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A CLOUD-BASED BUSINESS CONTINUITY FRAMEWORK FOR CONTAINER TERMINAL OPERATIONS: A SOUTH AFRICAN CASE STUDY

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DECLARATION

I, Felix Nyadzani Kutame (Student number: 11638193) hereby declare that this thesis for A CLOUD-BASED BUSINESS CONTINUITY FRAMEWORK FOR CONTAINER TERMINAL OPERATIONS: A SOUTH AFRICAN CASE STUDY, hereby submitted by me in partial fulfilment of the requirements for the Doctor of Philosophy Degree at the University of Venda has not been previously submitted for a degree at this university or any other university and that this is my own original work.

SIGNATURE

Student..................................... **Date: 03/07/2020**

DEDICATION

By finishing an education cycle which my parents started for me back in 1982, I dedicate this thesis to them.

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I would like to thank my family for their support through this journey.

A very special word of gratitude goes to my dad for being such an inspiration and for being my pillar of strength throughout this long journey.

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ABSTRACT

Contemporary cloud-based computing is crucial for the efficient delivery of ICT systems to users, as well as for versatile disaster recovery and business continuity management (BCM) platforms. Based on the need for efficient and fault-tolerant port operations, this study proposes a cloud-based business continuity framework (BCM) for the container terminal operations (CTO) in South Africa. The study examined the impact of ICT systems and services on Container Terminal Operations (CTO); determined Critical Business Functions in operations that must stay operational and analysed the impact of the unavailability of ICT systems and services on critical operations. This empirical study employed both quantitative and qualitative research designs and collecting data through self-constructed and self-administered questionnaires and interviews. Quantitative data was analysed using the IBM Statistical Package of Social Science (SPSS) Version 23 while qualitative data was analysed through thematic analysis of interviews. Results show that to realize effective organizational resilience using BCM, three insights, as underlying mechanisms for assimilating cloud computing in BCM can be inferred: the first is that a digitalized BCM architecture 'fits' the cloud computing model. The specific BCM characteristics that befits cloud computing are continuous data processing; continuous data access and delivery; multi-platform data access; always – on ICT Services; and better decision making. Secondly, the cloud computing model is a 'viable' model that can contribute to managing complex organizations characterized by business units that are highly differentiated in terms of size, structure, ICT and investment levels. For such complex organizations, viability is visible in terms of how the multi-units can harness collective intelligence (CI) for more effective BCM. Collective intelligence, as a form of universally distributed intelligence that is constantly enhanced, coordinated in real time, and which results in effective mobilization of organizational competence, is a core organizing metaphor for achieving BCM in a complex organization. Lastly, to realize BCM, underpinned by greater digitalization of BCM and harnessing of CI; there is need for rethinking strategy towards adoption of an 'Intelliport strategy' or 'smart' BCM for ports, currently intertwined with the notion of the 4IR. That the 'smart' nature of BCM require the assimilation of 4IR technologies that enable ubiquitous presence and real time information regarding organizational processes. Adopting an 'Intelliport strategy' is likely to have two main implications for BCM and practice: the first is linked to the development of a circular economy, in which aggregation of BCM activities can enhance sustainable development of the seaports; and secondly, adoption of a cloud computing model that can result in the enhancement of business growth of the units promote collaborative problem solving and decision making in BCM.

Keywords: Organisation, Business Continuity Management, Container Terminal Operations, Terminal Operating System, DRaaS, BCM Framework.

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Chapter 1: Introduction

1.0 Background of the Study

The increased demand imposed by modern day container terminal operations requires the use of highly efficient and reliable IT systems (Guan & Liu, 2009; Tijan, Agatić, & Hlača, 2010). Modern day container terminals utilise Information and Communication Technology (ICT) Systems to manage their operations. Although it is possible to run the operations without the ICT Systems, as has been in the past, it would be very difficult to cope with the increased demands of the modern container terminal. The large number of containers handled in large container terminals need to be placed in high-capacity ships and shipped to multiple destinations via an operation which needs a high level of coordination (Dowd & Leschine, 1990). It is this level of coordination by operations staff that makes it a requirement to use an ICT System. However, there are times when the ICT System becomes unavailable impacting negatively on container terminal operations.

Whenever the ICT Systems stops functioning, the operation halts for the period of the shutdown. All movements of containers cease and await the ICT System to be brought back into operation, before the container movements continue. The failure of the ICT System can also be felt outside of the terminal as it may cause thousands of collection agent trucks to queue outside the terminal and cause traffic problems around the harbour (Dowd & Leschine, 2006). The loss of the ICT System in container terminal operations is a highly undesirable event as it may result in considerable loss for the business and all agents collecting and delivering goods.

Business Continuity Management (BCM) is considered a key factor for the development and efficiency of modern port environments (Bosich, Faraone & Sulligoi, 2018). BCM consists of actions that can be taken to eliminate the problem of the loss of ICT Systems in Container Terminal Operations (CTO). In addition, robust Disaster Recovery (DR) solutions are considered a must for highly significant IT systems (Mendonça, Andrade, Endo & Lima, 2019).

Across the industry sectors, ICT systems are a critical enabler of the modern enterprise (Khalfay & Pittar, 2011; Tijan, Agatić, & Hlača, 2010). The ICT system consists of a set of hardware, software, infrastructure and trained personnel, and its function is to collect, store and process data and deliver it as information that can be used for planning, control, coordination, decision-making and operations management by organisations.

ICT, which is a significant driver of container terminal operations (CTO), consists of a set of symbiotic components whose function is to collect, store, manipulate and disseminate data and then provide feedback based on that data (Stair & Reynolds, 2014). The symbiotic components that Stair and Reynolds refer to are hardware and software, databases, telecommunications, procedures and people; and they can also be referred to as a Computer Based Information Systems (CBIS). Rainer and Cegielski (2011) also use a related definition to that of Stair and Reynolds, however, they divide ICT components into two sets, namely, Information Technology (IT) components – which consist of the hardware and software, databases and networks – and the System, which consists of the people and the procedures that the people use to interact with the IT components.

Contemporary cloud-based computing is crucial for the efficient delivery of such ICT systems to users, as well as for versatile disaster recovery and business continuity management (BCM) platforms. Prior research recognises that business continuity and efficiency are key factors for the development of port ICT systems (Bosich, Faraone & Sulligoi, 2018); and that such systems need to be designed using effective fault-tolerant techniques like Disaster Recovery (DR) solutions (Mendonça, Andrade, Endo & Lima, 2019). Based on the need for efficient and fault-tolerant port operations, this study proposes a cloud-based business continuity framework for container terminal operations (CTO) in South Africa. The emphasis of the study is on exploring current BCM practices that can aid in the development of a framework for Digital Business Continuity for container terminal operations if there is a loss of centralised ICT systems.

Long standing research in business continuity planning and disaster recovery ensures the long-term viability of organisations (Cervone, 2017); compliance to government regulations and to international standards (Alhazmi, 2016) and results in the reduction of supply chain disruptions, enhance disaster resilience and promote a more robust economy (Levy, Yu & Prizzia, 2016). Particularly for organisations, any system downtime leads to reputational damage, lost trade and impacts on long-term projects; thus, firms are beginning to realise that BCM and DR solutions are critical to success (Timms, 2018). Business continuity thus needs to be properly planned, tested and reviewed in order to be successful. However, despite the realisation that BCM and DR solutions are critical for the success of organisations, prior research acknowledge the dearth of application of BCM particularly in public sector agencies (Hamid, 2017). Ports, considered as a key cluster of economic activity for nations, are typically run as public enterprises, with minimal research confirming the application of BCM in these entities (de Langen & Haezendonck, 2012).

1.1 Context of the Study: Intermodal Container Terminal Operations

An intermodal container terminal is a facility where cargo containers are handled and transferred between different modes of transport for the purposes of transport, especially in imports and exports within a port. The container terminal facility can only handle containers and not any other type of cargo. There are port terminals that can handle cars, bulk goods such as wheat, coal, iron ore and break-bulk materials which are materials that are not of a uniform shape and other commodities such as oil. Other terminals may also handle a combination of the containers and bulk goods and other commodities.

There are different types of transport that move containers between destinations, and these include ships, trucks and trains. The movement of the containers between different types of transport is punctuated by a short stay in a container yard. This movement is determined by the arrival of goods and must not be interrupted as this may create backlog resulting in a critical loss in business. Sometimes containers are also moved from one vessel to another. This movement is referred to as a trans-shipment (Steenken, Vob & Stahlbock, 2004).

Containers are essentially uniform metal boxes that are used to transport different types of goods without having to be unpacked at different points of transfer. This system allows for the easy handling of freight (Steenken et al. 2004). Containers are commonly found in two sizes, that is, 20-foot and 40-foot containers, and these pertain to a description of the length of the container. The 20-foot container is used as the measuring unit of a standard container; a Twenty-foot Equivalent Unit (TEU). Thus, one 40-foot container is referred to as 2 TEUs (Brinkmann, 2011; Steenken et al. 2004; Ting, n.d.). The TEU is then used as a yardstick to determine the sizes of container handling facilities and vessels.

The Durban Container Terminal (DCT) is a container-handling port situated in Durban, KwaZulu-Natal, owned and operated by Transnet. It operates as two terminals, Pier 1 and Pier 2, handling 65% of South Africa's container volumes (transnet.net, 2013). The three other smaller container terminals in South Africa, Cape Town Container Terminal, Ngqura Container Terminal and Port Elisabeth Container Terminal, are also operated by Transnet.

The Shanghai container terminal in China is regarded as the world's largest container terminal, handling in excess of 32 million TEUs per annum (World Shipping Council, 2015). In comparison, the Durban Container Terminal handles about 3.6 million TEUs and was, until 2013, Africa's largest container terminal (Transnet.net, 2013). Container ships can carry goods from 3000 TEUs on the smaller vessels to as much as 15000 TEUs on some of the world's biggest containers ships. A truck typically carries one, two or even three TEUs (as 2 separate containers or one large 2 TEU container) per delivery. The system of delivery of containers is operated electronically since manual operation could be almost impossible considering the number of containers and the operations involved.

The operational area of a container handling facility is divided into three functional areas, namely, the quayside, the container yard and the landside (Brinkmann, 2011; Steenken et al. 2004; Ting, n.d.). Figure 1.1 depicts an overview of the container terminal operations which is described for easy reference in the following subsection:

The quayside is the area where the vessel sits alongside an inland wall called a berth. From there, a crane seated on land can reach into the vessel and load and offload

(load and discharge of a vessel) containers. The Container yard is an intermediate storage facility where containers awaiting shipment are stored for a few hours to a few days. Containers can be moved within the yard to prepare for load and discharge moves and between landside and quayside. In the landside, inland transporters, i.e. trucks and trains, are loaded and discharged of containers coming from the container yard. Trucks are subject to gate rules and bookings in order to enter and leave the container terminal.

