson Correlation	IT Component	People Component	Process Component	Organizational	Financial	Security & Privacy
	Education	.403	.403	.712	.408	.848	.782
	Experience	.815	.815	.223	.708	.609	.782
IT DRP	Implementation	-.304	.564	.403	.651	-.827	.779
	Continuity Management	.564	.037	.403	.332	-.574	.779
	People	-.403	.403	-.304	.408	.848	.782
	Technology	.651	.332	.408	.778	-.628	-.714
	Organizational	.827	.574	.848	.628	.338	.932
	Environmental	.779	.779	.782	.714	-.932	.840

Table 4.2: Pearson Correlation

As seen in the table 4.2 above, the relationships observed are both positive and negative (denoted by the – and + signs). The Pearson coefficient is measured from –1 to +1, wherein a negative relationship is assumed for values ranging from -1 to 0 and positive for 0 to +1. Also, the coefficient or the strength of the relationship whether positive or negative is strongest when is closer to 1 and weakest when closer to 0. Upon a close observation of the table above, it can be seen that positive correlations exists between the smart city and IT DRP components, indicating the ability of these components to support each other when integrated together as a comprehensive framework. However, there are negative correlations primarily between the financial component of smart city and implementation (-0.827), continuity management (-0.574) and technology (-0.628) component of IT DRP. Also, a negative correlation is observed between

IT DRP people component and smart city process component (-0.304). Similarly, negative correlation is observed between IT DRP implementation and smart city IT component (-0.304). With respect to education and experience, only positive correlations were observed with smart city components with a majority of strong relationships. This indicates that with increase in education and experience of the employees, the better is the knowledge, application and development of the smart city components.

To further examine the relationship strength, whether or not there exist any significance leading to acceptance or rejection of the hypothesis, the regression analysis was conducted. A statistical measure, regression test is utilized to examine the relationships that may exist between the variables (i.e. independent and dependent). It renders a causal approach to examine if the predictor variable has an effect on the target variable. The regression model will allow in identifying if there exists a significant relationship between IT DRP and smart city variables, thereby supporting the consolidated framework for smart city IT DRP (as presented in the chapter 3). The regression test is applied on the data collected through the aid of the survey questionnaire and will test the 5 hypothesis presented in the chapter 1. An overview of the five hypotheses is shared in the table 4.3 below.

Hypothesis Testing	Description
H1	There is a significant relationship between IT DRP components and Smart City Systems components leading to an efficient and effective integrated Smart City IT DRP Model
Hi	The information technology, People and Process components of Smart City has an effect of IT DRP Implementation Component
Hii	The information technology, People and Process components of Smart City has an effect of IT DRP Continuity Management Component
Hiii	ITDRP Implementation Component is effected by Smart City Financial Resources Component and Security and Privacy Component
Hiv	The technology knowledge and practice of Smart City Components is related to the Education and Experience level of the IT personnel
Hv	The technology knowledge and practice of IT DRP components is related to the Education and Experience level of the IT personnel

Table 4.3: Overview of the hypothesis for the research

4.2.4.1 Hypothesis 1

In this section, the hypothesis (i) is tested with the dependent variable as the IT, people and process components under smart city and independent variable as the IT DRP Implementation component. The hypothesis is as follows:

Hi: *The information technology, People and Process components of Smart City has an effect of IT DRP Implementation Component*

As observed in the table 4.4 below, the model summary for the three models (model 1 for IT component, model 2 for process component and model 3 for people component) with IT DRP Implementation component is presented. The correlation coefficient (R) for model 1 and IT DRP implementation is .531 indicating a positive correlation and a good prediction level. However, the correlation coefficient of IT DRP implementation component with process and people component is considerably lower (i.e. .187 and .307 respectively). The coefficient of determination (R^2) reflects a high variance of 28.2% for IT component of smart city with the adjusted variance dropped to 26.9%. The change statistics for the model 1 and 3 is found to be significant ($p < 0.05$). The variance reported for model 2 and 3 is 3.5% and 9.4% respectively.

Model Summary									
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1. IT Smart City	.531[a]	.282	.269	1.32197	.282	20.594	3	157	.000
2. Process Component Smart City	.187[a]	.035	.017	2.21911	.035	1.905	3	157	.131
3. People Component Smart City	.307[a]	.094	.077	1.84814	.094	5.446	3	157	.001

Table 4.4: Model summary for IT DRP Implementation and smart city components

To measure the statistical significance of the three models with IT DRP Implementation component, the table 4.5 below is referred to. As observed, the overall model of IT DRP implementation component with IT and people component of smart city is found to be statistically significant ($p < 0.05$), while with process component as insignificant ($p > 0.05$). It is seen that the IT component of smart city reported $F(3,157) = 20.594$, $p < 0.05$, and people component as $F(3,157) = 5.446$, $p < 0.05$.

ANOVA[b]						
Model		Sum of Squares	df	Mean Square	F	Sig.
1. IT Smart City	Regression	107.973	3	35.991	20.594	.000[a]
	Residual	274.375	157	1.748		
	Total	382.348	160			
2. Process Component Smart City	Regression	28.143	3	9.381	1.905	.131[a]
	Residual	773.137	157	4.924		
	Total	801.280	160			
3. People Component Smart City	Regression	55.808	3	18.603	5.446	.001[a]
	Residual	536.254	157	3.416		
	Total	592.062	160			

Table 4.5: ANOVA for the model – IT DRP Implementation and smart city components

To identify which sub-questions within the three models attributed to the significance of the overall model, the coefficients table presented in the Table 4.6 below is consulted. As observed in the table, the model 1 (IT Smart city) is found to hold a significant relationship only with 'the DR implementation strategy of the firms' and 'steps taken by the firms during IT disruptions' ($p < 0.05$) while 'alternative location' was found to be insignificant. Similarly in the model 2 (process component), only 'steps taken by the firms during IT disruptions' was found to hold a significant relationship ($p < 0.05$) while it is the only question that was found to be insignificant in model 3.

Coefficients[a]						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1. IT Smart City	(Constant)	5.176	.509		10.160	.000
	ICQ1	.521	.077	.494	6.767	.000
	ICQ2	.000	.060	.001	.007	.995
	ICQ3	.264	.107	.168	2.471	.015
2. Process Component Smart City	(Constant)	7.147	.855		8.358	.000
	ICQ1	-.140	.129	-.092	-1.083	.280
	ICQ2	.088	.101	.074	.869	.386
	ICQ3	.372	.180	.163	2.073	.040
3. People Component Smart City	(Constant)	11.314	.712		15.886	.000
	ICQ1	.407	.108	.311	3.785	.000
	ICQ2	-.195	.084	-.190	-2.318	.022
	ICQ3	.142	.150	.072	.950	.343

Table 4.6: Coefficients for the model – IT DRP Implementation and smart city components

Based on the analysis conducted in this section, a significant relationship of IT DRP implementation component with IT and people components of smart city is identified. This lead to the acceptance of the hypothesis i that '*the information technology, and People components of Smart City has a significant effect on IT DRP Implementation Component, while smart city process component was found to be insignificant.*'

4.2.4.2 Hypothesis 2

In this section, the hypothesis (ii) is tested with the dependent variable as the IT, people and process components under smart city and independent variable as the IT DRP continuity management component. The hypothesis is as follows:

***Hii**: The information technology, People and Process components of Smart City has an effect of IT DRP Continuity Management Component*

As observed in the table 4.7 below, the model summary for the three models (model 1 for IT component, model 2 for process component and model 3 for people component) with IT DRP continuity management component is presented. The correlation coefficient (R) for model 1 and IT DRP continuity management component is .107 indicating a weak correlation and a weak prediction level. A similar weak correlation is found for people component (.251) while process component has a strong prediction level (.416). The coefficient of determination (R^2) reflects a low variance attributed by the three models with the highest being 17.3% accounted by the process components of smart city. The change statistics for the model 2 and 3 is found to be significant ($p < 0.05$).

Model Summary									
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1. IT Smart City	.107[a]	.011	-.004	1.47234	.011	.755	3	196	.521
2. Process Component Smart City	.416[a]	.173	.160	2.07751	.173	13.652	3	196	.000
3. People Component Smart City	.251[a]	.063	.049	1.85614	.063	4.401	3	196	.005

Table 4.7: Model Summary for IT DRP Continuity Management and smart city components

To measure the statistical significance of the three models with IT DRP continuity management component, the table 4.8 below is referred to. As observed, the overall model of IT DRP continuity management component with process and people components of smart city is found to be statistically significant ($p < 0.05$), while with IT component as insignificant ($p > 0.05$). It is seen that the process component of smart city reported $F(3,196) = 13.652$, $p < 0.05$, and people component as $F(3,196) = 4.401$, $p < 0.05$.

ANOVA[b]						
Model		Sum of Squares	df	Mean Square	F	Sig.
1. IT Smart City	Regression	4.907	3	1.636	.755	.521[a]
	Residual	424.888	196	2.168		
	Total	429.795	199			
2. Process Component Smart City	Regression	176.771	3	58.924	13.652	.000[a]
	Residual	845.949	196	4.316		
	Total	1022.720	199			
3. People Component Smart City	Regression	45.487	3	15.162	4.401	.005[a]
	Residual	675.268	196	3.445		
	Total	720.755	199			

Table 4.8: ANOVA for the model – IT DRP Continuity Management and smart city components

To identify which sub-questions within the three models attributed to the significance of the overall model, the coefficients table in Table 4.9 is evaluated. As observed, the model 1 (IT Smart city) is found to hold no significant relationships with any of the sub questions of continuity management in IT DRP. However, in model 2 i.e. process component, significance is found for Q2 (most important functions within the firm and the response time for resumption of service) and Q3 (frequency of review of IT DRP) with $p < 0.05$. Similarly for model 3, only Q1 (if the firm has a continuity plan for IT) received a significance.

Coefficients[a]						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1. IT Smart City	(Constant)	7.530	.456		16.513	.000
	CMCQ1	-.004	.232	-.001	-.016	.987
	CMCQ2	-.021	.030	-.052	-.697	.487
	CMCQ3	.161	.135	.088	1.189	.236
2. Process	(Constant)	11.254	.643		17.490	.000

Component Smart City	CMCQ1	-1.740	.328	-.372	-5.309	.000
	CMCQ2	-.066	.042	-.108	-1.573	.117
	CMCQ3	.458	.190	.163	2.405	.017
3. People Component Smart City	(Constant)	12.996	.575		22.606	.000
	CMCQ1	-.955	.293	-.243	-3.262	.001
	CMCQ2	.065	.038	.126	1.724	.086
	CMCQ3	-.064	.170	-.027	-.376	.707

Table 4.9: Coefficients for the model – IT DRP Continuity Management and smart city components

Based on the analysis conducted in this section, a significant relationship of IT DRP continuity management component with process and people components of smart city is identified. This lead to the acceptance of the hypothesis ii that '*The People and Process components of Smart City has a significant effect on IT DRP Continuity Management Component, except for the Smart City IT component.*'

4.2.4.3 Hypothesis 3

In this section, the hypothesis (iii) is tested with the independent variable as the implementation component of IT DRP and financial resources and security & privacy components under smart city as dependent variables. The hypothesis is as follows:

Hiii: *ITDRP Implementation Component is affected by Smart City Financial Resources Component and Security and Privacy Component*

As observed in the table 4.10 below, the model summary for the two models (model 1 for financial resources component, and model 2 for security and privacy component) in smart city with IT DRP Implementation component is presented. The correlation coefficient (R) for model 1 and IT DRP Implementation component is .7.8 indicating a strong positive correlation but a weak prediction level with model 2 – security and privacy component of smart city. The coefficient of determination (R^2) reflects a high variance accounting to 50.1% for model 1 financial resources in smart city with a significant F change ($p < 0.05$).

Model Summary									
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1. Financial Resources - Smart City	.708[a]	.501	.492	.73601	.501	52.618	3	157	.000
2. Security & privacy - smart city	.087[a]	.008	-.011	1.60967	.008	.400	3	157	.753

Table 4.10: Model Summary for the model – IT DRP Implementation and smart city components

To measure the statistical significance of the two models with IT DRP implementation component, the table 4.11 below is referred to. As seen below, the model 1 i.e. financial resources of smart city is found to hold a significant effect on the implementation process of IT DRP ($p < 0.05$), while security and privacy component has an insignificant effect ($p > 0.05$). It is seen that the financial resources component of smart city reported $F(3,157) = 52.618$, $p < 0.05$.

ANOVA[b]						
Model		Sum of Squares	df	Mean Square	F	Sig.
1. Financial Resources - Smart City	Regression	85.511	3	28.504	52.618	.000[a]
	Residual	85.048	157	.542		
	Total	170.559	160			
2. Security & privacy - smart city	Regression	3.109	3	1.036	.400	.753[a]
	Residual	406.792	157	2.591		
	Total	409.901	160			

Table 4.11: ANOVA for the model – IT DRP Implementation and smart city components

To identify which sub-questions within the two models attributed to the significance of the overall model, the coefficients table in Table 4.12 is reviewed. As observed, the model 1 (financial resources in Smart city) is found to hold significant relationship with the sub questions Q2 (alternate location) and Q3 (actions taken during IT service disruption) of implementation component in IT DRP with $p < 0.05$. However, in model 2, no significant relationships were observed with the questions of IT DRP implementation component while the overall model.

Coefficients[a]						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1. Financial	(Constant)	9.689	.284		34.161	.000

Resources - Smart City	ITICQ1	-.430	.043	-.610	-10.020	.000
	ITICQ2	-.059	.034	-.107	-1.751	.082
	ITICQ3	-.235	.060	-.223	-3.939	.000
2. Security & privacy - smart city	(Constant)	4.846	.620		7.812	.000
	ITICQ1	.083	.094	.076	.880	.380
	ITICQ2	.016	.073	.018	.213	.831
	ITICQ3	-.047	.130	-.029	-.360	.719

Table 4.12: Coefficients for the model – IT DRP Implementation and smart city components

Based on the analysis conducted in this section, a significant relationship of IT DRP implementation component with financial resources component of smart city is identified. This led to the acceptance of the hypothesis iii that '*ITDRP Implementation Component is affected by Smart City Financial Resources Component, while no significance was attributed by and Security and Privacy Component of smart city.*'

4.2.4.4 Hypothesis 4

In this section, the hypothesis (iv) is tested with variables smart city components with the dependent variable as the education and experience of the IT personnel and independent variable as the smart city components. The hypothesis is as follows:

Hiv: *The technology knowledge and practice of Smart City Components is related to the Education and Experience level of the IT personnel*

As observed in the table 4.13 below, the model summary for the two models (model 1 for education and model 2 for total years of experience) is presented. The correlation coefficient (R) for education and smart city model is .524 indicating a positive correlation which is a good prediction level. The R^2 is the coefficient of determination reflects the proportion of variance attributed by education as 27.4% while the adjusted variance dropped to 23.5%. The change statistics for the model is found to be significant. Similarly, for model 2 between total years of experience and smart city components, R is found to be .441 indicating a good level of prediction, while the variance is reported as 19.5%. The variance attributed by experience is lower than education.

Model Summary									
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1. Education	.524[a]	.274	.235	.551	.274	6.963	9	166	.000
2. Total Experience	.441[a]	.195	.151	.950	.195	4.465	9	166	.000

Table 4.13: Model summary for education and experience and its relationship with smart city components

To measure the statistical significance of the two models with smart city components, the table 4.14 below is referred to. As observed in the table, the overall model for both education and experience is found to be statistically significant and hence, stated to be a good fit, with education reporting $F(9,166) = 6.963$, $p < 0.05$, and experience reporting $F(9,166) = 4.465$, $p < 0.05$.

ANOVA[b]						
Model		Sum of Squares	df	Mean Square	F	Sig.
1. Education	Regression	19.028	9	2.114	6.963	.000[a]
	Residual	50.403	166	.304		
	Total	69.432	175			
2. Total Experience	Regression	36.252	9	4.028	4.465	.000[a]
	Residual	149.742	166	.902		
	Total	185.994	175			

Table 4.14: ANOVA for Education and Experience for smart city components

To identify which sub-components of the smart city variables have a significant relationship with education and total years of experience, the coefficients table presented in the Table 4.15 below is consulted. As observed in the table, the model 1 (education) is found to hold a significant relationship with all sub components smart city components i.e. information technology components, process components, people components, financial resources and security & privacy ($p < 0.05$). However, organizational and structural component did not associate to the significance of the overall model ($p > 0.05$). Similarly in the model 2 (experience), all sub components of the smart city were found to hold a non-significant relationship with experience, except organizational and structural components ($p<0.05$).

Coefficients[a]						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1. Education	(Constant)	1.846	.608		3.034	.003
	Information Technology Components	.238	.040	.554	5.940	.000
	Process Components	-.099	.041	-.366	-2.423	.016
	People Components	-.079	.032	-.248	-2.471	.014
	Organizational and Structural Component	.038	.030	.109	1.274	.204
	Financial Resources Component	.228	.057	.385	4.014	.000
	Security and Privacy Component	-.099	.036	-.242	-2.773	.006
2. Total Experience	(Constant)	5.962	1.048		5.687	.000
	Information Technology Components	-.124	.069	-.176	-1.792	.075
	Process Components	.114	.070	.258	1.621	.107
	People Components	.076	.055	.148	1.395	.165
	Organizational and Structural Component	-.157	.052	-.273	-3.021	.003
	Financial Resources Component	-.100	.098	-.104	-1.024	.307
	Security and Privacy Component	-.106	.062	-.158	-1.718	.088

Table 4.15: Coefficients for the model - education, experience and smart city components

Based on the analysis conducted in this section, it is identified that there is a significant relationship between smart city components and education as well as total years of experience. This led to the acceptance of the hypothesis iv that '*the technology knowledge and practice of Smart City Components is related to the Education and Experience level of the IT personnel.*'

4.2.4.5 Hypothesis 5

In this section, the hypothesis (v) is tested with variables IT DRP components with the dependent variable as the education and experience of the IT personnel and independent variable as the IT DRP components. The hypothesis is as follows:

Hv: *The technology knowledge and practice of IT DRP components is related to the Education and Experience level of the IT personnel*

As observed in the table 4.16 below, the model summary for the two models (model 1 for education and model 2 for total years of experience) with IT DRP components is presented. The correlation coefficient (R) for education and IT DRP model is .3694 indicating a positive correlation and a good prediction level. The coefficient of determination (R^2) reflects variance of 13.6% with the adjusted variance dropped to 7.2%. The change statistics for the model is found to be significant ($p < 0.05$). Similarly, for model 2 between total years of experience and IT DRP components, R is found to be .662 indicating a good level of prediction which is significant, with variance of 43.8% which is comparatively higher than the variance attributed by education.

Model Summary									
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1. Education	.369[a]	.136	.072	.626	.136	2.133	11	149	.021
2. Experience	.662[a]	.438	.397	.842	.438	10.567	11	149	.000

Table 4.16: Model summary for education and experience and its relationship with IT DRP components

To measure the statistical significance of the two models with IT DRP components, the table 4.17 below is referred to. As observed, the overall model of IT DRP with education and experience is found to be statistically significant ($p < 0.05$) and hence, stated to be a good fit. It is seen that education report $F(11,149) = 2.133$, $p < 0.05$, and experience as $F(11,149) = 10.567$, $p < 0.05$.

ANOVA[b]						
Model		Sum of Squares	df	Mean Square	F	Sig.
1. Education	Regression	9.186	11	.835	2.133	.021[a]
	Residual	58.329	149	.391		
	Total	67.516	160			
2. Experience	Regression	82.417	11	7.492	10.567	.000[a]
	Residual	105.645	149	.709		
	Total	188.062	160			

Table 4.17: ANOVA for Education and Experience for IT DRP components

To identify which sub-components of the IT DRP have a significant relationship with education and total years of experience, the coefficients table presented in the Table 4.18 below is reviewed. As observed in the table, the model 1 (education) is found to hold a significant

relationship only with the implementation component of IT DRP ($p < 0.05$) while the rest of the components are found to be insignificant. Similarly in the model 2 (experience), the environmental component of IT DRP holds an insignificant relationship ($p > 0.05$) while implementation component, continuity management component, people component, technology component and organizational are significant ($p<0.05$).

Coefficients[a]						
Model		Unstandardised Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1. Education	(Constant)	2.467	.486		5.073	.000
	Implementation Component	.119	.041	.269	2.915	**.004**
	Continuity Management Component	.166	.145	.123	1.143	.255
	People Component	-.070	.044	-.182	-1.604	.111
	Technology Component	.008	.032	.027	.260	.795
	Organizational Component	.018	.044	.039	.410	.683
	Environmental Component	.024	.029	.095	.825	.411
2. Experience	(Constant)	1.740	.654		2.658	.009
	Implementation Component	-.335	.082	-.303	-4.074	**.000**
	Continuity Management Component	-.558	.195	-.247	-2.857	**.005**
	People Component	-.249	.059	-.385	-4.207	**.000**
	Technology Component	.127	.044	.245	2.908	**.004**
	Organizational Component	.129	.060	.164	2.155	**.033**
	Environmental Component	-.038	.039	-.089	-.959	.339

Table 4.18: Coefficients for the model - education, experience and smart city components

Based on the analysis conducted in this section, a significant relationship of IT DRP components with education and total years of experience is identified. This lead to the acceptance of the hypothesis v that '*The technology knowledge and practice of IT DRP components is significant related to the Education and Experience level of the IT personnel.*'

4.2.4.6 Testing the Main Hypothesis

Having examined each of the sub-hypothesis in sections 5.2.4.1 to 5.2.4.5, in this section, the main hypothesis (0) is tested with the independent variable as IT DRP and smart city as dependent variable. The hypothesis is as follows:

H0: There is no significant relationship between IT DRP components and Smart City Systems components leading to an efficient and effective integrated Smart City IT DRP Model

As observed in the table 4.19 below, coefficient of relationship between IT DRP and smart city is .504 indicating a strong positive correlation and a goof it of the model. Also, the variance attributed by the independent variable is 31.1% on the model, while the F change is found to be significant ($p < 0.05$).

Model Summary									
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.504[a]	.311	.006	10.83275	.011	2.170	1	198	.042

Table 4.19: Model Summary for the relationship between smart city and IT DRP

To identify if the overall model i.e. smart city and IT DRP is a good fit, the table 4.20 with ANOVA results is reviewed. As observed, a statistically significant prediction is made by the independent variable on the dependent variable, $F(1,198)=2.170$, $p<0.05$.

ANOVA[b]						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	254.589	1	254.589	2.170	.042[a]
	Residual	23234.991	198	117.348		
	Total	23489.580	199			

Table 4.20: ANOVA for the relationship between smart city and IT DRP

Based on the findings above, it is said that IT DRP is a significant predictor of smart city services. This leads to the rejection of the null hypothesis and acceptance of *'a significant relationship between IT DRP components and Smart City Systems components leading to an efficient and effective integrated Smart City IT DRP Model.'*

As per the testing of the hypothesis, the table 4.21 below presents the accepting or rejection of the hypothesis.

Hypothesis Testing	Accept / Reject
H1: There is a significant relationship between IT DRP components and Smart City Systems components leading to an efficient and effective integrated Smart City IT DRP Model	P = > 0.05 Hypothesis is accepted
Hi: The information technology, People and Process components of Smart City has an effect of IT DRP Continuity Management Component	P ≤ 0.05 Hypothesis is accepted, however, Smart City IT component was found to be insignificant
Hii: The information technology, People and Process components of Smart City has an effect of IT DRP Implementation Component	P ≤ 0.05 Hypothesis is accepted however, smart city process component was found to be insignificant
Hiii: ITDRP components Implementation Component are effected by Smart City Financial Resources Component and Security and Privacy Component	P ≤ 0.05 Hypothesis is accepted, however, security and privacy component was found to be insignificant
Hiv: The technology knowledge and practice of Smart City Components is related to the Education and Experience level of the IT personnel	P ≤ 0.05 Hypothesis is accepted
Hv: The technology knowledge and practice of IT DRP components is related to the Education and Experience level of the IT personnel	P ≤ 0.05 Hypothesis is accepted

Table 4.21: Accepting / Rejection of the hypothesis

4.3 Discussion

Smart cities are considered as a feature of the future that would not only make the lives of the citizens better than the past but also accelerate the economic growth of the nations as a whole. Such cities depend on highly interconnected systems which employ software and hardware to store and share data to organize the various services provided to the citizens in a controlled order. The infrastructure of such cities relies on their data centres, which are of high priority as the basic operations of the smart cities rely on them for operational efficiency. As discussed earlier, IT disasters raise the risk of lapse in operational efficiency, threatening to hinder the smart city channels and ultimately causing not only inconvenience to the public but also heavy losses to the government. Therefore, smart cities need to strengthen the IT disaster recovery systems to have workable solutions in event of an unexpected IT disaster. In this research, the aim was to develop an IT DRP framework to support the Abu Dhabi Government in

the initiatives of smart city services to assure its system and IT continuity. In order to achieve the above aim, a comprehensive framework was developed that consolidated the components of smart city with IT DRP to build an effective solution targeting IT continuity.