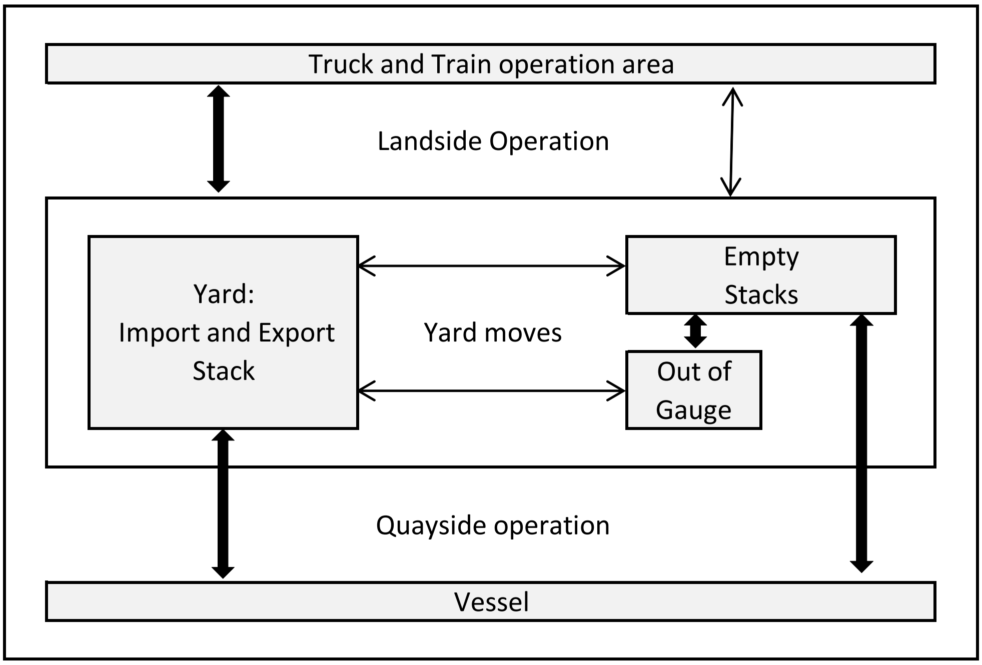

Figure 1.1 Container terminal operation overview

1.1.1 Container Terminal Operations

Operations are defined as the actions, processes and procedures that an organisation undertakes to take raw materials or resources and turn them into products or services (Kumar and Suresh, 2008). The basic container handling procedure follows a chain of events that runs within the container handling area to handle two types of transactions: import and export (Loke, Saharuddin, Ibrahim, Rizal, Kader & Zamani, 2014). During imports, a Ship To Shore (STS) crane lifts containers out of the vessel and places them on the quayside. A Container Handling Equipment (CHE) consisting of a Straddle Carrier or a Hauler Truck, removes the container from the quayside to the container yard. In such an operation, the logistics demand that a container, amongst thousands, be tracked from its original exporter, to its intended recipient without getting lost and timeously.

Tracking the movements of the containers in a container terminal is handled by the Planning department (Li & Yip, 2012) and operated electronically. At the container yard, the straddle carrier stacks the container with other containers in demarcated blocks. Containers can be stacked as high as four at a time in the block positions. Other terminals use Rubber Tyre Gantries (RTG) to load and offload containers from the haulers and place them in compact stacks that can be stacked up to six containers high. Later, those containers are then delivered to either trains or trucks delivered via straddle carriers, RTGs or haulers in conjunction with another CHE, the Reach Stacker. The system, once interfered with, stops the operations resulting in massive conduit disruptions causing immeasurable company loss in revenue. For exports, the process is handled in reverse. Loke et al. (2014) group these functions – ship operation, quay transfer operation, container yard operation and receipt/delivery operation – as the four main operation systems in a container terminal.

1.1.2 Planning

Yard planning is essential for efficient container operations (Li & Yip, 2012). Another type of planning that is deemed essential is Ship Planning where container positions are planned for stowage in the vessel and the vessels are allocated berths for load and discharge operations (Steenken et al., 2004). In operations, the planning department is responsible for the allocation of containers and instructions for the movement, stowage, stacking, load and discharge of containers in the vessels, yard and trucks or trains.

Rodriguez-Molins, Salido and Barber (2012) identify ease of access to the container at the time of retrieval as one of the main problems container terminal operations have to deal with in order to be efficient. The containers are loaded into the vessel in an order of “last in first out” and into planned positions on the vessel. Several days before the vessel arrives into port, the shipping line shares the load profile containing the sizes, positions and destinations of the containers. Thus, when offloading the containers, they are seated in the order from which they came from the vessel.

However, the arrival of the inland carriers for collection is in a random manner. This results in shuffling containers around the yard thus constantly changing their positions, which has proved challenging, thus resorting to ICT operations.

Planning needs to keep track of all container moves to ensure that they do not get lost. Operations are then responsible for the physical movement of the containers to their exact specified positions. For this to happen, ICT must always be available. In case it is not, some form of operation must be in its place to ensure continuous operation.

1.1.3 Terminal Operating System (TOS)

To plan and allocate for all these moves, the planning department uses an ICT system called the Terminal Operating System (TOS). A TOS is a fully automated software system designed to manage container terminals, to control delivery, storage, container processing and unloading operations at the container terminal, and to manage container terminal documentation in real time (Solvo.ru, 2013). The TOS serves, and is served by, labour, planners, supervisors, managers, liners, truckers, railroads, visitors, regulators, and analysts (Ward, 2013). According to Ward, a TOS impacts on both the tactical performance and strategic viability of the terminal, its customers, and its operator. Figure 1.2 depicts the general structure of a TOS.

1.1.4 ICT systems in CTO

The logistics of container terminal operations and planning used to be performed manually, however, according to Steenken et al. (2004), the processes have grown in complexity and is therefore done using computer systems. The TOS was first introduced in the 1980s (Kasiske, 2013) and has since become mandatory in the running of a container terminal (Younis, Kamar & Attya, 2010). This requirement is necessary to improve efficiency, eliminate loss of containers, maintain safety and take full control of the operation, and hence indispensable.

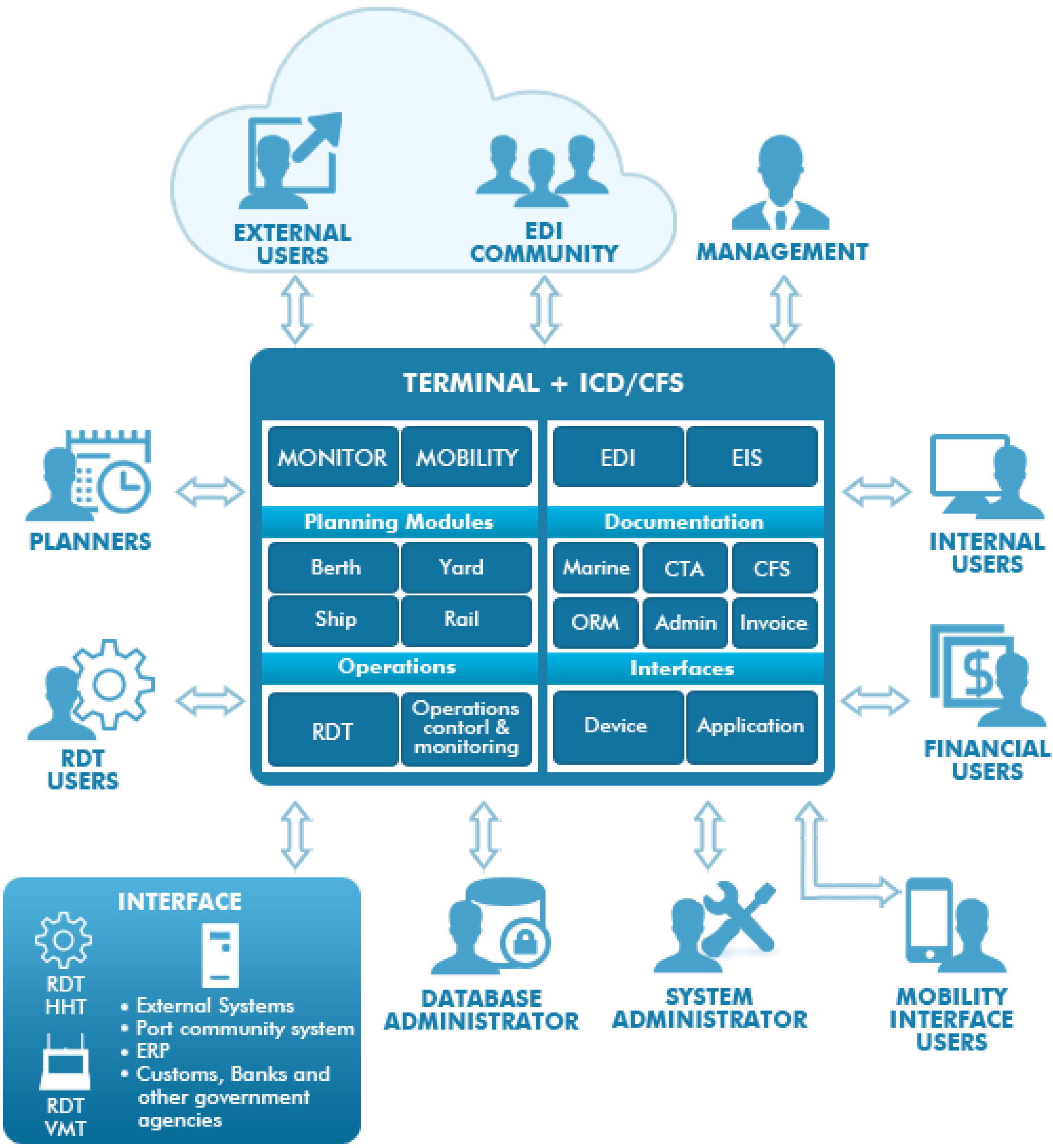

Figure 1.2. General structure of a TOS (Adapted from cmcltd.com)

Container terminal operations are reliant on four basic functions to operate namely

- Manpower – To perform all operations required in order to run operations.
- Equipment – Container handling equipment like cranes and straddle carriers.
- Electricity – Required to power the cranes, ICT systems and provide lighting at night.
- ICT Systems (TOS) – For planning and container handling management.

Without any one of these, operations stop, resulting in financial losses for both the organisation and its clients. The question which this study is investigating is: In case ICT, which is critical for container terminal operations, is unavailable, what should be done so that operations do not stop resulting in massive disruptions?

Loss, or unavailability, of ICT systems can be the result of several factors such as data loss, viruses or unavailability of ICT staff. An example can be a system crash caused by running an upgrade of an old system. Another loss may be caused by the unavailability of competent technicians to fix a problem. Currently, in a container terminal like the Transnet Durban Container Terminal (DCT), the TOS experiences loss of connectivity, thus becoming unavailable. When that happens, container handling operations are stopped because even though machinery is still physically capable of moving containers, they still need instruction from the TOS on what to do. In addition, since container positions are updated in real time, any movement of containers without instruction from the TOS will cause immediate disarray and containers will be misplaced. The sheer volume of the containers handled in a terminal like DCT rules out working manually with the intention of updating the system later. The system handles so many different types of transactions simultaneously that if they were performed manually, they would take many hours to reconcile, much longer than it would take to rather fix the problem and get the system back online. The use of an ICT system is critical to the successful operation of a container terminal (Valentina, 2014). Arguably, without a TOS there could be massive loss in productivity akin to a cessation in operations. Along with highly advanced machinery, the TOS is regarded as the main solution to improving efficiency.

The container terminal is a 24-hour operation and highly sensitive to the loss of the TOS. During container terminal operations, processes are highly coordinated and handled in a choreographed manner. All these are controlled by the TOS. When the TOS crashes for whatever reason, the entire operation stops and each time this happened, chaos ensued. There have been such incidences in the Durban port. There is therefore a need to establish what should happen in the loss of ICT Systems in CTO which has a negative impact on the delivery system of the port.

1.2 Statement of the Problem

Container terminals have a goal to operate efficiently and without interruption for 24 hours a day. Business disruptions to the 24-hour business model characteristic of CTOs call for a re-look into the business model of ports to ensure continuity, even during system downtimes. Such reconsideration and re-organisation of business models is not new and has been witnessed in various sectors such as the retail, transport, manufacturing and various service providers in different fields (Niemimaa, Järveläinen, Heikkilä & Heikkilä, 2019). Business model re-organisation and reconsideration is particularly urgent in the current digital economy, in which human and technological systems are not only intertwined with ICT Systems, but that the prior manual platforms on which they were modelled are becoming obsolete due to the influences of the Fourth Industrial Revolution (4IR) (Padayachee, & Mukomana, 2019). Further, as the environment within which these ports operate has increasingly become fluid and competitive, the ability to be resilient and maintain business continuity during and after system disruptions has become a critical strategic and operational issue for modern ports (Padayachee, & Mukomana, 2019). Prior research identifies various initiatives for realising a modernised port. For instance, Muhammad et al. (2018) advocates for the application of robotics and automation for improving port operations; Jun, Lee, and Choi (2018) view the application of Internet of Things (IoTs) as a critical enabler of port logistics; while Tijan and Aksentijević (2014) and Heilig and Voß, (2017) elevate the notion of seaport cluster information systems as indispensable to the competitiveness of ports, facilitating communication and decision making and for value-added port analytics and information services.

Due to their "natural location", container terminals continuously face infrastructure threats, manpower threats, planning threats, and security threats, all of which can cause major disruptions (Loh & Thai, 2015). When these threats become disruptive events, the consequences can have both short term and long-term adverse effects, some of which not only impact individual ports but also entire economies by straining trade flows and national logistics (Lam & Su, 2015). The resilience of container terminals after these adverse events is therefore a critical consideration for ensuring business continuity before and after disasters. However, contemporary research has placed more emphasis on disaster recovery rather than business continuity. For instance, Touzinsky, Scully, Mitchell and Kres (2018) advance the argument that disaster resilience has been well documented in the literature and has been enhanced by input from many different scientific disciplines; and that research in disaster recovery (DR) field for ICT systems is overwhelming (Mendonca et al., 2019). Nevertheless, while disaster recovery remains a vexing issue, the paucity of research in business continuity management (BCM) in the context of port operations provides traction for the focus of this study.

Thus, while modernising container terminal operations (CTO) is inevitable during the 4IR, uniqueness of context and frequent business disruptions, particularly in developing and emerging economies such as South Africa, calls for prioritizing business continuity management (BCM) as part of modernisation efforts. Focus on BCM is attributable to manmade and natural disruptive events that continue to negatively impact global supply chains, causing serious shipment delays, financial losses and sometimes the total breakdown of supply chain resilience (Niemimaa et al., 2019; Alesi, 2008). However, to motivate for effective BCM for CTO, newer digital platforms need to be considered that aid in realising resilient business continuity in case of disruptive events. For instance, in the wake of increased terrorist attacks and hurricanes/earthquakes, Saleem, Luis, Deng, Chen and Hristidis (2008) proposed a web-based model for pre-disaster preparation and post-disaster business continuity/rapid recovery, thus elevating the Internet as a viable platform as the foundation for BCM. The digital twin is deployed as a cloud-based service, allowing for simple deployment and scalability. Other researchers have called for extending the digitalisation of CTO by considering the use of IoT and cloud-based services to increase scalability and simplicity of BCM (Hofmann & Branding, 2019); adoption of cloud computing as part of a repertoire of key technologies for digitalisation of CTO (Inkinen, Helminen,& Saarikoski, 2019); the democratization of data management by using Big Data and Cloud Computing (Gamoura, 2019); and the use of Artificial Intelligence (AI) such as autobots or robots to improve context awareness (Shibuya & Tanaka, 2019). This study responds to these recent calls for improving pre- and post-disaster business continuity by motivating for a resilient cloud based BCM for CTO in the context of South Africa.

1.3 Aim and Objectives of the study

The aim of this study was to develop a Cloud-based BCM framework for sustainable container terminal operations. In order to realise the aim of the study, the following objectives informed the study:

i. Examine the impact of ICT on operations of container terminals

ii. Assess the extent to which container terminal operate in the event of a loss of centralised ICT systems

iii. Determine Critical Business Functions in operations that must stay operational

iv. Explore the current BCM practices with the aim of developing a framework for ICT continuity for container terminal operations during disruptions of centralised ICT Systems.

1.4 Research questions

The primary research question was the following: How can Cloud Computing be the basis of a Resilient Business Continuity Management framework for Container Terminal Operations? To address the primary research question, the following secondary research questions underpinned the study:

RQ1

What is the impact of ICT on operations in the container terminal sector?

RQ2

What are the critical processes and functions that a container terminal requires to stay operational?

RQ3

What are the current BCM practices that are employed by container terminal operations that respond to the loss of centralised ICT systems?

RQ4

What framework for BCM can container terminal operations use in the loss of centralised ICT Systems?

1.5 Significance of the Study

This study will contribute to the improvement of ICT operations in container terminals not only at Transnet but also in other container terminals globally. The intention of this this research is to encourage the Policy Makers and Practitioners to be drawn to this new method of business continuity - an ICT-based BCM approach - and to adapt it as an effective business continuity strategy that will benefit the container terminal operations. The outcomes to be considered consist of the following:

The updating of Policy to require the use of an ICT system to conduct BCM in CTO. This requirement is in line with the consideration of the 4IR and its aligned technologies which include Cloud Computing, IoT and the management of Big Data. Policy Makers can always refer to the framework presented in this study to provide a basis for this requirement. The evidence presented in the study is solid and calls for an urgent redesign and reconfiguration of BCM to move away from “manual” approaches to a cloud-based computing model.

Practitioners will also be able to benefit from the BCM framework as a technical guide based on the technology of their choice to implement their system for BCM. A cloud based strategy makes a good reference point for this particular implementation of BCM based on current technology usage. The inclusion of the Fit and Viability theory further cements the reasoning behind the usage of cloud computing as a BCM technique.

The study also provides a rich source of reference for Academia, particularly when considering the Actor Network Theory, or its counterpart, the Socio-Technical Theory by looking at how they can be considered for BCM for container terminal and other port operations. The study further examines the theory of Fit and Viability to further determine how it can be applied to research. This study's significance is bolstered by following a mixed method approach since it allows for a population-sourced information to add to literature.

1.6 Delimitations of the Study

Delimitations are constraints that a researcher imposes on themselves in a study. They are the boundary that a study is to be conducted within. This study was delimited according to the following four constraints:

1. Container terminal operations.
2. ICT systems that are used in container terminal operations.
3. Transnet Port Terminals and a small selection of other worldwide container terminals.
4. Business continuity based on the cloud.

1.7 Structure of the Thesis

This study consists of nine chapters which are arranged as follows:

Chapter 1 addresses a brief summary of the whole research, including the research topic and an exposition of the background to the research problem, statement of the problem, research aims or objectives and the structure of the research.

Chapter 2 presents a review of literature relating to ICT systems for container terminal operations, BCM and Cloud-based BCM

Chapter 3 presents the structure of the research by indicating the conceptual and theoretical framework and underpinnings that was followed.

Chapter 4 focuses on a discussion and rationale for the research design and methodology.

Chapter 5 presents the quantitative research findings which include data presentation and a statistical analysis of the results.

Chapter 6 presents the qualitative research findings which include the data analysis.

Chapter 7 presents the design of the BCM framework and describes how it can be implemented and summarizes the results of this study,

Chapter 8 draws conclusions from the findings, and make recommendations relating to the study and further research.

Chapter 2: Literature Review

2.0. Overview of Literature Review

In this chapter, literature on container terminals is reviewed, how they operate and how their operations are intertwined with the TOS. Literature is also reviewed on BCM, Cloud-based BCM and Disaster Recovery (DR). Firstly, we investigate what literature there is regarding CTO and the TOS, which is the main ICT System that container terminals utilise for operations. A presentation and critique of literature on the ICT systems which are used in container terminals is described along with how they assist in CTO and the impact that they have on CTO.

Secondly, we review literature that discusses the implementation of BCM in CTO. BCM on its own is an overviewing concept which is designed to be used for any type of organisation. Within an organisation, it needs to be applied according to department, or operation and function. After that, we review literature on the implementation and use of the cloud. Lastly, we investigate the usage of BCM and the Cloud.