4.3.1 Linking Education and Experience of IT Personnel with IT DRP and Smart City Components

The role of people in development of a service, a system or an enterprise is not hidden. In the area of IT disaster recovery or smart cities, people are involved from the design phase to implementation, however, overlooking people within the above two areas is often overlooked. As found by Snedaker (2013) people or personnel affect the way operations are managed, maintained and executed. The authors identified that almost 30 – 40% of loss in data occurs due to the poor capability of the people involved to handle operations, and while 20 – 30% is attributed by emergencies, terrorist attacks or IT disasters. While it is true that errors may occur even without human negligence, however, it can be interlinked with the efficiency of the overall IT infrastructure. As pointed by Herbane (2010), within a system of an enterprise or a smart city, there are multiple layers that define the processes followed by people (personnel) involved to achieve IT continuity. However, this requires efficient people capable to understand the requirements and possess the knowledge to operate as per the requirement (Iyer and Bandyopadhyay, 2015; Järveläinen, 2012). The planning of an IT DRP relies on the people involved and how effectively people can fit in and contribute towards the effectiveness of the plan (Järveläinen, 2012; Townsend, 2013).

In this research, the relationship between education and experience of the people involved in the smart city and IT DRP projects was evaluated. As seen in the section 4.2.4.1 and 4.2.4.2, a significant relationship ($p < 0.05$, at 5% confidence interval) exists between education and experience of IT personnel with the smart city and IT DRP components. It was found that a positive correlation exists between education and experience of the IT personnel with the smart city and IT DRP components. This indicates that with the increase in education and experience, the capability of the IT personnel to apply technology knowledge and practice towards the Smart City and IT DRP Components increases. While there are negligible researches conducted in the past that evaluate the role of education and experience in strengthening the operations of smart cities and/or IT DRP, the available research acknowledges this aspect (Balakrishna, 2012; Wu et

al., 2016, Datta, 2015). Snedaker (2013) highlights that the response of people involved in IT disaster response operations may be different from those of other departments as they are trained to response in a defined order. Moreover, the effectiveness of the decisions taken during the disaster response increases with the leadership experience the person possesses. Snedaker (2013) noted that people with overall less or nil years of experience in IT services or in IT disaster response may feel overwhelmed and may not be able to take effective action. Hence, it is crucial that the people involved in the IT DRP and Smart city projects are aware of the technological environment and are prepared to take action when the disaster hits. On the contrary, experience is interlinked with education, as found by Snedaker (2013) who emphasized on the role of education and training in enhancing IT response and continuity during disasters and emergencies. It is found that IT disaster planning is usually limited to IT personnel that are directly involved in the backup, recovery and control operations (Chang, 2015; Robles et al., 2015).

4.3.2 Role of IT, People and Process components of Smart City in Effective IT DRP Implementation

The results indicate that information technology and People components are the most important criteria for effective IT DRP implementation in smart cities. The hypothesis testing conducted in section 5.2.4.3 led to the identification that a significant relationship exists between smart city variables (people and IT) with IT DRP implementation ($p < 0.05$, at 5% confidence interval). This confirms the positive correlation that exists between people (.564) component of smart city and IT DRP implementation, as well as the negative correlation between IT DRP implementation and Smart city IT component (-.304). However, the negative correlation between smart city process and IT DRP implementation (.403) was not validated (as $p > 0.05$). As stated by Snedaker (2013), people, process and technology are the most crucial attributes of an affect IT DRP model. They are essential pre, during and post implementation of the DRP process. As discussed in section 4.3.1, a misbalance between education and experience in the people involved in the IT DRP and Smart city projects can hinder the efficiency of the overall IT continuity. Similarly, a mismatch between IT and people can hinder the efficiency of the IT components and increase the vulnerability of the system in case of an IT emergency or disaster (Bartholomy et al., 2013; Snedaker, 2013; Yang et al., 2015). Operations with a smart city are interdependent, and any disruption in service within a project of the smart city can affect the

other project (Chołda et al., 2014; Bartholomy et al., 2013). For example, an attack or failure on the energy project within a smart city can affect the operations of all projects such as healthcare, or education. In such situations, it is the collective operation between the technology and people components of the smart city that allow coordinated control of the situation and remediation of the disaster (Prazeres and Lopes, 2013; Wunnava, 2011).

Management of vulnerabilities with the technology component of smart cities is crucial to improve the implementation of IT DRP (Snedaker, 2013; Chołda et al., 2014). The degree of reliance of technology in smart city operations is ever evolving and needs a broad look at the strategies and tools involved (Chang, 2015; Datta, 2015). While the smart city may be able to overcome an IT Disaster today, however, the situation may not be the same after few years as the technology is either out-dated or slow to respond to the situation. In such a case, implementation of IT DRP is hindered. This brings into picture the need for effective process integration that bridges the gap between planning and implementation of IT DRP strategies in smart cities. In this research study, no significant relationship was observed between IT DRP implementation and the process component of smart city. This can be attributed to the point that the current system of smart city does not render effective balance between the smart city and IT DRP as a simple system, but considers them as separate entities leading to the insignificant relationship. Also, the point that the process components reviewed in this study included benefits achieved in processes Economic development, Safety and security benefits, Capital/operational cost savings, Resilience for critical operations, and Enhanced services for residents were too broad for the respondents understanding, leading to the disconnect. The need to focus on developing the IT DRP process is to strengthen the implementation, so that the system is reactive towards different types of IT disasters and reduces the lapse that may occur to achieve IT continuity (Snedaker, 2013; Bailey, 2010). This can be achieved by focussing in identifying and expanding the role of each process within the smart city framework and linking it to the IT continuity plan with the IT DRP.

Within the process component of smart city exists testing and developing, which constantly tests the existing IT DRP against various IT disasters with a certain degree of probability and lowers the gap between failure and recovery (Zalewski et al., 2008; Robles et al., 2015; Bartholomy et al., 2013). While in this research, no significant relationship is found between smart city

processes and IT DRP implementation, yet past research confirms the dependency of technology and people components on process (Prazeres and Lopes, 2013; Snedaker, 2013). In a smart city with different forms of services (each as a project), all processes work together for a common goal i.e. to optimize public services and achieve efficiency in operations. Therefore, to achieve IT DRP for smart cities, the process phase within each sub project of the smart city should follow an initiate-plan-execute-control-close stages (Townsend, 2013; Balakrishna, 2012). The process component in a smart city allows the system to achieve its goals set, which may range from economic development, safety and security in the public services, enhancement of the services, resilience in critical operations to cost savings in operations (Chang, 2015; Bartholomy et al., 2013; Yang et al., 2015). However, to achieve the above aims, it is crucial for the smart city system to optimize its process component internally focussing on developing and executing a strong IT architecture plan (model) with interconnected management (Herbane, 2010; Järveläinen, 2012). For example, in case of an IT disaster that interrupts the services of the HR department in a specific smart city project; one process that may be affected is processing of salaries. The department should have a standard pre-developed protocol that allows them to follow an alternate action in case of lapse in the system or a specific process. In simpler terms, the success of IT DRP implementation is based on the clarity provided to the people and process components within the smart city.

4.3.3 Role of IT, People and Process components of Smart City in effective IT DRP Continuity Management

The aim of a continuity management process is to identify any potential risks that may emerge and prepare to avoid / reduce their impact on the operations without an interruption in the services (Wunnava, 2011; Prazeres and Lopes, 2013). In this research study, the role of information technology, people and process of smart city in affecting the IT DRP continuity management was reviewed. It was found that, as found in section 4.2.4.4, 'The People and Process components of Smart City has a significant effect on IT DRP Continuity Management Component (i.e. $p<0.05$), except for the Smart City IT component.' This finding has validated the positive correlation found between IT (.564), people (.037) and process component (.403) and IT DRP continuity management. As identified by Järveläinen (2012), service disruptions effect continuity management, as they are found to have a negative impact of overall service quality. The literature available on IT continuity management highlights the need for building a

strong internal IT relationship primarily within interconnected organizations / projects such as in a smart city (Chang, 2015; Zalewski et al., 2008). The internal relationships may refer to the relationship between the IT and people component, or IT and process components, and between IT, people and process components as a whole (Campbell, 2013; Komninos, Schaffers and Pallot, 2011).

IT DRP continuity management, as identified in the literature review, comprises of a well-defined process that ensure availability of IT sources in event of an IT disaster (Robles et al., 2015; Chang, 2015). It is aimed to provide the needed level (pre-determined) of service in the event conditions (Bailey, 2010; Bartholomy, Greenlee and Sylvia, 2013). Its common responsibilities, as identified by Komninos, Schaffers and Pallot (2011), include risk management, option selection as per the project requirements, defining of responsibilities and roles, and alignment of IT recovery plans with testing. It has a heavy reliance on the IT, people and process component of the smart city system. In this research, it was found that the participating firms associated with Abu Dhabi Government smart city projects have defined procedures and function-wise priority in event of an IT disaster. However, they still lack in the management of the IT DRP, especially in the review and development phase. Also, the IT DRP continuity management is found to hold a statistically insignificant relationship with the IT component of smart city. While the technology properties and priorities in the IT component of smart city indicate a well-developed and clear IT outlook, the level of engagement with respect to the community attributes (i.e. Smart payments and finance, Water and wastewater, Customer service/public engagement, Energy, and Telecommunications) is mostly in the pilot to planning stage. This can be attributed to the negative relationship between smart city IT component and IT DRP implementation. Unless, all departments within the smart city network are ready in technology capability, the integration of the IT DRP framework and its implementation will remain insignificant. As per the standard principles of IT continuity management, it is essential that a firm maintains service level agreements by prioritizing services in event of a disaster (Järveläinen, 2012; Yang, Yuan and Huang, 2015). The components within the system (in this case people, process and IT) should be linked to one other, following a service to component relationship achieved at the service level. It focuses on removal of single failure points to achieve availability of services, with due consideration on risk management caused due to the IT outage / disruption (Prazeres and Lopes, 2013; Wunnava, 2011).

IT DRP continuity management holds a significant relationship with the people component, as it allows in effective incident management. As identified by Järveläinen (2012), informed recovery from an IT disaster is achievable only with effective incident management that focuses on availability of the needed information to the incident management team. The information may include documentation and knowledge for decision-making. However, IT DRP continuity is challenged by the change management, which as found by Datta (2015) is dependent on the process component. The process component of smart city is found to hold a significant effect on the IT DRP continuity management ($p < 0.05$). Change management is a process to allow bridging the gap of system continuity and IT disaster through the implementation of a series of steps for service continuity (Järveläinen, 2012; Campbell, 2013). Such a process allows the smart city system to send notification in case a change /action may impact the IT disaster recovery or continuity. In this research, it was found that recovery of IT development and deployment as the priority function of the participating firms in case of an IT disaster with the least recovery time i.e. less than a week. This coincides with the goal of the IT DRP continuity management goal to ensure the recovery and continuous provision of IT services (telecommunication, IT systems and networks, and technical support) (Komninos, Schaffers and Pallot, 2011; Datta, 2015). This is achievable with the support of people component i.e. senior IT management, on-going maintenance and an effective process design (Järveläinen, 2012; Herbane, 2010).

4.3.4 Effect of Smart City Financial Resources Component and Security and Privacy Component on ITDRP Implementation

Examination of the effect of smart city components i.e. financial resources and security and privacy on the implementation of the IT DRP led to a significant result. As reviewed in section 4.2.4.5, IT DRP Implementation Component was found to be statistically significant with Smart City Financial Resources Component ($p < 0.05$), while no significance was attributed by Security and Privacy Component of smart city. The acceptance of the significance confirms the strong negative correlation between IT DRP implementation component and financial resources component of smart city (-.827). This indicates that with the drop in financial resources in smart city projects, the implementation of IT DRP is affected. Similarly, the rejection of any statistical relationship between IT DRP implementation and smart city security and privacy component can be attributed of the independent nature of both the systems. The security and privacy aspects of smart city reviewed in this research study included level of importance to security and privacy,

towards evaluation of products/services, and towards evaluation of technologies and their relevance to abide security protocols. On the other hand, the IT DRP implementation evaluated DR implementation strategy, alternate location and steps taken when disruptions are caused by third party components. Given the inclusion of the finance component, the overall model between IT DRP implementation and Smart city finance and security and privacy components was accepted. This indicates that the security and privacy component is interlinked with the finance component of smart city in order to have any form of statistical significant effect on the IT DRP component.

As identified in the literature review, financial resources contribute effectively in the development of the smart city system and services (Maheshwari and Janssen, 2014; Covell, 2016; Vidar and Medalla, 2015). Smart cities are developed under the government funding under PPPs, and such funding is distributed across various verticals of the smart city (Abdallah & Fan, 2012; Liu & Zhou, 2010). This includes IT infrastructure, transportation, and other infrastructure. It is essential that such a huge development should pre-develop the IT DRP in any event of IT disaster (Liu & Zhou, 2010; Snedaker, 2013). Given the intensity of public information involved in the smart city system through the various projects (smart economy, smart education, smart people, smart governance, smart living and smart mobility), it becomes crucial to have a strategy in plan to ensure availability as well as the security of the public information (Vidar and Medalla, 2015; Abdallah & Fan, 2012). In this research study, it is found that a majority of the funds available for smart city projects are procured through public private partnerships, followed by strategic partnerships and government funding. This indicates that through there is certain level of availability of funds for the overall smart city system, however, there also needs to be a clear allocation of funds for DRP operations (Snedaker, 2013).