2.1 Port Terminals

The modern-day port terminal started as the docks where all types of cargo used to be shipped from or to. There are different types of port terminals that are based on the type of cargo being handled, and these are (Steenken, Voß & Stahlbock, 2004):

- Roro terminals, which handle the import and export of cars.
- Container terminals (CT), which handle import and export of containers.
- Break bulk terminals, which handle the import and export of materials that are not of uniform sizes such as steel and timber.
- Bulk terminals, which move materials such as coal, woodchip, iron ore or sugar.
- Some terminals handle bulk goods like oil or gas and others can handle a mixture of goods like bulk and containers.

This study focuses on container terminals which are defined as port facilities for moving containerised cargo from ships to inland transport and vice versa.

2.2 Container Terminals in a global sense

In cargo, freight and logistics, container shipping is one of the most preferred methods of transporting goods. Container terminals are the port facilities in which container shipping occurs. Several studies (Steenken & Stahlbock, 2004; Günther & Kim, 2006) indicate that container shipping was already transporting about 60% of all goods that were being transported via deep sea shipping in the 1990s. This statistic, which is still relevant today (worldbank.org, 2015), suggests that container shipping is a major part of global trade. The rise in popularity of containerisation is attributed to containers being versatile and able to transport various types of cargo. Contents in a container remain unknown unless the container is opened and inspected or by checking the manifest. Their mobility, affordability, greater security, which results in low insurance costs; and standardisation, which is confirmed by Parker (2013) make them practical.

By 2015, China was listed by the World Bank as the most prolific shipper of containers at well over 155 million TEUs per annum according to worldbank.org (2015). Second to China is the United States at 44 million TEUs and then Singapore at 32 million TEUs (worldbank.org, 2015). These statistics translate to millions of individual containers with unique identifiers and which need to all be accounted for as they are being moved around. This is the essence of the need to employ ICT systems that can accurately track these items always within a short space of time.

2.2.1 Process flow of Container Shipping

According to Rodrigue and Notteboom, (2009), there are four layers of dynamics that relate to how containers are moved around the world, namely:

- The locational dynamic denotes the geographical location of the ports where vessel report to.
- The infrastructural layer regards the infrastructure provisions at the port of call.
- The transport layer deals with operation of transport services from start to finish.
- At the top, the logistical layer deals with the link between the customer and the shipping line

The logistical layer is the layer that involves the system which ensures that containers can move from point A to B correctly and in the most efficient manner (Figure 2.1.). The logistical layer and its sublayers; customer and shipping lines, are handled by terminal operations department who rely on the ICT system to operate machinery and move containers. Paixão and Marlow, (2003) regard terminals as bi-directional logistic systems which import containers to inland destinations and take containers from inland and export them to international destinations. The complexity of bi-directional logistic systems demands high coordination, which is possible via ICT systems, according to Paixão and Marlow (2003). For efficient operations, the terminal needs proficient usage of the ICT systems and equipment control by operations staff (Koumaniotis, 2015). Koumaniotis is of the view that the extent to which the ICT application is used effectively, is very reliant on operators. Ward (2013) is also of this view adding that ease of use of the system should be one of the main aims of the ICT systems.

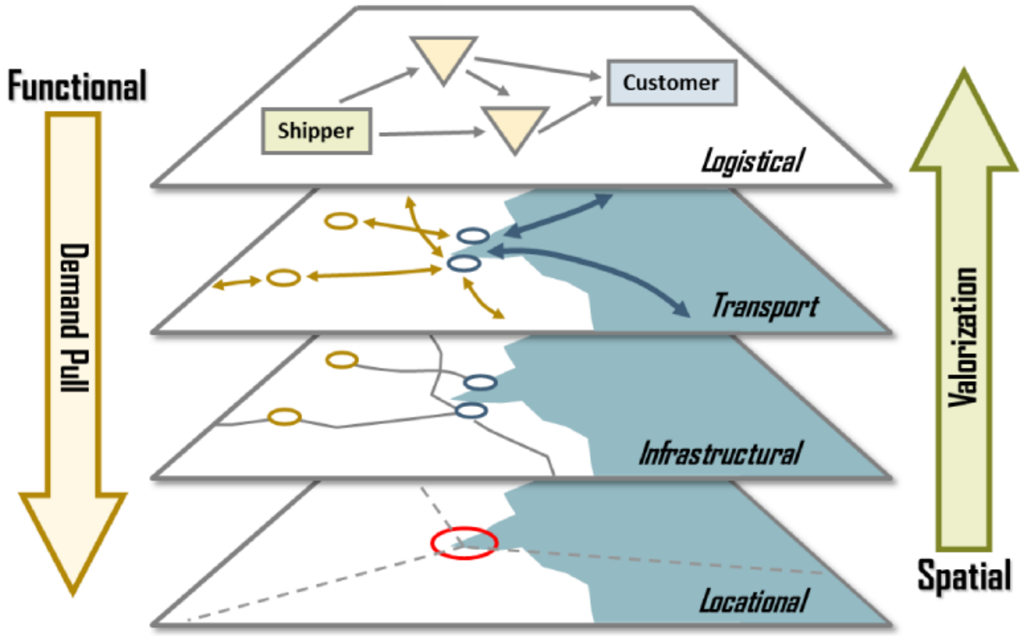

Figure 2.1: A multi-layer approach to port dynamics (Source: Rodrigue and Notteboom, (2009)

In part, the arguments set forth by the various authors above lend credence to this study's argument that operations in container terminals are highly complex and need some form of automation. Although Rodrigue and Notteboom, (2009) have summed up the logistics of container shipping into a simple bi-directional view, on the ground the complexity of bi-directional logistic systems remains. Views from a number of studies (Koumaniotis, 2015; Ward, 2013, Paixão & Marlow, 2003) indicate that the simplistic view of container movement should be complemented by simple processes. Paixão and Marlow (2003) further suggest that the complexity of the logistics systems should be handled by ICT systems which should be easy to use.

2.2.2 In-depth Understanding of Container Terminal Operations

When running waterside operations, a vessel is first docked along the berth. Once the vessel has docked and discharge operations begin, a Ship To Shore (STS) crane picks up a container from inside the vessel and places it either on the ground for the Straddle Carrier (SC) to pick up and move, or onto the back of a Hauler, for hauler-based operations, and then moved to a stack in the yard (Brinkmann, 2011). The serial number of each container is captured by a Cargo Controller (CC) into a Handheld computer Terminal (HHT) which then updates the Terminal Operating System (TOS). When loading the vessel, an SC picks up a pre-determined container from the stack and places it underneath the crane. A hauler operates by collecting the container from the Rubber Tyre Gantry Crane (RTG) and drives underneath the STS crane where the crane picks the container and loads it into the vessel (Stahlbock & Voß, 2008).

Figure 2.2. Mobile Data Terminals – VMT and HHT (Teklogix.com, 2013)

While the discharge operation begins the process by feeding data to the TOS, it is the TOS that guides the load operation process using work instructions. Inside the SC, hauler and the RTG, resides a Vehicle Mounted computer Terminal (VMT) otherwise also known as a mobile data terminal (Figure 2.2) which lets the operator use the TOS to receive work instructions (Rintanen, 2011). The information displayed by the VMT – i.e. the work instruction – contains the container number and its position in the stack along with the instruction that the operator must go and pick it up. Once the operator has done the pick-up, he/she updates the TOS with the VMT. Some terminals are also capable of issuing Work Instructions using voice command (Dematic, 2009), thus freeing the operators' hands to concentrate on steering controls. The access to and interaction with the TOS needs to be easy for the operators and that can be evidenced by the design of the data terminals. The data terminals run on well-known operating systems such as Windows and the interaction is further simplified by issuing simple instructions that require few responses. The result of simplified interactions like these is that there is an intended high dependency on the ICT system by operations. This dependency is what gives rise to the constraint on BCM when it gets applied manually.

2.2.3 Example of a set of Work Instructions

A series of events take place which include (Steenken & Stahlbock, 2004; Günther & Kim, 2006):

a. The TOS issues the next work instruction indicating where the container must be taken to.

b. The TOS gives the number of the STS crane, e.g. 525 where the container should be taken to.

c. The operator moves the container to the crane and then updates the TOS on arrival at the crane.

d. The crane lifts the container and loads it into the vessel and the crane operator updates the TOS.

e. The TOS issues the next instruction which can either be to pick up another container under another crane that is discharging or to go back to the stack and pick up a container.

Interactions like these create flow in an environment which has to operate in a conveyor-like fashion. Continuous operation is the main goal for container terminal operations and the reason why an ICT based BCM method is required. When operators no longer rely on vocal instructions on what to do, they work seamlessly. If there is loss of the ICT systems, operators must revert to vocal communication and this has delays productivity. Further work instructions according to Rintanen (2011), can be issued to operators to move containers around in order to get to a particular container in a process referred to as “shuffling”. Such moves, which are to pick up a container and place it elsewhere, take long to complete and as such, are considered unproductive. Functions on the TOS are very useful in avoiding these unproductive moves. The ability of the TOS to coordinate all these moves and avoid unproductive moves means that operations become highly efficient. Therefore, the TOS is responsible for a large amount of processing which surpasses manual processing. When processed manually (i.e. by humans), it can become a constraint to operations and possibly lead to mistakes.

The literature reviewed in this section indicates to us that at a micro level operation require a lot of sub processes. These sub processes, i.e. the movement of containers, have remained the same over the years according to these authors, and efforts have therefore been to improve on the management of these processes. There is agreement in the literature reviewed that the use of ICT systems improves the processes in any industry at any given moment. We can show the validity of these arguments by comparing the performance of the various processes when using ICT systems to different times when those processes were performed without ICT systems.

2.2.4 Measurement of container terminal performance

To show performance of operations (or productivity), we would need to measure it and compare figures from different times. Pernia (2014) identifies four pillars of operations that can be measured as; turnaround time, operational cost, berth schedule reliability and operational control and visibility. To improve performance, it has become the norm to rely on automation according to Pernia, and the use of ICT systems is the main form of automation that is used in CTO. Once performance is measured, it is possible to evaluate the impact of the factors that influence that performance. By contrasting the difference in performance levels between manual and ICT based processes, this study seeks to demonstrate the impact of ICT systems.

2.2.4.1 Commonly used productivity metrics (measurement of productivity)

The productivity metrics that container terminals are measured against to evaluate their performance can vary greatly. Comtois, Slack, Hall and McCalla (2011) for example, list some of the common metrics that terminals use:

- Truck turnaround time (TTT) is a measure of how long on average trucks enter the terminal, load or discharge containers and then leave the terminal.
- Ship turnaround time (STT) is a measure of how long on average ships berth at the terminal, load or discharge containers and then leave the terminal.
- Crane moves per hour, also otherwise known as Gross Crane moves per Hour (GCH) count the average number of containers that that a crane loads or discharges in an hour.

The metrics mentioned by Comtois et al. (2011) measure the same activities as Shayan and Ghotb (2000) of moving containers quickly in order to move the transporters quicker and make space for the next one. The TTT is used as a yardstick by both terminal operators and customers alike and can be a hot topic of discussion (Manaadiar, 2011; Mongelluzzo, 2004). Too high a TTT means that truckers are waiting too long to load or discharge resulting in a loss of productivity. Mongelluzzo (2004) also shows that the TTT is determined by activities inside the terminal, which also rely on proper and fast sequencing of processes which in turn, rely on ICT systems. The TTT is therefore a metric that is greatly affected by ICT systems since it relies on fast processing of trucks and load and discharge instructions. While Mongelluzzo (2015) blames many factors for truck congestion outside terminals for example, truck driver strikes, bad weather and large vessels at port, he suggests reducing high TTT by improving on automation in order to get trucks flowing again. As an example, an improvement of 70% on TTT at Abu Dhabi’s Khalifa port was directly attributed to the introduction of a new ICT application (Arabia 2000, 2014).

2.2.5 Benefits on Operations derived from ICT

There are many advantages and benefits that operations derive from ICT systems usage (Guan & Liu, 2009; Dowd & Leschine, 2006; Shayan & Ghotb, 2000) as follows:

- Faster operation when loading and discharging containers
- Faster turnaround times for container handling results in higher productivity
- Better stack management because of better monitoring of the storage of containers
- Much more accurate information in real time
- More consistent information shared easily between all stakeholders

The reason why the benefits and advantages mentioned are deemed as being better becomes clear when they are compared against paper based manual systems. In their simulation, Shayan and Ghotb (2000) demonstrated improvements of more than 25% reduction in costs and time and up to 43% improvement in stack occupancy. The benefits of using ICT systems help us realise the need to use ICT systems in operations. As indicated by Shayan and Ghotb (2000), work is faster, production times are better and so forth, when an ICT application is in place. Justification for these claims can be presented via demonstrable improvements which can be verified through contrasting performance metrics.

2.3 Terminal Operating System

Harris, Wang and Wang (2014) recognise the early sixties as the time around which ICT systems first came into use in the transport sector. Those systems, which were function-based, handled inventory management, transport routing, scheduling, planning, and billing systems. In the 1960s, the Electronic Data Interchange (EDI) format was developed to be used by the freight and logistics industry (Evangelista and Sweeney, 2003). EDI is the computer-to-computer exchange of business documents in a standard electronic format between business partners. It moved business to business transactions from a paper-based exchange of business documents to one that is electronic and, has been standardised to be used by any organisation (Copeland & Hwang, 1997). By 2005, more and more container terminals were starting to use computers to schedule and control different kinds of container handling operations (Gunther & Kim, 2005). Since then, container terminals have grown in size and complexity along with container handling operations and the vessels that call at the ports.

These days, it is hard to separate ICT systems and logistics (Evangelista & Sweeney, 2003). According to Barrons (2013), the first TOS was designed in the late 1980s by Navis for replacing and complementing the manual, paper-based systems which were used (Pelzer, 2011). They involved reporting measures, such as home-grown spreadsheets, wall charts, or in some cases, clipboards, pens and paper to record data that must be collected and processed at critical points in the gate, yard and quay (Barrons, 2013).

Container terminal growth can be invariably linked to the use of ICT systems. The introduction of the TOS gave terminals freedom to grow into the sizes that they are today and to continue growing. The TOS become a permanent feature of container terminal operations. Unavailability of the TOS hampers the essence of container terminals functionalities and availability should be managed properly to prevent operational stoppages.

2.3.1 Common versions of the TOS

There are many different vendors of TOSs based around the world. Table 2.1 illustrates different TOS products and their associated modules. There are five different TOSs in the table and each of the common modules are aligned with the associated modules in the TOS. Each TOS has different names for its modules and the table shows how the vendors have ensured that they cover the important functions that are required in CTO by providing a module that corresponds to the common modules. Information in the table was derived from vendor's website for Solvo, Tideworks, CITOS, Cosmos and Navis. This comparison of the different TOS offerings shows the important requirements for operations and how they are covered by the different vendors. It shows how vendors have each met the demand to fulfill the requirements.

Table 2.1: Common versions of the TOS

			TOS Vendors				
	Module	***Function***	***Navis***	***TideWorks***	***Cosmos***	***Solvo***	***CITOS***
1	**Berth Planning**	Allocation of docking and mooring of vessels	Berth Planner	Spinnaker	BAS	Vessel and berth planning	Berthing System
2	**EDI**	Automate transmission and receipt of EDI messages	XML interface	EDI Porter	Signal	EDI	TradeNet
3	**Yard Planning**	Allocation of space in the yard for containers	SPARCS	Spinnaker	SPACE	Yard planning optimisation	Yard Planning System
4	**Ship planning**	Allocation of space inside the vessel for containers	SPARCS	Spinnaker	SHIPS	Vessel and berth planning	Ship Planning System
5	**Resource planning**	Allocation of resources; ie. Manpower and machinery	SPARCS	Intermodal Pro	CTCS	Resource planning	Resource Allocation System
6	**Customer service portal**	Interface with which customer interact with TOS in real time	Customer N4 Links via Web Browser	Forecast	Corebis	Document management	PortNet
7	**Delivery interface (Gate operations)**	Manage truck movement and gate delivery	3rd Party (COSMOS, ZETES etc)	Gate Vision	AGS	Gate planning and processing	Flow-through gate
8	**Traffic (Equipment control)**	Movement of terminal equipment and containers	SPARCS	Traffic Control	TRAFIC	Equipment dispatching	Prime mover operations
9	**System Monitoring**	Check system health	Hyperic		TOM		

The table shows the important functions as follows:

- Module - Each function in CTO has a corresponding module that covers it. Each TOS covers the CTO functions by implementing its own corresponding module. e.g. for Berth Planning, Navis has a module called "Berth Planner" whilst TideWorks has a module called "Spinnaker".
- Function - explains what the module is for.
- TOS vendors - Represents the five vendors and their TOS products: Navis, Tideworks, Cosmos, Solvo and CITOS.

Some vendors do not cover all functions and they therefore utilise third party systems to cover the functions which they themselves do not provide; e.g., Navis uses Camco or Zetes as their gate interface modules.

2.3.2 ICT subsystems governing the TOS

There are four types of ICT subsystems that are used in container terminals as described by Nagarajan, Canessa, Nowak, Mitchell and White (2005) and are as follows:

Electronic Data Interchange (EDI) - The inter-company communication of data shared between the companies' computer systems. EDI contains information currently standing with one company and consisting of the positions, sizes, number and destinations of containers to be transported (Sternberg, Prockl & Holmstrom, 2014).

Decision Support Systems (DSS) Essentially this is an information system used by management and planners to synthesise data and generate information and recommendations for action, such as loading and discharging of containers (Murty, Liu, Wan & Linn, 2005).

Mobile Communication Systems (MCS) – Communication devices such as Vehicle Mounted Terminals (VMT) and Hand Held Terminals (HHT) that offer operators an interactive platform on which to receive instructions on moving containers.

Automatic Vehicle/Equipment Identification Systems (AVEIS) – A system to control road and rail traffic coming into and out of the port terminal. This eliminates the use of paper bases and manual capturing of rail and trucks and their container serial numbers by using Optical Character Recognition (OCR) and RFID tagging. An AVEIS can identify equipment moving in and out of the yard and identify equipment that is available inside the yard (Sternberg et al. 2014).

From a holistic point of view, there are a considerable number of systems to cover just about every need of operations. These services, the EDI, DSS, MCS and AVEIS are ICT subsystems that optimise operational processes. They represent a forward movement in the provision of services by eliminating a lot of manual handling of operational processes. Thus, a manual handling of these processes represents a step backward in the quest for more efficient operations. Working manually goes against the requirements of continuous and efficient operations and spawns the need for an ICT based BCM Framework.

2.3.3 Selection criteria for a TOS

The choice of a TOS is critical in CTO because the tactical performance and strategic viability of a terminal, its operators and customers, is dependent on the TOS at a very deep level (Ward, 2013). Ward feels that aside from the operational procedures, the TOS is the single, highest determinant of CTO performance and that even those CTO procedures, including the organisational culture, should all be built around the TOS. The TOS, continues Ward, should be transparent; that is, work unnoticed, to the labour force in the background and yet, provide an easy interface for labour to access commands.

2.3.3.1 TOS cost implications

Sokolov (2013) weighs in on the TOS choice by advising us to choose the TOS vendor after careful research, and warns us to not be parsimonious when it comes to investment in the TOS. Pitfalls may be encountered if the TOS choice is based solely on its licensing or implementation price while overlooking the potential cost of maintenance services. The vendor must also have a certified, tried and tested solution continues Sokolov (2013). Ward (2014) also warns us that if an operator gets thrifty with the TOS, they end up spending more, presumably in terms of lost billing, unchecked labour costs and not attracting more volume as a result of poor performance.

2.3.3.2 TOS scalability

Both Sokolov (2013) and Ward (2014) urge us to consider the scalability of the TOS by emphasising the need for the ease to customise the TOS when demands grow and processes change. While Sokolov looks at the modularity of the system, Ward delves deeper and recommends that we need to have stability, high availability and performance, among others.

2.3.3.3 TOS communication capability

Communication with operators and planners is of paramount importance to the terminal (Meersman, 2011; Ward, 2013). Both Ward and Meersman agree on the need to have the device intuitive and easier to use by labour. As Ward emphasises, labour is not there to determine where containers need to go, they just want to be instructed on where to take the container. Meersman adds that it is essential that those that are charged with choreographing the precise steps needed to run the operation and take every advantage there is.

Just as it is important to use ICT systems for optimising operations, it is also important to ensure that the TOS that is employed is sound. Apart from handling the various functions as presented in Table 2.1, a TOS needs to have strength in the characteristics mentioned above. The emphasis put on the proper choice of the TOS by the different authors illustrates that the TOS is essential for operations. Therefore, the final choice of the TOS, which is of something that can be considered an investment, needs to be above board. The product that the organisation will end up with will be probably be for a long term thus it will need to perform well. Performance of the TOS has already been deemed invaluable to the performance of the operations and the loss of such a system will severely hamper operations.