As identified by Snedaker (2013), financial constraints are also accounted for, in case of an IT disaster. In such as event, the loss of data and resources heavily impact the operations of the smart cities, leading to inability of the overall smart city project/ the system to not being able to meet the customer requirements or remain operations. Such events result in financial loss to the government if the event was of catastrophic to major level, while moderate to minor level disasters may cause dissatisfaction amongst users with lower level of financial loss (Nijaz & Moon, 2009; Snedaker, 2013). Based on the level of impact, a designated fund may be allocated

towards the development of IT DRP and Continuity management planning without causing serious effect on the overall operations. The management of funding for IT services, as highlighted by Nkohkwo & Islam (2013), is to secure the needed financial resources for designing, development & delivery of smart city services as per the core strategy of the smart government. It focussed on identifying the cost of service provision in case of an event, evaluating the impact financially due a change or introduction of a new strategy, or securing additional funding (Abdallah & Fan, 2012; Nkohkwo & Islam, 2013). Poor financial management for smart city IT services can affect the operational visibility of the projects and lower the capabilities of decision-makers (Tanguay et al., 2010; Huston et al., 2015; Vanolo, 2014). Some primary activities that may be performed as part of the financial management of smart cities include service valuation, demand modelling, budgeting and compliance, service portfolio management and variable cost dynamic (Vidar and Medalla, 2015; Snedaker, 2013).

Apart from the financial resources component, the security and privacy component of Abu Dhabi Government smart city is found to be positively correlated with IT DRP implementation (.779). However, the relationship was found to be not significant (i.e. $p > 0.05$). In a smart city, various projects are linked to each other, forming an interconnected network that shares data on large scale (Kitchin, 2016). The data is with respect to citizens, government, infrastructure and services and is supported by a well-developed IT infrastructure wherein services are able to act upon real-time data (Elmaghraby and Losavio, 2014; Greenfield, 2013). A serious breach in the data security and privacy raises the question of overall system security. In event of an IT disaster that effects the optimal operations of the system, lapse in public data for instance or sensitive data such as the personal identification details and security numbers of the residents of the smart city are at risk. While the relationship between security and privacy component of smart city may not be significant with IT DRP implementation, it still has a strong positive correlation. This indicates that if there is a lapse in security and privacy in smart city projects, there may an effect (to a certain degree) on the IT DRP implementation. The IT disaster recovery team may have to diverse funds to first restore and secure the security and privacy lapse and later, redevelop and connect the aspect in the overall IT DRP framework for future security (Greenfield, 2013; Snedaker, 2013).

4.3.5 Bridging the Gap between IT DRP components and Smart City Systems components

Smart governments reflect in smart cities enabling the public with high quality of life and with convenient services (Albino, Berardi and Dangelico, 2015; Koech, 2016). Information technology is the building block for the smart city models and thus drives the corporate continuity. While corporate recovery is a complete different entity with information technology as a specific part of it, it does not actually relate to achieving continuity in operations through integration of IT services (Gradner, 2016; AlAwadhi and Scholl, 2013). In smart urban models such as the smart cities, governments are focussing on building a well-connected and integrated systems that disseminates information efficiently within a controlled environment (Hoong and Marthandan, 2014; Shaw, 2016; Lee, Phaal and Lee, 2013). The gap between smart city framework and the role of IT in case of an IT emergency or disaster raised the question of IT Continuity for smart government services. In this research, the aim was to develop a comprehensive framework integrating the two element i.e. smart city and IT DRP into an effective model that retaliates and protects the system. The hypothesis testing conducted in the section 4.2.4.1 to 4.2.4.6 led to the identification of the components of smart city and IT DRP that are complementing each other and the relationships that exist between them. Similarly, the main hypothesis was tested to find if there was any statistical significance between IT DRP and smart city as a model, which was found to be significant ($p < 0.05$). This indicates that the framework proposed in chapter 2 for a comprehensive IT DRP for Abu Dhabi Government smart cities is accepted.

4.4 Summary of the Chapter

The chapter examines the data collected through the survey questionnaire using statistical package, presented the results in detail. The chapter presented the results in the form of demographics along with factor wise analysis of each component under smart city in smart government services for Abu Dhabi Government and IT DRP. Post review of each individual factor, correlation testing and hypothesis testing was conducted that examined the relationship between smart city variables and IT DRP variables. Post validation of the hypothesis, a detailed discussion was presented on each hypothesis and the findings. In the next chapter, the conceptual framework presented in the chapter 2 will be revisited, examining the validity of the framework.

5 Revisiting the Framework

5.1 Introduction

In this chapter, an outline supported with a discussion on the key findings of this research study is presented. The chapter addresses the lessons learnt from the data collection from IT professional professionals involved in smart city project as part of the smart government services and the framework presented in chapter 2 (2.5.3) is revised. Also, the researcher reflects on the findings against the research questions and objectives, and reviewed whether or not the research aim was met. As per the data analysis conducted in chapter 4, some additional factors were identified to have prominence in improving the validity of the framework. These factors are discussed in detail along with an overview of the key issues and limitations that may be involved for effective implementation of the Smart City IT DRP framework in the Abu Dhabi smart government organizations.

In the chapter 2, the detailed review of the past literature in the area of smart city project as part of the smart government services and IT DRP was discussed, along with the development of the conceptual framework. Based on the framework, a survey questionnaire was developed and the data collected analysed in the chapter 4. Within this chapter, the empirical findings identified from the literature review are synthesized and the framework revised as per the new factors identified - be it components of smart city or IT DRP that may influence the IT DRP for smart city projects in Abu Dhabi smart government services in UAE. The researcher discusses the disaster recovery and continuity approaches and its requirements in smart government services, based on the findings. Also, a reflection on the roles of the components of smart city and IT DRP validated and considered relevant is presented to support the framework.

By reviewing the research aim and objectives, this chapter attempts to validate the framework for IT DRP in smart city, under smart government services as per the data results of chapter 4. This supports the researcher in the development of a strong conceptual framework targeting continuity of IT services for smart city, thereby ensuring continuity of services in Abu Dhabi smart government services in UAE.

5.2 Key Findings

5.2.1 Lessons Learnt from the Research

This section aims to summarize the core findings as identified in the Chapter 4 and present a clear idea. Based on the literature review, this research study encountered a limited amount of studies that have evaluated components, advantages, barriers as well as the challenges of smart city and IT DRP, or both in general in the UAE and GCC. The researcher in this study carried out a quantitative research on the firms in Abu Dhabi associated with smart city projects under smart government services in (constituting both public and private sectors) to:

1) Test and confirm the factors of smart city and IT DRP influencing the smart city IT DRP model for smart government services continuity in Abu Dhabi

2) Test and confirm the relationship between the Abu Dhabi Government IT DRP and smart city components, and whether or not they hold a significant effect on each other.

3) Combining the point 1 and 2 above, to form a comprehensive model for smart city IT DRP for Abu Dhabi smart government services, achieving continuity of IT Services in case of an IT emergency or disaster.

4) Test, and validate the components of smart city and IT DRP implementation and continuity management for smart government services in Abu Dhabi.

5) Identify and map the approach to be taken for effective smart city IT DRP continuity management for smart government services in Abu Dhabi.

As per the findings from the responses of the IT personnel associated with smart city projects in Abu Dhabi in Chapter 4 and the analysis of data, distinct from data validation, some additional factors are discovered. Based on this, few changes are made to the framework which involves addition of new factors and removal of less dominant factors from the framework for smart city IT DRP. This change is presented in figure 5.1.

The following listed are the lessons learnt from the research study and analysis conducted on the quantitative data collected through the aid of the survey questionnaire.

1. The new comprehensive framework for smart city IT DRP for Abu Dhabi smart government services was tested as well as evaluated for validity. It was found that the framework proposed with the subcomponents of IT DRP and Smart city have a strong relationship when integrated together. In order for the framework to be implemented successfully, it is vital that the sub-components should be prioritized based on their relationship strength of each components of IT DRP possesses with smart city components. The prioritization was made based on the strength of the correlation. As seen in the chapter 4, the main hypothesis i.e. 'There is a significant relationship between IT DRP components and Smart City Systems components leading to an efficient and effective integrated Smart City IT DRP Model' was accepted ($p < 0.05$). This indicates that the majority of the IT professionals that participated in the research study were found to hold significant knowledge and experience in implementing IT DRP within their respective firms. Amongst the components of smart city, the most important components identified in strength of the relationship include people, process and technology components, while financial components did display an effect on IT DRP implementation restrictions.

2. Based on the quantitative survey questionnaire executed, it was found that the majority of the participants (50 – 60%) held a strong outlook towards IT DRP and its benefit to support smart city elements under Abu Dhabi smart government services. However, they lacked in terms of organizational and environmental components of IT DRP, wherein a lapse or delay in responding to IT disasters was noted. Also, while the respondents agreed on the availability of regulations (as part of the external environment component of IT DRP), they clearly lacked clear knowledge. This was found in terms of regulations prescribed by the government, fulfilling minimum requirements, and maintaining regular surprise checks.

3. To validate the implementation of the framework shared in the chapter 2, the IT continuity management component as part of IT DRP was reviewed for Abu Dhabi. The responses received indicate the need to widen the focus on IT DRP implementation to include IT backup support through alternative site. Based on this, new factors such as IT Inventory and Policies and Procedures were added to the framework as they can improve the implementation scope for IT DRP in case of IT disasters in smart city. This will improve the overall performance of the smart government services in case of an IT disaster.

4. To strengthen the relationship between Abu Dhabi IT DRP and smart city projects under smart government services, there is a need to enhance the overall integration. Though this is a challenge, higher management of the two departments i.e. IT DRP and smart city should work together to develop a comprehensive set of policies and procedures that dictate the mandatory requirements to meet to achieve a resilient IT DRP for smart city projects. Also, focus should be made on training the teams under both departments to understand the process and requirements. This will enable the team to maintain IT services and achieve IT continuity in scenario of an IT disaster.

5. From the survey conducted with the IT professionals, it was observed that though the respondents had knowledge about IT DRP and IT continuity, they lacked detailed information. This is found to be true especially for implementation and continuity view points as they may not have adequate knowledge on these aspects of IT DRP. This can also be attributed to the fact that IT services are sometimes outsourced, thereby creating a service gap affecting the IT professionals in gaining adequate working knowledge on IT Implementation and continuity during disasters.

6. The linkage of the factors of IT DRP and Abu Dhabi smart city have the capacity to support IT professionals and scholars in this area to take up further research. The relationships tested between the components of IT DRP and smart city under government services can be re-examined by the exclusion of factors to be insignificant. In this research the following components were validated:

- **Smart City:** People, Process, and Technology
- **IT DRP:** IT Implementation, IT Continuity and Financial Resources

7. It is found that education and experience level of the people involved play a critical role in the success of IT DRP in smart city, under smart government services. For instance, IT professionals with higher experience were found to hold higher knowledge and technical experience. Hence, the relationship of education and experience were significant with smart city components. By focusing on enrolment of IT professionals that possess higher education and experience, smart city projects can benefit in terms of better IT implementation and continuity in scenario of an IT disaster.

8. A slight deviation in the responses of the IT professional that participating in the survey questionnaire was observed, especially in terms of IT implementation and continuity of IT DRP services in Abu Dhabi. However, the above two factors were found to be significant in relationship with smart city people, process and technology.

9. For the success of the IT DRP framework for Abu Dhabi smart city projects, under smart government services, there is a need to build effective policies and procedures that outline the mandatory operational, people and technology requirements to address IT disasters and continuity in such scenarios. While safety and security were found to be not significant in the model, it should be given due consideration given the sensitive information in government services.

5.3 Reviewing the Achievement of Aims and Objectives

In this research study, the aim was 'to develop a IT DRP framework to support the Abu Dhabi Government in the initiatives of smart city services to assure its system and IT continuity.' To achieve the above aim, a comprehensive evaluation on the factors of smart city and IT DRP were executed for smart government services in the Abu Dhabi. The research was carried out through the aid of a survey questionnaire, which was quantitative in nature and comprised of IT professionals as respondents from various public and private sector firms in the country. A detailed view of the questionnaire utilized in this research study can be found in the Appendix 1. The aim of this research study was classified into the following objectives, with each evaluated based on the findings.

5.3.1 Research Objective 1

To review and compare the existing literature / models in relation to IT DRP and their application in a disaster situation affecting the IT continuity of Abu Dhabi Smart City services.

Findings: The research conducted led to the identification of individual components of smart city and IT DRP that were found to influence the smart city services IT continuity. In the literature, an extensive review of each of the factors was conducted specifically in the context of Abu Dhabi with evaluation of the contribution made by the factors. Also, a detailed review of the past researchers was made, identifying the benefits and barriers of IT DRP and smart city

components for effective IT continuity post disasters. Based on the components identified, the researcher developed and validated the framework for smart city IT DRP for smart government services in Abu Dhabi. The validation of the framework was executed through the identification of the significant relationships that may exist between the components of smart city and IT DRP.

5.3.2 Research Objective 2

To identify, analyse and evaluate the prime factors in the IT DRP framework of Abu Dhabi government for smart city services in terms of security and IT continuity in event of an IT disaster.

Findings: In this research study, a detailed examination of the role of technology in Abu Dhabi smart city developments and future developments was made, with focus on reviewing the components of IT DRP. Each of the components of IT DRP were evaluated in detail, focused on the stages involved from IT disaster identification to system maintaining in event of a disaster. Also, the process of the IT DRP was reviewed in light of the core six components. The proposed conceptual framework was based on the core factors of IT DRP and smart city. As no direct theories and models that examine IT DRP and smart city in collaboration were found, the components were utilized for the model development. In total there were six core factors identified for smart city and IT DRP each, with the relationship between the components validated in the chapter 4.

5.3.3 Research Objective 3

To suggest improvements in the current IT DRP framework adopted by Abu Dhabi governments to support its Smart city System through the development of IT DRP plan that can ensure high level of security and reliability of smart city system even during a disaster.

Findings:

As per the data analysis conducted in the chapter 4, the suggestions for improving the IT DRP were presented as part of the key learning (section 5.2.1) and also, in the chapter 6. The aim of the suggestions was to enhance the collaboration between the IT DRP team and smart city team under the Abu Dhabi government (i.e. smart government services) to achieve IT continuity in event of an IT disaster.

5.4 Reviewing the Research Questions

5.4.1 Key Factors Affecting Smart City IT DRP in Abu Dhabi Government

RQ1: What is the existing factors that contribute towards the IT DRP framework for Smart City in Smart Government Services in general and Abu Dhabi smart city in focus?

This research study aimed to identify the various factors that contribute towards the framework development of IT DRP that can be applied for smart city projects, under smart government services. Based on the findings identified from the data analysis of chapter 4, the following components were identified to be significant related and contribute towards the effectiveness of the overall model (see table 5.1). Also, education and experience of the IT professional (under the people component) can also be seen as influencing factors.

Smart City Components	IT DRP Components	Other Factors
People	IT Implementation	Education
Process	IT Continuity	Experience
Technology	Financial Resources	

Table 5.1: Key Factors of IT DRP for smart cities in Abu Dhabi Government

5.4.2 Key Factors Limiting Smart City IT DRP in Abu Dhabi Government

RQ2: What are the factors that limit the application of the current IT DRP framework of Abu Dhabi Smart City, in terms of efficiency?

As per the data analysis conducted in the chapter 4 and the findings identified, it was found that there are certain factors that limit the implementation of the framework. As seen in the table 5.2, these include smart city IT and security & privacy components. For example, smart city IT can be insignificant in effect on the overall framework, given the lack of people and process efforts in the smart city projects. Similarly, while financial resources govern the procurement of technology and manpower for Abu Dhabi smart city IT DRP, it does not guarantee security and privacy within the sector as it is insignificant with IT DRP implementation.

Smart City Components	IT DRP Components
Information Technology	Environmental
Security & Privacy	Organizational
Financial	

Table 5.2: Key Factors Limiting IT DRP for smart cities in Abu Dhabi Government

5.4.3 How to build an effective Smart City IT DRP for Abu Dhabi

RQ3: How can Abu Dhabi Smart City can switch to a reliable IT DRP framework without affects its current IT continuity

As per the results found, it was observed that a significant relationship exists between IT DRP continuity management and the people and process components of smart city ($p < 0.05$). While the overall model a positive correlation, it failed to validate the dependence of IT continuity management with the technology component of smart city. This is supported by the fact that a majority of the respondents (i.e. 127 out of 200 respondents) indicated that their organization is in progress to develop a continuity plan. Similarly, IT development and deployed received only 115 responses out of 200, with the resumption of services post IT disaster to be 1 – 2 weeks. This reflects the progress to be made in the area of IT continuity management in smart city projects to enhance the overall continuity management for smart government services.

A significant relationship was recorded between the information technology and people components of smart city and IT DRP implementation component ($p < 0.05$). However, significance was not established for the process component of smart city. This indicates that for effective IT DRP implementation in smart city projects under smart government services, there is a requirement for adequate technology infrastructure and people support. While the relationship strength between smart city technology and IT DRP implementation correlated positively (.531), however, with people and process, the relationship strength was quite low. On the technology front, the significance was linked with the positive response received on aspects such as ‘steps taken by the firms during IT disruptions’ and ‘DR implementation strategy’. A clear lack of focus on the selection of alternate site to support IT DRP implementation during IT disasters is found.

5.5 Changing the Framework Post Validation

In this section, the updated conceptual framework for smart city IT DRP for smart government services in Abu Dhabi, UAE is presented in the figure 5.1. The table 5.3 presents the validation of the factors of the model.

Factors of the Model	Validation	Outcome
Smart City		
Technology	Not Validated	Addition of two new sub components [IT Inventory and IT Backup]
People	Validated	No change
Process	Not Validated	No change
Organizational	Not Validated	No change
Financial	Validated	Addition of one new sub-component [Risk Assessment]
Security & Privacy	Not Validated	No change
IT DRP		
Implementation	Validated	Addition of one new sub-component [Policies and Procedures]
Continuity	Validated	Addition of one new sub-component [Policies and Procedures]
People	Validated	No change
Technology	Validated	Addition of two new sub components [IT Inventory and IT Backup]
Organizational	Not Validated	No change
Environmental	Not Validated	No change
Other Factors (under people component)		
Education	Validated	No change
Experience	Validated	No change

Table 5.3: Validation of the Components of the model

5.6 Revising the Framework for Abu Dhabi Smart City IT DRP

The framework presented in the figure 5.1 outlines the factors influencing the smart city information technology disaster recovery plan. Also, it outlines the new factors that affects the overall efficiency of the framework based on the data analysis. The framework enables smart government services in Abu Dhabi to focus on a wider and efficient IT continuity in case of an IT disaster, while creating and meeting the mandatory codes for the disaster recovery. While the factors for the new smart city IT DRP framework is not limited to Abu Dhabi (or UAE in particular), there is a chance of identifying more factors that may influence the execution of the framework. The framework was validated focussing on Abu Dhabi Government for smart city projects, with the components covering every stage of the IT disaster recovery within the smart city and recovery context. However, the framework can also be extended to smart cities around the globe that aim to integrate the elements of smart city and IT DRP together to form an effective comprehensive model. As observed in the revised framework for smart city IT DRP for smart government services and related organizations, the following steps are required for a holistic execution of the disaster recovery and for achievement of IT continuity.

Step 1: Creating Awareness for IT DRP and performing assessments

Building awareness amongst the people involved in the smart city projects under smart government services on IT disaster recovery. The personnel involved in IT recovery operations should have a clear outlook on the factors influencing technology and process, with attention to developing technology standards and protocols. Focussing on awareness creation enhances the overall competences of the people involved thereby increasing the success rate of the IT DRP activities. However, building awareness need supports from senior management as well as funding. Employees can be encouraged to participate in the DR programs given the inclusion of senior management in the program on a regular basis. On the other hand, the people and process components can work collectively through the effective management of HR, in the form of training activities for technical recovery, continuity activities, emergency response activities, system restoration and specialized recovery through the aid of hot sites or backup sites.

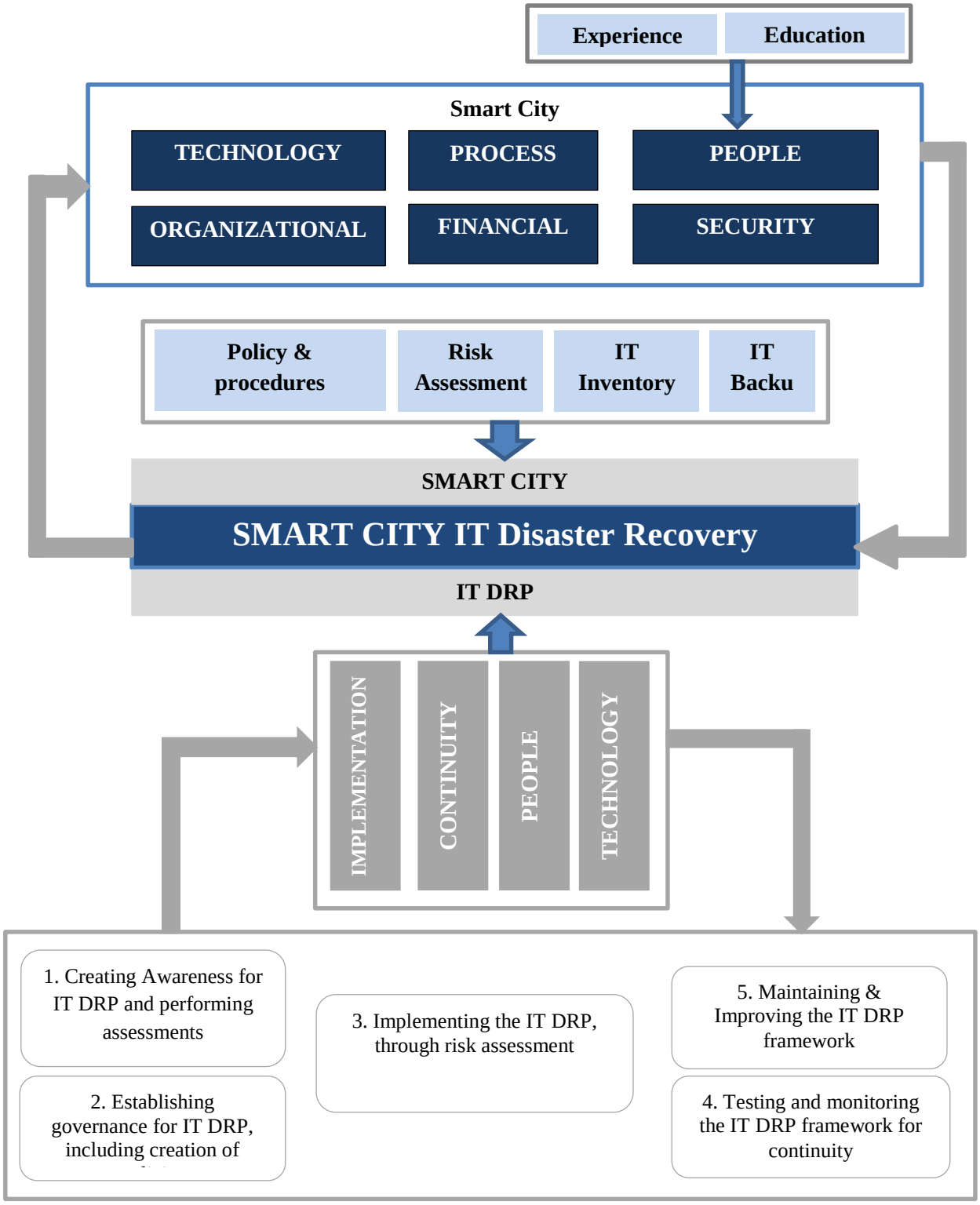

Figure 5.1: Smart City IT DRP framework for Smart Government Services

Step 2: Establishing governance for IT DRP, including creation of policies

Policies and procedures guide organizations in not only effective operations management but also, in recovery and emergency services. For smart city projects, under smart government services, it is found that there are no clear guidelines or policies on the steps for IT continuity in case of an IT disaster. Establishment of policies for IT DRP brings in effective controls in the form of the following (see Table 5.4).

Control Types	Description
Guidance	Providing guidance in the development of IT DRP related documentation while prioritizing the need for developing relationship internally
Protection	Protecting the smart city operations under smart government, involving the consumers, staff and stakeholders through the minimization of interruption impacts availed through the IT DRP IT DRP arrangements
Recovery	Recovering the smart city critical operations / services as per priority through a controlled approach while meeting the department wise requirements, along with consideration of regulatory factors
Continuity	Ensuring IT continuity in smart city projects as part of the current and future planning and development, through the effective integration of the policy in the IT DRP Plan

Table 5.4: Controls achieved through policy development

Developing the policy for smart city IT DRP eventually will transform into a policy for the smart government services for continuity of IT services. It not only guides the authorized personnel in recovery of the essential services and components internally and externally in event of an IT disaster, it also assists in applying best practices. Firms involved in the Abu Dhabi smart city projects should customise their respective IT Disaster recovery controls as well as procedures through the adoption of principles & practices that are put forward as part of the policy.

Step 3: Implementing IT DRP, through risk assessment

Planning for continuity is the main goal for an IT disaster recovery plan. In the smart city project under smart government services, wherein several individual systems are connected together, a step-by-step approach to implement the framework is required. Based on the analysis conducted, the researcher is proposing the following implementation plan with focus on risk management.