2.4 Alignment of the TOS with Operations

A review of extensive literature regarding TOS's reveals that there is a pattern that they all follow (Kim & Lee, 2015). Some serve around nine functions that by all intents and purposes are aligned with operations. According to Kim and Lee, these nine functions can also be aligned with the CTO. The nine functions are listed below and the first six will be discussed in the following subsections while the last three are common functions such as system monitoring, customer service and the EDI.

- Yard Planning
- Berth Planning
- Ship planning
- Traffic control
- Resource planning
- Delivery interface (Gate operations)
- Customer service portal
- System Monitoring
- EDI

Optimisation of operations within the terminal is of utmost importance since it accelerates service and reduces costs for moving containers (Mabrouki, Faouzi & Mousrij, 2013). The TOS, whose main function is to optimise operations, consists of modules that match the functions mentioned above. The breakdown of the component modules of the TOS is critical for understanding how the TOS works in relation to operations. Understanding of the relationship between the TOS and operations can help us figure out how much operations need the TOS. Operations can be seen as operating on two levels; a complex one and a simplified one. The TOS simplifies operations according to Kim and Lee (2015) and Mabrouki et al. (2013).

2.4.1 Yard Planning Module

Yard planning plays a major role in CTO. Yard planning consists of planning for the storage of containers in the yard in preparation for receiving, discharging and loading (Kim & Zhang, 2010) There are many different authors (Ku, Lee, Chew & Tan, 2010;

Won, Kim & Zhang, 2012; Ng, Make & Li, 2010) who have designed different models to approach the handling of containers when they are stored. While the various authors differed on which models to use, they agreed that there is no one size which fits all solutions. Ku et al. (2010) for example, proposed a mathematical IT search engine-based solution for yard planning, while Won et al. (2012) proposed a mathematical workload-based solution. The model that Ng et al. (2010) proposed is approximate and is based on an integer program intended to produce templates for yard planning for vessel services with a cyclical calling pattern. The common theme amongst all the authors is that the models that they proposed are heuristic models. This is very interesting as it confirms that there are many options to consider for many specific environments. The planning module is crucial for operations as it handles the high amount of decision making required for planning.

2.4.1.1 Mind-map of Operations in a Container Terminal

Li and Yip (2012) reminded us that whatever happens in the yard directly affects what happens on the quay. The sequence of container handling by operations, also known as a work queue, seems straightforward when explained by Li and Yip (2012) as follows:

- A container arrives by truck for export.
- The container is placed in a pre-assigned stacking location for exports.
- Containers are moved to specific storage blocks for certain vessels where they are arranged according to size, type, weight and discharging port.
- Once the vessels arrive, the containers are loaded.

2.4.1.2 Complexities of yard planning

Kim and Zhang (2010) highlight that the method of yard planning has been studied so many times by so many different authors because of its complexity. The yard operations that result in the proper placement of containers are in practice beset by complex practical considerations. These practical functions are also referred to as work queues and they are used to give step by step instructions to operators. This can also be explained by the reason why authors like Li and Yip (2012), or Kim and Zhang

(2010) are always writing about different methods of the best way to plan for yard operations. Li and Yip (2010) also list the following complexities that planners face:

- Many container handling jobs from yard to quay require collaboration from many different equipment types of resources
- Congestion needs to be avoided in the yard
- Containers need to be placed as close to the assigned berth as possible to shorten distances from yard to quay
- Containers should be stacked in adjacent slots in the block
- Containers should be easy to locate

Advice from Kim and Zhang (2010) is to spread the workload of containers into many storage blocks. However, those storage blocks should be close to the berthing positions of vessels to reduce travelling distances. The problem that Kim and Zhang highlight is that all these complexities must be catered for while taking into consideration limited resources.

2.4.1.3 Yard Planning Module Complexity Reduction

All the TOSs (Navis, Cosmos, TideWorks, CITOS & Solvo) studied while conducting this study, emphasise on how the systems improve the yard planning functions. Navis (Navis product documentation, 2011), for example, provides a tool that can be used to create a new yard from scratch. Users can then use Navis' SPARCS N4 to plan the actual container placement in the yard. Cosmos (Cosmos product brochure, 2013) provides similar functionality and highlights problems such as traffic congestion and unproductive moves, which it claims to resolve easily. The functions that Spinnaker from TideWorks (Tideworks product brochure, 2014) handles are yard space optimisation, automatic stowage and scheduling. The same can be seen on Solvo and CITOS; all of which are graphically based. Just as operations require, SPARCS N4 can be used to configure yard elements, determine geographic coordinates of the yard, associate transfer zones with yard blocks and so forth.

2.4.2 Berth Planning Module

Berth planning is basically the planning of the usage the quay by vessels (Kim & Lee, 2015). Steenken, Voß, and Stahlbock (2004) consider the length of time during which a vessel is moored at a berth, a measure by the shipping line of how well they are serviced. For a terminal operator, the process of mooring a vessel to a berth is a lengthy one involving appointments measured in time windows, servicing primary clients and determining the number of cranes that will be utilised (Hendriks, Laumanns, Lefeber & Udding, 2010).

2.4.2.1 Complexities of Berth Planning

Researchers have collated the complexities of berth planning into what they term the Berth Allocation Problem (BAP) (Hendriks et al., 2010; Meissel & Bierwith, 2008; Song, Cherrett & Guan, 2011; Liang, Hwang & Gen, 2011). In summary, a BAP is the problem of allocating berth space to vessels without prior knowledge of exactly what time they will be arriving. The complexities associated with BAP can be because of various factors such as late or early arrivals of vessels caused by tailwinds, storms or technical problems (Hendriks et al., 2010). This uncertainty is why vessels use an arrival window as opposed to a specific time. Complications also arise when a vessel arrives and finds another vessel still busy in its allocated slot (Guan & Cheung, 2004). Guan and Cheung point out variables such as multiple vessels mooring on a berth, whether vessel waiting is allowed or not and the length of processing time derived from vessel size; as being influential to the BAP. As a result, the various authors who tackle the BAP come up with a multitude of mathematical formulations in their attempt at simplifying things.

2.4.2.2 Berth Planning Module Complexity Reduction

A review of the TOSs by Kim and Lee (2015) determines that the berth planning module in a TOS should be able to estimate vessel arrival times, edit calling schedules, assign vessels to berths, allocate quay cranes and support ad-hoc vessel calls. Bartosiewicz (2014) feels that the berth planning module is essential in the optimisation of the marine side operations of a container terminal. The identification of conflict caused by multiple bookings to the same berth, vessel draft violations, channel conflicts and lack of confirmed resources to service the vessel, is made easier by the berth planning module.

The BAP is so prolific, that there are many different proposals for running computer simulations for berth planning. This gives an indication that berth planning can also be enhanced via computer simulations. An investigation of simulation by Hartmann, Pohlmann and Schonknecht (2011) draws a conclusion that the BAP can be simplified by playing around with the different presentable variables. Arango, Cortes, Munuzuri and Onieva (2011) support this view after determining that with simulation, the real environment can be aided to reduce vessel handling times by 14% and up to as much as 21%.

2.4.3 Ship Planning Module

In ship planning, the Stowage Plan is built on decisions about where containers will be placed on the ship for the upcoming journey (Monaco, Sammarra & Sorentino, 2014). Stowage planning is important, not only because it is key in determining the cost factor of the vessel, but also because it can determine the length of stay in port for the vessel. The length of stay, according to Monaco et al. (2014) also has the cascading effect on port fees, fulfilling schedules, sailing speeds (high speed uses more fuel) and, subsequently, environmental impact. Stowage of containers also determines the stability of the vessel. Heavier containers are stored at the bottom of the vessel with lighter ones on top to prevent the vessel from being top-heavy. For terminal operators, it also impacts on their operations since it determines loading cycles.

2.4.3.1 Complexities of Ship Planning

All the variables (port fees, schedules, sailing speeds, length of stay, container positioning) that get considered when planning for stowage, give rise to the stowage problem (Tierney, Pacino & Jensen, 2014). The subject of overstowage – part of the stowage problem – is a widely-studied subject by many different authors (Tierney et al., 2014; Monaco et al., 2014). This problem occurs when a container that is required to be moved, is stored underneath another one thus requiring that the other one be removed first. In a vessel, it can also be exacerbated by having the over stowed container located underneath a hatch cover which is holding many other containers.

2.4.3.2 Ship Planning Module complexity reduction

The ship planning module in a TOS is a graphical based tool which is used for planning. The standard view of most planning modules is presented in the Figure 2.3.

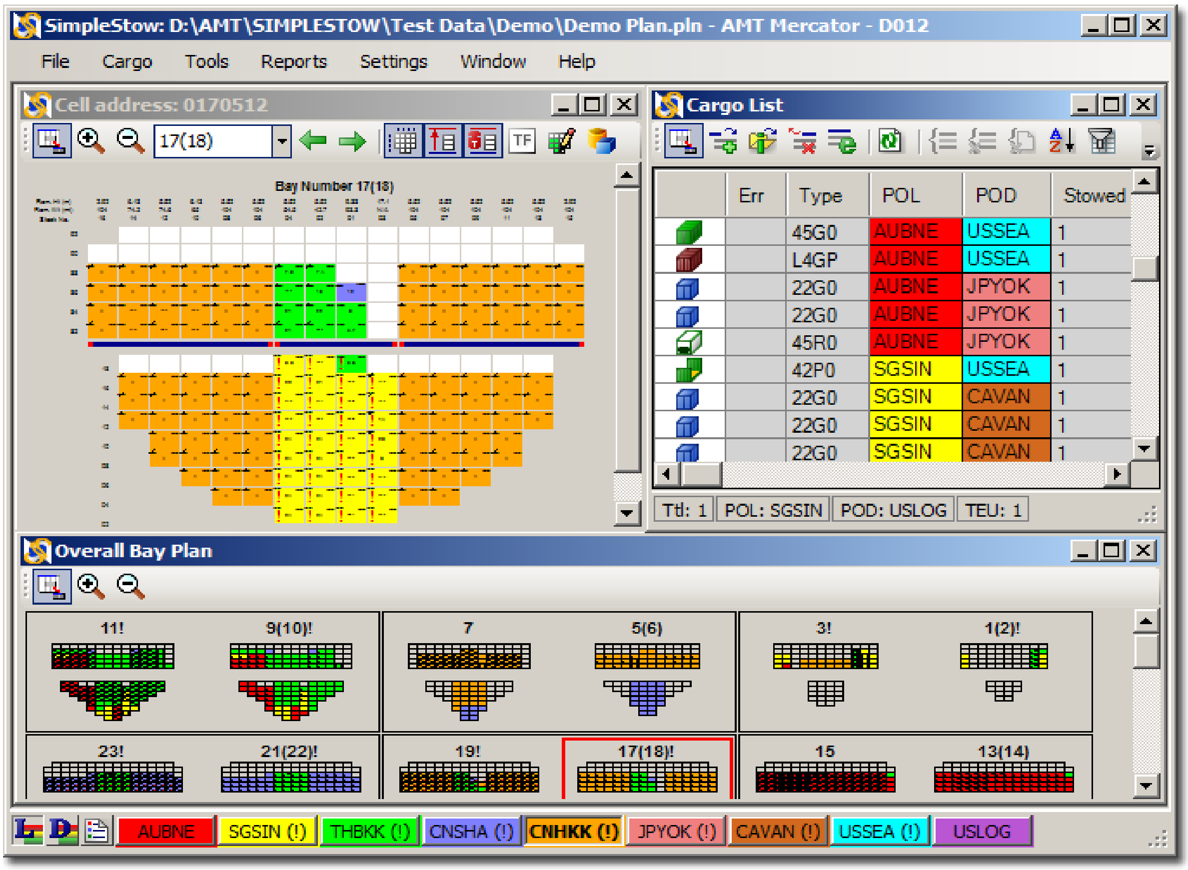

Figure 2.3: Example of a Ship Planning tool – adapted from (amtmarine.ca, 2015)