Steps	Action
1. Defining Assets and Threats along with scenarios	Effort should initiate with the identification of the primary assets of the smart city projects (systems) with a clear definition of the loss and its impact. Assets include the system(s) and connected components, communication systems, customer database, employee database, corporate database, and strategy files amongst others. Potential threats for smart city systems include terrorist threats, cyber-attack, and failure of core system, hardware failure, power /c communications failure, explosion, or epidemic.
2. Recovery Window	Following the step 1, recovery window outlines the time permissible to operate without access to key resources, defined per asset in the smart city system. It can range from 3 – 5 hours to 3 – 5 days, based on the type of sub-system. However, care should be taken to reduce the threshold time for specific systems that are related to decision making (less than 1 hour). Also, clear directions should be provided on to operate the plan as per the priority set per asset.
3. Defining the recovery operations	In this step, a suitable approach is developed in support to step 1 and 2 which can be recovery to a backup (alternative) site or a temporary backup. However, a suitable budget must be allocated to cover the asset recovery operations while being in line with business value and its overall impact. For example, failure of IT services to a smart city service (such as online parking payment) should be operational 24x7 (excluding the free parking periods). This requires co-location with the facility for data replication to avoid customer inconvenience.
4. Framing a plan of action for DR	Following the preliminaries set out in the above steps, a plan should be developed outlining the key processes in the smart government services in smart city projects, and how each should be addressed. The plan will act as a guide for the IT DR team clarifying on how many employees are needed for the recovery operations for IT continuity, and what actions are needed amongst others. The core of an IT DR plan for smart city is the development of a disaster operations centre, wherein the concerned employees and (or) partners/vendors associated work together for IT continuity and restoration of services. As education and experience of the IT personal in smart city is found to have a significant effect on IT DRP implementation and continuity, it is essential that the DR plan should provide clear procedures on on-boarding the right talent to perform the DR operations. Focus should be on hiring the IT personnel with due consideration on the experience as well as education of the candidates, as it leads to enhanced technology application and practical approach to issues. Also, such a consideration

	requires policy support, highlighting the need for regular training and development of the IT personnel on a regular basis to stay up to date with technology advancement and prepared to take the necessary action when the need arises.
5. Developing communications plan with role assignment	Post development of a plan of action, a clear communications plan should be developed which identifies the plan taken for communications and the role/ responsibility of each individual as part of the IT DR team. The plan should include accurate / up to date list of contacts with contact details including mobile numbers, emails, emergency numbers, etc. Employees should be trained to understand how to use the communications plan during an IT disaster. For scenarios wherein outsourced IT services are used, clear SLA (service level agreement) on the role of the vendor during IT DR should be developed and made understood.
6. Site Planning for DR	Having the plan ready, focus should be made on developing the infrastructure (capabilities and (or) systems) needed for the delivery of the plan. The sub-services of the smart city operations should be classified with the identification of the type of site required for DR operations (ranging from a hot site to a cold site). Given the heavy financial constraint in developing a recovery site, focus should be given on allocation of appropriate funds for IT DR operations.
7. Data Access	In this step, a mechanism for access of the necessary systems (i.e. data as well as applications) for smart city operations should be defined. Focus should be made on improving connectivity even in conditions where low bandwidth is available. Inbound communications should be carefully monitored and planned with effective re-routing to the DR site.
8. Documentation of the Plan	This step requires a detailed documentation of the IT DR plan, while it is developed as a part of the step 4. Focus should be given to detailing of each step given the probability that the change of IT team or a gap in training.

Table 5.5: Step by Step process of IT DRP Implementation for Smart City

Step 4: Maintaining & Improving the IT DRP framework

In support to the step 3 above, regular management (maintenance and review) of the IT DR plan for the smart city operations is crucial. Apart from regular documentation of the plan testing and retesting, focus should be given to regular training of the IT DR team and vendors. Also, it will allows identification of the loopholes or issues that may exist in the plan, later, being updated to improve the performance of the plan when required.

Step 5: Testing and monitoring the IT DRP framework for continuity

Regular testing of the smart city IT DRP framework is essential to maintain and boost he continuity of smart government services. The smart city firms should develop a testing plan for IT services for smart government services continuity in event of an outage or disaster. To support the testing activities, focus should be made on recovery activities for hardware and software, network, data, data centres and people. The testing phase is connected to the risk assessment component, wherein the risk of individual process is established and addressed. For the success of the testing of smart city IT DRP, the scope as well as the objectives of the plan should meet the overall goals of the smart government with clear technical objectives. There are three types of testing that can be conducted: Walk through, simulated and operational.

- Walk through testing involves the key members of the IT DRP team in smart city projects coordinate to review and understand the plan and take actions as needed
- Simulated testing involves running the test through a simulation program the measuring the operational performance of the systems connected
- Operational testing involves conducting a full-scale testing activity on a certain system under the smart city project or a group to review and analyse how the systems work and are recovered

Supportively, regular data collection on the systems involved in the smart city projects allows better organization and management of time lines, resources and expectations. In such scenario, the impact of an IT disaster is minimized as the system is periodically tested through assessments.

From the above discussion, the researcher is satisfied on the validation of the IT DRP framework for the smart city operations, under smart government services. The framework is developed to support IT heads and managers at firms associated with smart city projects in Abu Dhabi and for smart cities (new and existing) across the globe to have a holistic framework and guidance on the need for a reliable IT DRP framework with the key factors that can improve its performance. The IT DRP framework for smart cities can also be used for the update (development) of effective policies and procedures by firms associated with smart city projects in Abu Dhabi Government, bringing forth a change efficient to ensure IT continuity in case of an IT disaster. The new framework on IT DRP for smart cities will guide governments in other countries globally to focus on the elements rendering a significant effect on the overall model efficiency. The framework will also be guidance for organizations connected to the smart city processes in improving their overall preparedness in being ready for IT DRP integration with the smart city. For other sectors, the IT DRP framework can be considered in light of the key elements that lead to its efficient execution, such as implementation and continuity, and the dependence on people and technology factors affecting the overall model performance.

5.7 Implementation for Smart City IT DRP

Given the need for developing an implementation plan for smart city IT DRP, a guide for decision makers and practitioner is required in determining the key events /aspects of the systems and sub-systems involved in smart city projects. In this section, an implementation flow chart for smart city IT DR operations is developed, outlining the process flow and the factors involved. As seen in the figure 5.2, an overview of the framework implementation and the integration of the IT DRP policies is shared. The integration of the policies and procedures for IT DRP with the smart city IT DRP framework allows in gaining full effect of the recovery operations for smart city systems under smart government. The IT DRP for smart cities initiates (in the full purview of the IT DRP policy) with two steps: first to reduce vulnerability in the available IT infrastructure and the second to improve the IT disaster response capabilities for Abu Dhabi Government.

Stage 1: Improve IT disaster response capabilities

The aim of this stage is to monitor and improve the IT DRP system for smart cities by reviewing the failed responses and inadequacy in preparation to respond to an IT emergency during disaster recovery operations. The stage aims to identify the deficiencies within the IT DRP system for smart cities thereby contributing towards the IT continuity planning leading to system, task and resource continuity.

Stage 2: Reduce Vulnerabilities in IT Infrastructure

The second core stage within the IT DRP framework is aimed at reducing vulnerabilities within the IT infrastructure. The IT DRP framework is heavily reliant on IT infrastructure to support disaster recovery operations and any failure in the IT infrastructure due to a minor/major issue can lead to total system failure. The stage 2 allows is analysing the areas, connections and nodes within the IT Infrastructure for DRP operations in smart cities leading to achievement of key protection to high priority activities and operations leading to IT continuity. The stage is linked with IT continuity planning to the overall system continuity i.e. in the form of task, process and resource continuity which form an essential part of the IT DRP policy.

The inputs received from the stage 1 and stage 2 are contributed towards enhancement of the IT DRP policy for smart cities, allowing the government to update the system to overcome vulnerabilities identified and increase IT continuity during DRP operations in smart cities. The IT DRP policy, as observed in the figure has three main sectors. The first sector deals with policies and contracts thereby governing the service level agreements (SLA) for the operations. The second sector deals with the disaster recovery policies, with governance of impact and risk, architecture, plan and test guide for DR operations. The third and the final sector of IT DRP policy deals with governance on availability and change management for the disaster recovery process.

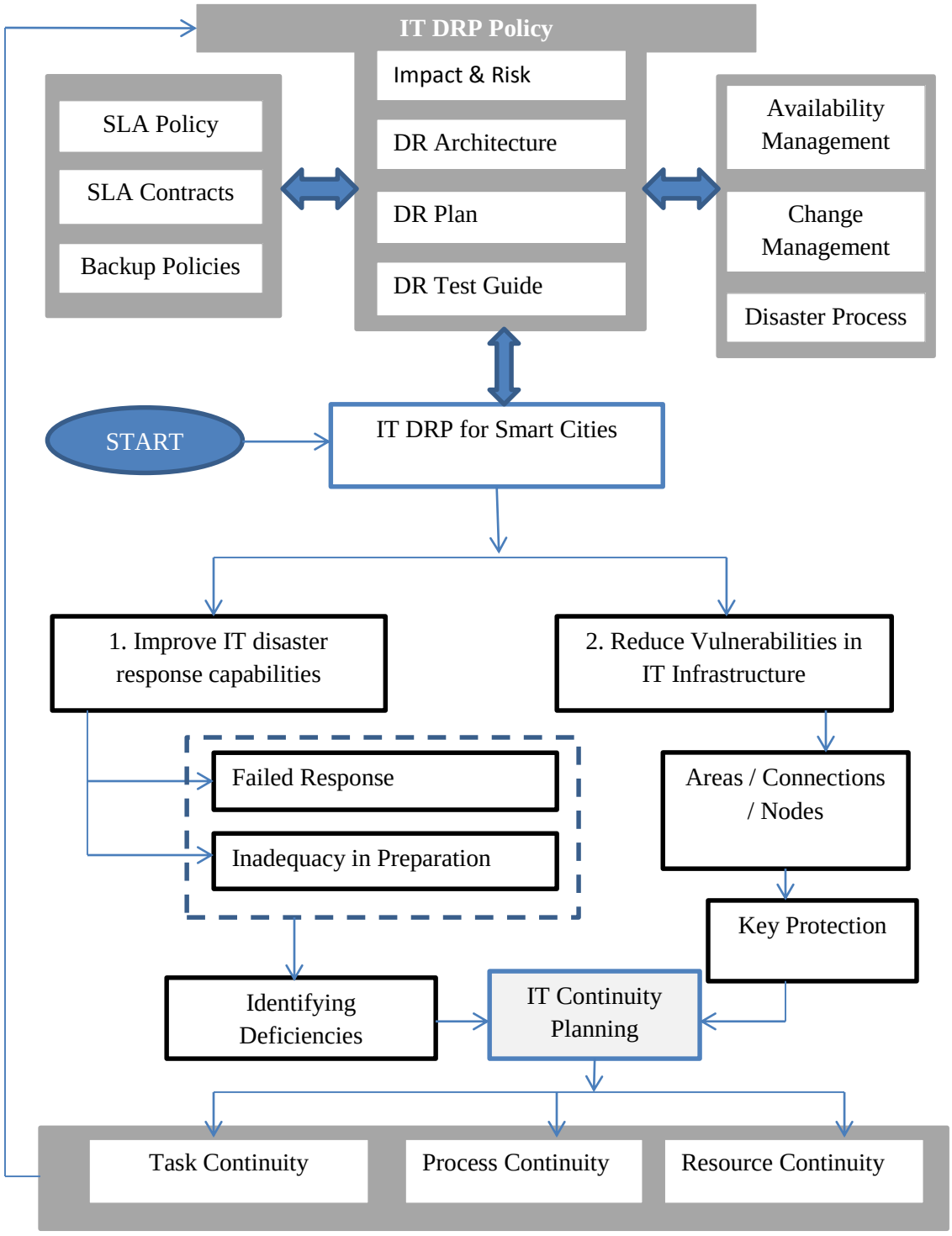

Figure 5.2: Disaster Response for IT continuity

As observed in the figure 5.2, the IT DRP framework for Abu Dhabi Government smart city services should have a synchronous process with the IT DRP Policy for high efficient. The policy comprises of policies and contracts (for service level agreements) with vendors and third party consultants along with backup policies to govern their operations in case of IT emergencies and disasters. The IT DRP policy also governs the availability management, change management and disaster process while controlling the impact and risk, the DR architecture, plan and test guide.

5.8 Conclusion

This chapter evaluates the various components affecting the information technology disaster recovery planning for smart city operations, under smart government services in Abu Dhabi, UAE. It focussed on examining the key findings, while outlining the key lessons learnt from the research along with a detailed review of the achievement of the research questions and objectives. Following to the review, a validation of the components of the framework was achieved with the identification of new factors influencing smart city IT DRP success. The new framework developed for smart city IT DRP is a contribution made by the researcher due to the following:

1. The new framework is the first-of-its-kind framework developed exploring the components of smart city and IT DRP. The framework was aimed to support the smart government of Abu Dhabi, however, can play a much wider role in supporting governments in the GCC region too. The new IT DRP framework can be applied by governments globally in their existing or planned smart cities thereby achieving success in the integration of smart city with IT DRP. Also, the new framework can be utilized by corporates in other sectors that may or may not be connected with smart city services.

2. In this framework, a comprehensive review of the concepts as well as the components of smart city and IT DRP is conducted with the intention to identify how the components inter-relate to one another. The aim was to identify which components form the most influential relationships and hence should be targeting extensively during the implementation of the smart city IT DRP framework.

3. The new framework forms the guide for decision-makers in Abu Dhabi, UAE to understand the impact of each component of smart city on IT DRP (and vice versa). Also, given the identification of the stages involved within the policy development to support the framework, a novel contribution is made that outlines on the role of each component within the framework and its effectiveness.

4. Another contribution made is the usefulness of the framework for government decision-makers and smart city project implementers in considering the IT DRP framework during the initial stages of the smart city conceptualization. This will reduce redundancies in the overall system and allow the decision-makers to give due consideration on the financial resources to support IT DRP operations in the smart city projects.

In the chapter 6, the conclusion with an overview of the research findings are presented with the research limitations and recommendations for future research.

6 CONCLUSION & RECOMMENDATIONS

In this chapter of the thesis, an analysis of the research objectives developed in the 1st chapter of the study along with their discussion is presented so as to achieve the research aims. The research limitations are also highlighted and some suggestions are made for future.

6.1 Conclusion

Smart government is focussed on integrating various IT services, facilitating enhancement of the smart government services (along with services as part of the smart city projects) for its citizens. It is based on a transparency, efficiency and accessibility principles, rendering the people as well as the businesses associated with its services with effective connectivity. However, given the high dependence of the smart government services on information technology, continuity of IT services for the smart city projects is at risk given the rise in IT disasters/threats. In the research, the aim is.

A brief explanation is provided regarding the background to the research context in Chapter 1 wherein a detailed discussion has been provided regarding the rationale for undertaking the present research on IT DRP in smart cities, for smart government services in Abu Dhabi, UAE. Furthermore, the present chapter also helps to elaborate on the aim of the study, which is to develop an IT DRP framework to support the Abu Dhabi Smart Government in the initiatives of smart city services to assure its system and IT continuity.

In order to achieve this aim, the following research objectives were formulated:

1. To review and compare the existing frameworks in relation to IT DRP and their application in a disaster situation affecting the IT continuity of Abu Dhabi Smart City, as part of the smart government services.
2. To identify, analyse and evaluate the prime factors in the IT DRP framework of Abu Dhabi government for smart city system in terms of security and IT continuity in event of an IT disaster. This objective aims to understand the benefits and limitations of the current IT DRP system applied for smart cities.

3. To suggest improvements in the current IT DRP framework adopted by Abu Dhabi governments to support its Smart city System through the development of IT DRP plan that can ensure high level of security and reliability of smart city system even during a disaster.

Smart cities across the globe rely heavily on IT infrastructure in order to integrate the smart city processes. Due to this, there is high dependency on the availability of the systems as well as high recovery capacity in case of an outage or disaster. In Chapter 2 the literature review enables to understand IT recovery in a smart city set up. The literature review focuses on explaining what is the roe of IT DRP and what are it's various components. Furthermore, the discussion about the characteristics of smart cities helped to identify the role and importance of IT in the smart city set-up. Therefore, it is vital to safeguard smart city set up which further led to the discussion about the role of IT in a smart city development. The chapter also shed light on how important stake holders are and the role they play in the IT DRP framework. To further drive the importance of IT in smart city set up, various smart cities across the globe were discussed. Additionally, the benefits of DRP framework were discussed that reinforced the importance of IT DRP in organization. Various DRP models were examined after which a conceptual framework was proposed by the researcher which contained all the vital components that ensured success of the framework.

In Chapter 3 the researcher has specified the methodology that has been adopted for this research that would validate the proposed IT DRP conceptual framework. While discussing the various theories the researcher has pointed out that in the context of IT DRP in smart city, the positivist approach is most suited since this approach identifies the presence of a social world that is influenced by critical factors. The researcher has worked independently, without being influenced by the research, thus helping in the identification of critical factors. Furthermore, for this research, the researcher has opted for a quantitative approach that opts for the deductive approach wherein 1 main hypothesis and 5 sub-hypotheses are empirically tested to establish whether they are rejected or confirmed. For this, the researcher has undertaken the survey method to draw out conclusions and validate the theories. With respect to the sampling methods, the researcher opted for non-probability; convenience sampling as it is less costly, requires less time and efforts and is easily accessible. The sample size for this study constitutes of 219

respondents which is considered fair by researchers (Tabachnich and Fidell, 2001; Comrey and Lee, 1992). The SPSS methodology has been applied for the data analysis since the data obtained is in large quantity and for the survey, the Likert scale is used for rating of the questions so that the responses can be collected for data analysis. The researcher has also pointed the ethical considerations along with research limitations so that future researchers can concentrate and build on the limitations of the present study.

Chapter 4 in the study discusses the results that were derived from the survey responses and analyses them to identify the critical factors of IT DRP framework. Each question from the questionnaire has been recorded, analysed and discussed to understand the various components and there relationship to IT DRP. This chapter helped to validate the conceptual framework while also pointed out which components were missing from the framework, which helped the researcher to revisit and amend the framework.

Chapter 5 presents a detailed discussion regarding the findings of Chapter 4 and identifies the fact that there is limited amount of studies that have evaluated components, advantages, barriers as well as the challenges of smart city and IT DRP, or both in general in the UAE and GCC. Based on the findings, the researcher made a few changes to the conceptual framework which included addition of new factors and removal of less dominant factors from the framework for smart city IT DRP. The new framework was also validated and thus was suggested as an ideal framework for IT DRP in Smart City.

6.1.1 Research Findings

The aim of the present study was ‘to develop a IT DRP framework to support the Abu Dhabi Government in the initiatives of smart city services to assure its system and IT continuity.’ In order to achieve this aim, the research first evaluated the crucial factors of IT DRP and smart city via survey questionnaire methodology and the responses were reviewed and analysed by the researcher. The main objectives that were formulated as result of the above aim and the ensuing findings are presented below:

Finding 1: The research that was conducted by the researcher led to the identification of vital components of smart city as well as IT DRP which are crucial for the continuity of services. In order to validate each factor, a thorough literature review of each component was carried out

especially in the context of Abu Dhabi Government, UAE. Furthermore, the researcher also conducted a detailed review of past literature in order to identify the barriers and benefits of Smart city as well as IT DRP components in order to ensure continuity of services. Once the vital components were identified by the researcher, the framework was validated for IT DRP in smart city in Abu Dhabi Government, in UAE. In order to validate the framework, the researcher identified the significant relationships that exist between the components of IT DRP and smart city.

Finding 2: As discussed earlier, for this research study, the role of technology within the sphere of smart city development along with future developments was made, with a focus on IT DRP components and its review. Each component was reviewed individually in detail, starting from the stages of IT disaster identification to steps undertaken in case of a disaster. Based on 6 core components, the IT DRP process was reviewed. Since no models or theories were found which examine the collaboration of IT DRP and smart city together, the researcher chose to review factors of IT DRP and smart city separately. After the review, 6 factors each for smart city and for IT DRP were identified by the researcher. The relationship between these factors was established and validated in Chapter 4.

Finding 3: Upon reviewing the components of the framework and conducting the data analysis in Chapter 4, certain suggestions were made, with respect to improvement of IT DRP. The main aim of these suggestions were to improve the collaboration between smart city and IT DRP in Abu Dhabi Government, UAE in order to ensure continuity in case of an IT disaster.

Findings 4: This research was focussed on identifying those factors which contributed towards the development of a framework for IT DRP which can be applied to the smart city projects. From the data analysis in Chapter 4 certain factors were identified which would make the model effective, these factors included:

- Smart City Components: People, Process and Places
- IT DRP Components: Financial Resources, IT Implementation, IT Continuity
- Other Components: Experience and Education

Furthermore, the data analysis also revealed that a number of factors also limited the implementation of the framework. These included both, smart city as well as IT DRP components. The researcher also found that there is an important relationship between technology and continuity of IT DRP along with people and process components of smart city. Thus it indicates that it is vital that for the implementation of IT DRP framework in a smart city initiative under smart government, it is important to have a strong relationship between technology infrastructure and people support.

6.1.2 Meeting the Aims and Objectives

Table 6.1 presents the research questions and the findings, bringing forth an overview on meeting the aims and objectives.

Issues in Research	RQ #	RQs	Chapter	Findings
IT DRP and Smart City Literature	1	What is the existing IT DRP framework used for Smart City in Smart Government Services in general and Abu Dhabi smart city in focus?	Chapter 2	The aim of the study was to identify the various factors which contribute towards the framework development of IT DRP that can be applied for smart city projects, under smart government services. Based on the findings identified from the data analysis of chapter 4, the components in table 5.1 were identified to be significant related and contribute towards the effectiveness of the overall model.
IT DRP and Smart City Components	2	What are the factors that limit the application of the current IT DRP framework of Abu Dhabi Smart City, in terms of safety and efficiency	Chapter 2	As per the data analysis conducted in the chapter 4 and the findings identified, it was found that there are certain factors that limit the implementation of the framework (table 5.2). These include smart city IT and security & privacy components.
IT DRP and Smart City Integration	3	How can Abu Dhabi Smart City can switch to a reliable IT DRP framework without affects its current IT continuity?	Chapter 4 Chapter 5 Chapter 6	As per the results found, a significant relationship exists between IT DRP continuity management and the people and process components of smart city. Majority of the respondents indicated that their organization is in progress to develop a continuity plan. This reflects the progress to be made in the area of IT continuity management in smart city projects to enhance the overall continuity management for smart government services. Lack of focus on the selection of alternate site to support IT DRP implementation during IT disasters was also found.

Table 6.1: Meeting the aims and objectives

6.1.3 Research Outcome

The researcher was able to identify and analyse the research findings as was presented in the Chapter 4 and 5. Based on the findings, the researcher revisited the conceptual framework and the data was analysed. Based on this analysis, the conceptual framework was changed to remove and incorporate certain important components. One of the outcomes of the study was that the researcher was able to ascertain that in the present context there are no studies which are exclusively based on the examination of components and concepts of smart city IT DRP implementation together in Abu Dhabi Government, UAE or even globally. Furthermore, the conceptual framework has been developed as such that it enables to identify the crucial factors along with the vital smart city components. The research outcome of the study has helped to widen the outlook of smart city IT DRP implementation by important practical as well as theoretical contributions made by the researcher.

6.2 Contribution to Knowledge

The research findings helped to determine the progressive contribution towards smart city IT DRP implementation for smart Government services in the following areas:

Contribution 1: Up until now, the literature review revealed that a lot of components have not been researched previously; the present framework has explored each component of smart city and IT DRP separately so that it formulates a validated framework which supports the smart government of Abu Dhabi, UAE. Furthermore, the researcher has formulated a framework whose application can be extended to all the countries in the GCC. As for other developing nations, the framework can be tweaked and validated accordingly.

Contribution 2: The new framework consists of concepts and components of IT DRP and smart city which have been reviewed thoroughly in order to identify their inter-relation. The aim was to identify those components which form a strong relationship. Once identified, these relationships should be targeted by the smart government during the implementation of the framework. Such a focus would help in smooth implementation.

Contribution 3: The new framework has been formulated as a guide for implementers of change along with strategic decision makers to identify the impact of each component of IT DRP on

Smart city and vice-versa. Furthermore, the various stages within the policy development for the support of the framework helps to identify the role of each component comprehensively and also explains its effectiveness within the framework.

Contribution 4: Another major contribution that is made by the research is the usefulness of the framework for implementers along with decision makers while undertaking the implementation of smart city initiatives. As mentioned earlier, smart cities are heavily reliant on IT and therefore the framework will enable the responsible authorities to consider the financial aspect of the framework during the implementation of smart city.

6.3 Research Limitations

While conducting the research, researcher may have to experience a lot of difficulties and one of the worth mentioning limitation of this particular research is the limited access to the smart city areas government resources. Also, given the sensitive and political nature of IT DRP, it was hard to collect relevant information. Collecting the relevant data about smart city projects was also a rather difficult task because the pertinent data is considered relatively politically sensitive and the employees working in such organizations were not willing to disclose it.

Another constraint is that not much work is done about the concerned topic and especially only a diminutive research is done previously about the concept of smart projects of Abu Dhabi, Government, UAE. The results of the earlier researches were not even made available publicly, so the researcher could not benefit much from that and had to rely on her own professional experience and perceptions.

After the collection of data, few restrictions were faced by the researcher with respect to research findings. At times, the information was inconsistent from the participants with respect to the same subjects. Due to this, the researcher had to dedicate more time in clarifying the questions to the respondents so that accurate answers were received. The objective of the researcher was to collect data from each section of the questionnaire in order to meet the aim and objective of the research.