Figure 2.3 includes several windows that show the following items:

- Detailed view of a single selected bay,
- Overall bay plan or scan plan,
- Cargo List in the tabular form,
- Port Rotation bar.

A graphical based tool like this, can allow a single planner to plan for thousands of containers within one shift. The great thing about these tools is that they give error messages when they detect that a plan that a planner is working towards will be problematic. The planner can then make changes accordingly before confirming that plan.

2.4.4 Traffic Control Module

Traffic inside the container terminal refers to the equipment that is used to move containers around the terminal. In the yard operations, the task of moving containers is handled by the container handling equipment (CHE). The traffic in Container Terminal Operations (CTO) have been the subject of many studies from the Operations Research community over the past many years. Valuable insight and description on CTO has been articulated significantly by Günther and Kim (2005), Steenken et al., (2004), Stahlbock and Voss, (2008) and many others. Traffic in CTO is mostly geared towards the goal of moving containers for loading and discharging onto vessels. Other operations act as a sort of feeder functions, from the trucks and trains bringing export and fetching import containers, to the yard operations stacking and moving containers to and from the quay crane.

2.4.4.1 Complexities of Traffic Control

In their research for optimisation solutions for yard transfer operations, Vacca, Salani and Bierlaire (2010) identify several problems that affect decision making, such as vehicle routing and dispatching strategies. In situations where loading and discharging operations occur simultaneously and interactively with other equipment, the level of job assignment complexity is heightened (Lau & Lee, 2008). Lau and Lee feel that the complexity is such that computer simulation of the operations is run in order to squeeze out the best performance possible.

2.4.4.2 Traffic Control Module complexity reduction

CHE dispatching is one of the most important activities in container terminals. Figure 2.4 illustrates the various equipment that need coordination to facilitate CTO. Most modern-day researchers on CTO concur that control of this type of operation is so complex that it is best handled by computer systems (Bish, Chen, Leong, Nelson, Ng & Levi, 2007; Boer & Saanen, 2012). The overall aim of CHE dispatching in the TOS is to simplify instructions for the operators of the CHE. In the background, the TOS has to ensure that the traffic is routed properly to prevent congestion. The list of features in a TOS like Tideworks is aimed at specifically ensuring that the main aim and background processes mentioned above are optimised. A TOS can group certain moves together, monitor movements in real time and change instructions if a problem occurs that may cause stoppage.

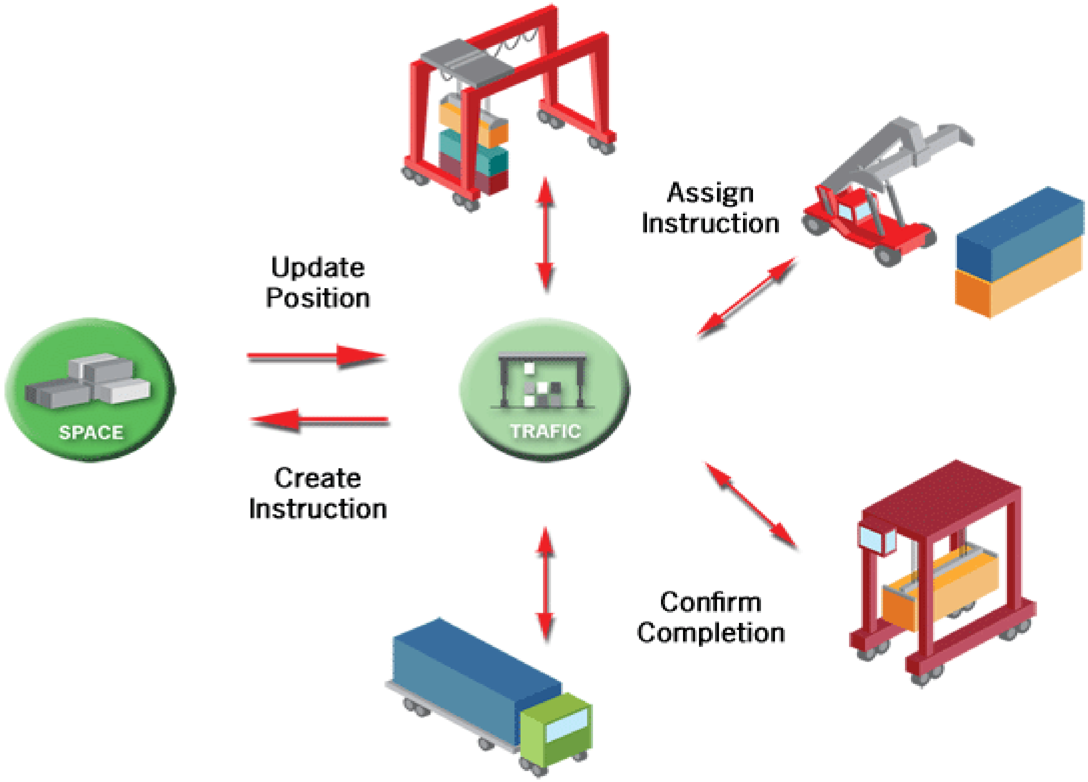

Figure 2.4: Traffic control module (Illustration from www.tideworks.com, 2014)

2.4.5 Resource Allocation module

Resource Allocation (RA) in a container terminal is a term used to describe how some resources which include manpower and machinery are strategically allocated to move containers around a terminal. The importance of RA is articulated in a description of CTO by Zaffalon, Rizolli, Gambardella and Mastrolilli (1998) and also in the descriptions of the TOS by Kim and Lee (2015). Zaffalon et al. (1998) argue that since terminals get their income from the movement of containers, and more resources mean more movement of containers, it therefore should mean that more resources should result in more income. However, they further point out that more resources mean more costs for the terminal on the other hand. Thus, RA should aim to bring the right balance between the costs and the income for the terminal by using fewer resources to move more containers. This RA problem is dealt with by many different authors who come with their own unique solutions. Zehendner (2013) for example, proposes a mathematical model to forecast future allocation of straddle carriers and human resources, and for task allocation. Jin, Han and Higuchi (nd) on the other hand propose the use of computer simulation.

2.4.6 Delivery interface (Gate operations) module

The operations' processes at terminal gates are described by Lun, Lai and Cheng (2010) and Kim and Lee (2015). Lun et al. (2010) discuss that in gate operations, lanes are allocated, trucks weighed, containers inspected and documentation is handled. All these activities are handled by personnel who can then redirect truckers should there be any problems. Kim and Lee (2015) on the other hand, give a more detailed list of the procedures which they then describe as being simplistic. The only difference here is that simplicity of the procedures which Kim and Lee (2015) describe is based on the use of the TOS rather than the use of personnel. This is very important because by relying solely on the automation, the human element and the problems humans may bring are eliminated. Lun et al. (2010) separate gate operations into what happens to trucks at the gates and what happens to the trucks inside the terminal which is where trucks are directed to their allocated interchange areas. Kim and Lee (2015) also highlight the fact that gate and truck movement controls tie in with the RA within the terminal.

Optimisation of the gate operations can be combined with the TOS in order for it to be efficient. All the operations mentioned above can be automated via the use of Radio Frequency Identification (RFID), Optical Character Recognition (OCR) and Differential Global Positioning System (DGPS) and strategically placed cameras for inspection (Zehendner, 2013; Way, 2009). The inclusion of such technology speeds up operations because trucks can simply drive through portals without stopping and truckers are able to interact with the TOS in a simple user interface that is offered by the Gate Operating System (GOS), thus eliminating paperwork. A GOS's main function can be viewed as that for elimination of the human element. It eliminates the need to manually control external traffic movements and guards against losses of containers and fraud while speeding up the process.

2.4.7 The impact of the TOS planning modules on CTO

The impact of ICT systems in general has been established by authors including Sternberg, Prockl and Holmström (2014). They conclude that increased information availability is the main catalyst for improved efficiency and that increase is facilitated by ICT systems. The effort necessary to plan for operations as described by the various authors (Li & Yip, 2012; Kim & Zhang, 2010; Zehendner, 2013; Way, 2009; Bish et al., 2007; Boer & Saanen, 2012) is coordinated via the TOS. All vendors that were considered in this study offer products that have robust modules which cover every planning step that is required by operations. Therefore, the TOS is essential to the planning department for them to create the work plans that operations follow. The planning department can plan for the efficient use of resources in the different areas of the terminal because of the ability of the TOS to effect changes in real time. Such ability is essential for CTO because of the unpredictable nature of arrivals of vessels and inland transport.

The impact of the TOS and the GOS on operations has been shown. By describing the processes that planning and operations follow we can see the complexity that planning and operations face when they operate without the ICT systems. The TOSs ability to handle those processes seamlessly has allowed the TOS to completely take over those processes to the point that there are no longer ways to perform them manually.

2.5 The need and role of ICT systems in CTO

Many authors agree that ICT systems play a vital role in CTO to such an extent that operations in a modern-day container terminal cannot take place without an ICT system in place. By combining literature from Stahlbock and Voß, (2008); Rodrigue and Notteboom, (2009); Koumaniotis, (2015); and Shayan and Ghotb (2000), we can determine that ICT systems have a high impact on CTO.