The researcher also faced problems in collecting responses online. For this research, the data collection method includes web base questionnaires that the respondents had to complete. However, the responses were being delayed and the researcher had to keep reminding the respondents to complete the questionnaire. The researcher also noticed that most respondents preferred completing the questionnaire in form of hard copies instead of online forms.

While a revised conceptual framework is presented by the researcher after validating the data and conducting a detailed analysis, the framework is applicable for Abu Dhabi Government, UAE and might be difficult to generalize it for other countries unless it is tested and validated separately for each country. However, the good practice guidelines can be utilised as an action plan for the implementation of the IT DRP framework for smart city, especially within emerging countries.

6.4 Recommendations for Future Research

6.4.1 For Policy Makers

The definition of smart city for each nation is different, they all delineate it in terms of what in actual is important for them according to their own specific needs. The goal of Abu Dhabi Government is to turn the city into the world's smartest city by the year of 2020 and to achieve this objective it has devised many plans. It can avail the latest advancements of the technology to realize that scheme into reality. The numerous organizations involved in this mega project, along with the society and the government should all work collectively to keep up the pace with the ever increasing developments of the technology to make the process agile and to prevail over any redundancies that could hinder it.

The information and communication technology also ensures a more collaborated effort by connecting various departments and to reduce the effect of any uncertainties or redundancies. It helps in discovering new smart solutions and to predict future trends to avert any costly mistakes. It could help the policy makers to make a more comprehensive and sharp analysis of the numerous external factors having the potential to impact the plans in one way or the other and to devise more intelligent plans and strategies accordingly. As mentioned previously in this research paper that even though many endeavours are being made by many government entities

to attain this aim, yet there are some factors that are beyond control and led to disappointment. Hence, by considering all those dynamics the government of Abu Dhabi, UAE can make the success of IT DRP model more doable.

6.4.2 For Academic Researchers

In this study in order to examine that how by fusing together the features of IT DRP and the smart city system a more effective and pragmatic framework could be developed so as to pull off the plan of the smart city, data was gathered from the pertinent organizations in UAE. The respondents of the research were basically the employees working in both the public and the private organizations offering smart city services. The three noteworthy parties who have the power to affect this project or will get affected by 1. The government of Abu Dhabi, UAE at all the different levels, 2. Organizations associated with this project and 3. The public of the city.

For academic researchers, this study suggests to investigate on how to identify and then manage the identified stakeholders effectively for better results. The following suggestions are raised to aid future researchers in expanding the framework on IT DRP for smart cities:

1. Policies and procedures are a potential area of research identified in this research study and needs further research, by keeping in view the specific needs of the public, government can formulate more effectual policies to administer in ICT projects (Pernille & Martina, 2013). Researchers can explore the different techniques adopted by the government entities and determine the order in which they execute different activities within the IT DRP framework for elements in smart cities. Focus can be made on researching on policy development to strengthen people and processes dimensions in smart cities, to be capable to undertake the activities of IT DRP.

2. Security in smart city IT DRP is another area of research proposed for future researchers as it is linked with the success of the overall program. With the rapidly advancing technology the automation of data and wireless sharing within public sector entities, vulnerabilities may arise threatening the execution of the IT DRP framework in smart cities. The security element is a contingency element within the smart city IT DRP that connects with policies and procedures. Researchers can focus on identifying the protocols needed to strengthen the security aspects for

smart cities and thereby enhance its preparedness during IT disasters. Formulation of the guiding security protocols and the role of different departments in those protocols will allow strengthening the overall system and thereby security the smart city in IT emergencies.

3. IT Backup and Risk assessment is identified as an important area of future research in smart cities wherein future researchers can study and examine the differences in risks at organizational and departmental levels across different public sector organization that contribute to the smart city network. Examination of framework development at this level can allow refinement of the new smart city IT DRP framework proposed in this research study that can be applied to specific government sector organizations across the globe.

6.5 Chapter Summary

In this chapter, an overview of the research conducted on IT DRP in the context of smart cities for Abu Dhabi Government was presented. The chapter reviewed the research findings in light of the aims and objectives and presented the research outcome. Also, it shared the contributions made by the researcher to knowledge while also presenting the research limitations and the recommendations for future research, in context of policy makers and academic researchers.

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8. Appendix

Information Technology Disaster Recovery Plan (IT DRP) Framework – A study on IT Continuity for Smart City in Abu Dhabi Smart Government

Dear respondents,

Thank You for participating in this survey. i am conducting this survey as a part of my doctorate thesis with the British University in Dubai. My research aims to examine the current state of the information technology disaster recovery planning (IT DRP) in the emirates and develop a framework to support smart city operations in Abu Dhabi.

By being a part of this research, you have the opportunity to share your professional knowledge and contribute towards the IT DRP framework development.

Your responses will be kept anonymous and utilized collectively, with no reference to any respondent directly or indirectly. No personal details such as your name, or contact details will be collected in this survey.

You have the right to withdraw from the survey at any time during your participation.

Thank You!

Linda

Part 1: Demographics

<table>
<tr><td>Title</td><td colspan="2">□ IT Manager</td><td>□ Systems manager</td><td>□ Systems Engineer</td><td>□ Operations Manager</td><td>□ Others</td></tr>
<tr><td>Gender</td><td colspan="2">□ Male</td><td>□ Female</td><td>Age</td><td colspan="2">□ 20-30
□ 31-40
□ 41-50
□ 51-60
□ 60 and above</td></tr>
<tr><td>Total years of experience</td><td colspan="3">□8-10yrs □ 11-15yrs □16-20yrs
□21yrs and above</td><td>Years of experience in current position</td><td colspan="2">□2-4yrs □5-6yrs
□7-9yrs □10yrs above</td></tr>
<tr><td colspan="7">Qualifications level</td></tr>
<tr><td>High School □</td><td colspan="2">Diploma □</td><td>Bachelor □</td><td>Master □</td><td colspan="2">PhD □</td></tr>
</table>

Part 2: Identifying Core Components of Smart City

2.1 Information Technology Components (ITC)

Smart City Applications need to integrate different "technological silos" and various technologies involved. We first need to identify these technological properties.

Q1. Please select the applicable data feed sources mentioned below that you have worked with

Data Feed Source	**Please Tick**	
Cameras	Yes □	No □
GPS Systems	Yes □	No □
Traffic Data Streams	Yes □	No □
Disaster Prevention Data Stream	Yes □	No □
Security Data Streams	Yes □	No □
Energy Saving Data Streams	Yes □	No □
Others: Please Specify		

Q2. From the following sectors, what is the priority level of smart city technologies which represent for your community?

Important Sectors	Top Priority	Significant Priority	Minor Priority	Not a Priority
Public safety				
Customer service/public engagement				
Water and wastewater				
Telecommunication				
Education				
Transportation				

Q3. Currently, what is your community's level of engagement with respect to smart city technologies?

Smart City Technologies	Active deployment	Pilot stage for program or policy	Planning stages or creating detailed roadmap	Assessing readiness level	Not active
Smart payments and finance					
Water and wastewater					
Customer service/public engagement					
Telecommunications					
Energy					

2.2 Process Components (PC)

Q1. How important are the following benefits in encouraging government to implement use of smart city technologies?

Benefits Achieved	Very important	Important	Moderately Important	Less important	Not important
Economic development					
Safety and security benefits					
Capital/operational cost savings					
Resilience for critical operations					
Enhanced services for residents					

Q2. Which of the following processes have been optimized for Smart government initiative?

Internal Processes	**Pls Tick**
New IT architecture plan and organization	
New organization model	
New, interconnected management positions	

2.3 People Components (PEOC)

For implementation of Smart Government Services in Smart City project, people skills are important. In the absence of proper training, smart government services implementation cannot take place.

Q1. What type of IT training do employees receive at their workplace for smart government services in smart city implementation?

Training Type	Yes	No
Data Entry		
New Software Use		
New Hardware Use		
Network and Maintenance		
Programming		
Internet		
Installation		
New Machinery		
Digital Management		
Others: Pls Specify		

2.4 Organizational and Structural Component (OSC)

Q1. How will your organization/community implement the smart government initiatives? Select the most relevant.

Sr. No	Actions taken for implementation of smart government initiatives	Pls Tick
1.	Build and operate systems internally	
2.	Operate consultant advised solutions	
3.	Acquire long term solutions from consultant	
4.	Outsource operations and developments to consultant	
5.	Combination of 1. and 2.	
6.	Others	

2.5 Financial Resources Component (FSC)

Q1. What is the widely adopted financing mechanism for Smart Government Services in Smart City implementation?

Method	Yes	No
Private Investment		
Government Funding		
Public-Private Partnership		
City Budget		
Strategic Partnerships		
Use of financial instruments		

2.6 Security and Privacy Component (SPC)

Q1. How much importance is given to security and privacy during and after implementation of the initiatives?

Security and Privacy Measures Undertaken	Very Important	Important	Moderately Important	Less Important	Not Important
What level of importance is given to security and privacy in the implementation of the smart government in smart city initiative? For smart government, after new smart city service implementation, how important is follow-up for ensuring there are no information security loopholes?					
Is it important to carry out security evaluation for the products that are acquired for smart government implementation?					
How important is it to evaluate technologies and choose them based on their proper cyber security controls as well as protections?					

Part 3: Identifying IT DRP Components

3.1 Implementation Component (ITIC)

Q1. What is the DR implementation strategy for your organization? Choose from below

Strategy	Please Tick
Secondary site that mirrors the primary site	
Secondary site, but does not mirror the primary site	
Make use of software based replication for DR	
A hosted or Managed Service Provider (MSP) environment	
Purchased Disaster Recover as a Service (DRaaS) solution from a provider	
Hardware/ array-based replication for DR	
Public Cloud for DR	
Others: Pls Specify	

Q2. Alternate Location

Alternate Location Options	Yes	No	In Progress
Do you have an alternate location for your organizations backup facility?			
Are the backup facilities in a separate geographical location?			
Do these backup facilities make use of a separate telecommunications provider?			
Are the system resources portable, i.e. can they be easily transported to backup location?			

Q3. When disruptions are caused by the following third-party components, what specific steps are taken by the organization?

3rd Party Disruption	Steps Taken
Banks	
Data Providers	
Disaster	
Service Providers (Etisalat)	
Other third parties (Specify)	

3.2 Continuity Management Component (CMC)

Q1. Does your organization have a continuity plan in place?

□ Yes □ In Progress □ Not Started

Q2. Which are the most important functions of your organization and how soon can they resume after a disruption?

Sr.No	Operation Description	1 Week	2 Week	3 Week	Longer
1.	IT Development and Deployment				
2.	Production and Procurement				
3.	IT Research and Development				
4.	Accounting and Finance				
5.	Customer Service				
4.	Others:				

Q3. How often is the IT DRP reviewed in your organization?

□ Quarterly □ Yearly □ Every 2 Years □ After every disruption

3.3 People Component (ITDRP PC)

Employee Readiness	Yes	No	Under Training
Does your organization have an IT recovery team?			
Employees along with the Stake holders are aware of what to expect in case of an IT disruption?			
Employees have participated in emergency preparedness workshops?			

3.4 Technology Component (IT DRP TC)

Q1. In order to protect your organization from data loss identify if the following steps are followed.

Steps Undertaken	Fully	Somewhat	Not documented	Not applicable
DRP is documented				
DRP identifies vital applications that need to be recovered along with the critical components which form this applications				
DRP documents Recovery Time Objects (RTO)				
DRP documents failback/failover processes				

Q2. Are the following components for IT Services incorporated?

IT Services Components	Yes	No
All IT services offered by the IT department have been identified?		
All system requirements have been identified to provide IT services?		
Assessment has been done regarding risk to IT services and infrastructure?		
In case of a disruption, IT services have been ranked to prioritize recovery?		

3.5 Organizational Component (IT DRP OC)

Q1. Organizational identification and notifications for IT disasters. Answer Yes or No.

Steps taken to Identify and Notify IT Disasters	Yes	No
We have measures to detect and identify IT disasters		
We have ways to assess the magnitude of IT disasters		
We have the necessary means to notify necessary personnel responsible for IT recovery		
We have a system set in place to notify stakeholders in case of an IT disaster		
In case of emergency, we have established an alternative route of communication		
We have assessed the risks and threats posed to IT services		

3.6 Environmental Component (IT DRP EC)

Q1. Are regulations followed binding the IT DRP for Smart government?

Regulations Followed	Yes	No	Not Applicable
Are there any regulations prescribed within the organization necessary while formulating the IT DRP of your organization?			
Are there any minimum requirements laid down by the government concerning IT DRP?			
Has the organization prescribed any regulations to keep the IT DRP framework up-to-date?			
Are there any surprise checks conducted with the organization to check the adequacy of IT DRP?			
Are there any surprise checks conducted by the government to check the adequacy of IT DRP?			

Part 4: Suggestions and Feedback

Please mention any feedback or suggestion which you have for the presented survey.

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