The benefits achieved by CTO from the TOS that Dotoli et al., (2010); Kamwela and Kampelewera, (N.D.); and Pilat, (2004) describe mean that ICT systems have taken complete control of the processes that CTO need to execute their duties. Therefore, if the TOS was to stop working, operations have to stop and wait for the TOS to be restored.

Another author (Lucas, 2003) also emphasises on the use of ICT Systems to complete a transaction. In his description, Lucas lists the following steps:

- Shipping line indicates when it will be arriving and applies for berthing space by sharing the EDI
- Operations planning begins preparation on the TOS
- Planning determines whether containers will be transhipped or imported or exported
- Containers are moved around at the yard to prepare for loading
- The vessel is loaded and discharged and the allowed to set sail

Lucas effectively reinforces what other authors have been saying; that ICT Systems are basically what runs all operations in a container terminal. Another author (Zehendner, 2013) takes a holistic approach to the reason why ICT systems are necessary for CTO. Zehendner provides a rundown of the different technologies that optimise the utilisation of ICT systems in CTO. The growing use of technologies such as RFID, OCR and DGPS means that more and more terminals are becoming more efficient than before. By looking at the factors that put pressure on CTO (Increasing volumes and vessel sizes, space restrictions and severe competition) Zehendner concludes that optimisation by ICT systems is the best manner to handle CTO.

The labelling of ICT systems as an enabler by Khalfay (2011) is an apt definition of the importance of the role of ICT systems. This importance is necessitated by the high volume of containers that are handled in the hundreds of container terminals worldwide. The reviewed literature from porttechnology.org shows that container terminals operate similarly and use mostly off the shelf ICT systems like Navis and

Tideworks. Because each terminal operates similarly, it means that standardisation of operations is possible, which leads to standardisation of ICT systems that are able to operate in a similar fashion.

When looking at the history of ICT systems for container terminals we can see that going back into the sixties, transport and logistics were already using ICT systems to conduct their operations. This has allowed over the years for ICT system capability and usage to grow to such a point that they have almost completely done away with manual systems. The fact that almost all shipping lines make use of the EDI forces container terminal operators to employ ICT systems in order to exchange information about containers between themselves and shipping lines. This is just part of the flow of information that is the major force that drives container handling. Without the TOS, CTO would be a logistical nightmare (Hanley, 2004).

2.6 The TOS in African container terminals

Most container terminals around Africa have started using TOSs to process container shipping. Cases reported by various maritime publications (Sudan Sea Ports Handbook, 2016-2018; Kenya Ports Authority Handbook, 2014-2015; Ghana Ports Handbook, 2016-2017) show that the implementation of ICT systems by container terminals is on the rise. Arguably, these implementations are viewed as essential introductions of optimisation via ICT as evidenced by the way they are reported as news in maritime publications.

The Sea Ports Corporation (SPC), an independent state corporation of Sudan that governs, constructs and maintains the ports, harbours and lighthouses of Sudan. SPC operates and manages the following ports of Sudan:

- Port Sudan
- Al Khair
- Osman
- Digna and,
- El Zubir,

The SPC setup is similar to the Transnet Port Terminals (TPT) setup which runs a number of ports located around the country. The difference between SPC and TPT is that SPC uses its own in-house TOS (n.a.1., 2016). Information on the architecture of the TOS used by SPC indicates that it runs on an Oracle database.

The Ghana Ports and Harbours Authority (GPHA) is the national port authority of Ghana, responsible for the governance, maintenance and operation of the ports of Ghana. GHPA operates and manages the following ports:

- Port of Sekondi-Takoradi
- Port of Tema, and
- The Fishing Harbour at Tema

The two ports of Sekondi-Takoradi and Tema handle both break bulk cargo and container cargo. GPHA uses the Navis TOS for its container handling operations. This is separate from the break bulk terminals which use the Jade Master Terminal Operating System (n.a.3. 2016). In Maputo, a new version of the Zodiac terminal operating system went live in March 2014, offering further improvements to terminal performance and efficiency (n.a.4., n.d.).

In 2008, the Kenya Ports Authority (KPA) installed the Kilindini Waterfront Automated Terminal Operations System (KWATOS) (n.a.2., 2014). KWATOS is described as an application which automates container, conventional cargo and marine operations in the Port of Mombasa. After its implementation in 2008, KPA had to halt all operations when the system went live and experienced a number of glitches (Wanjiku, 2008). Most of the problems experienced with the implementation of KWATOS were due to poor project management whereby users were not properly trained on using and supporting the TOS. Further details on the architecture of KWATOS are not available in literature.

Apart from South Africa's TPT, there is scant information on the use of the TOS in other African ports, possibly this is due to the small size of the ports and therefore volumes handled by the ports. Furthermore, the use of in-house ICT systems which are therefore not widely promoted outside of their use areas, robs us of acquiring any useful information about them. This sample of African ports that utilise the TOS for their operations, some of them only recently, shows that the use of the TOS is on the uptake amongst African terminals.

2.7 The TOS in Asian port terminals

Asia contains some of the largest container terminals in the world. A look at some the largest terminals in Asia reveals how implementations of the TOS in the large terminals are being managed.

2.7.1 The TOS at Singapore ports authority

The Port of Singapore Authority (PSA), one of the top three biggest container terminals in the world, considers ICT Systems to be their most important infrastructure element (Lee-Partridge, Teo & Lim, 2000). ICT Systems became so important that PSA invested hundreds of millions of dollars, such that they became the largest computer network in Singapore, according to Lee-Partridge et al. (2000). The size of PSA's investment in ICT can be witnessed through the number of subsystems that have been developed by PSA (Branch, 2014):

- TradeNet – EDI system
- BOXNET – Coordination between PSA and hauler for container movement
- CITOS – Computer integrated information system
- CMMS – Crane maintenance and monitoring system
- CICOS – Computer integrated conventional operating systems
- CIMOS – Computer integrated marine operating system
- PMIS – Personnel management information system

Multiple subsystem applications like CITOS are usually the result of major investment by the proprietor. When such large investments are made, it is possible that there is much better and improved resiliency of the system. However, information on how continuity is handled for such a large system such as CITOS is not available.

2.7.2 The TOS at COSCO (China Ocean Shipping (Group) Company)

The China Ocean Shipping (Group) Company, also known as COSCO, is a major port operator that has invested heavily in IT systems for port environments (n.a.5, 2010). COSCO enterprises introduced an office automation system and invested capitals for independent development and introduction of an information system based on nature of the business, so as to improve working efficiency and realise information sharing. COSCO have so far developed their own system called Mutlimodal - FOCUS, a system which runs their entire cargo supply chain and provides multimodal cargo transport agency information service for COSCO Logistics. The system is an operational and management information coordination system compatible with all sectors of international cargo agency business and it realises visibility of entire business and management processes.

COSCO Container Lines, also known as COSCON, the container shipping subsidiary of COSCO, invested capitals to promote upgrade of the Integrated Regional Information System (IRIS-2) and optimise and improve the performance of their existing information system. The upgrade also accelerated the informationisation construct of ships based on technological innovation. The amount of investment and optimisation effort by COSCO in their IT systems implies that the information systems used by COSCO improves their overall container operations. COSCON leveraged a service-oriented architecture (SOA) to improve overall corporate agility, thereby streamlining its shipping and logistics-related operations and improving its competitive advantage over rivals (Barnes, 2006). This implementation was meant to consolidate its overly scattered domestic and international EDI systems onto a common J2EE and Web-services-based platform and to reduce the cost of maintaining and modifying its core IT system, while simultaneously increasing response time to business change requests.

The architecture employed by COSCON is similar to that used by TPT for their Navis infrastructure. Some of the problems indicated by Barnes (2006) are also similar to those facing TPT. For example, TPT is highly intolerant of any IT based disruptions. These disruptions can cause shipping delays, container delivery delays and low customer satisfaction. Its centralised nature means that should the entire IT system become unavailable, a business continuity system should be in place to cover the unavailability.

2.7.3 The TOS at Hong Kong International Terminals

Hong Kong International Terminals (HIT) runs on an ICT application named Next Generation Terminal Management System (nGen) which was implemented in 2005. nGen is an application which was developed in 2003 by Hutchinson Ports and is in use at more than ten ports including in Spain (Terminal Catalunya), China (Huizhou International Container Terminals), Panama (Panama Ports Company) and Australia (Brisbane Container Terminals) (n.a.7, 2012). It controls the entire scope of terminal operations, including ship and yard planning, gate operations, and vessel operations; plus, overall operations monitoring, equipment utilisation, productivity, and costs optimisation (n.a.6, n.d.). The system runs on industry-standard, open-platform technologies such as Java and XML and is scalable across all non-proprietary computer system hardware. nGen provided real-time operator alerts where each control staff can customise more than a dozen automated alerts to suit different situations. These alerts not only allow operators to take the appropriate action at the appropriate time but also relieves the need to constantly stare at the computer screen to look for problem areas.

Features such as the ones offered by nGen are what keep operations working more efficiently and optimally. Information is not available however, on the resiliency of the application or on how HIT continues with operations when the nGen is not available.

2.8 The TOS at Transnet Port Terminals

As a collective, container terminals that are run by Transnet Port Terminals (TPT) use Cargotec's Navis as their TOS. As illustrated in Table 2.1, Navis has various subsystems which cover the different modules and also relies on external vendors for some of its subsystems. Figure 2.5 depicts a simplified view of the basic architecture of the Navis system for TPT which was derived from the architecture documentation (Multi Terminal Transnet Environment Prod 2.6, 2016).

Currently, the Terminal Operating Systems (TOS) is based on a central database. Nodes that represent each container terminal connect directly to the central database. From each terminal node, there are two connections; one for the planning department and the other for operations. Each terminal node holds temporary data while a transaction is being processed. Transaction times vary depending on the terminal's performance, but can take between 30 and 45 minutes to complete. Once the transaction is complete, the terminal node updates the central database. The components of the TPT Navis system in Figure 2.5 are briefly described as follows:

- TOS DB - TOS DB is the central, main database which stores and run the TOS. On the TPT Navis system this is where the central Navis system which overlooks the entire country is implemented and the main administration is performed.
- TOS DB (Terminal Level) - At the terminal level, the TOS DB interacts with the central database while being directly connected to the planning computers and the data terminals in operations.
- Planning and OPS - The computers that are used by the planning department and the data terminals that are used by operations are represented by the Planning and the OPS labels. These devices connect to the terminal level TOS DB.

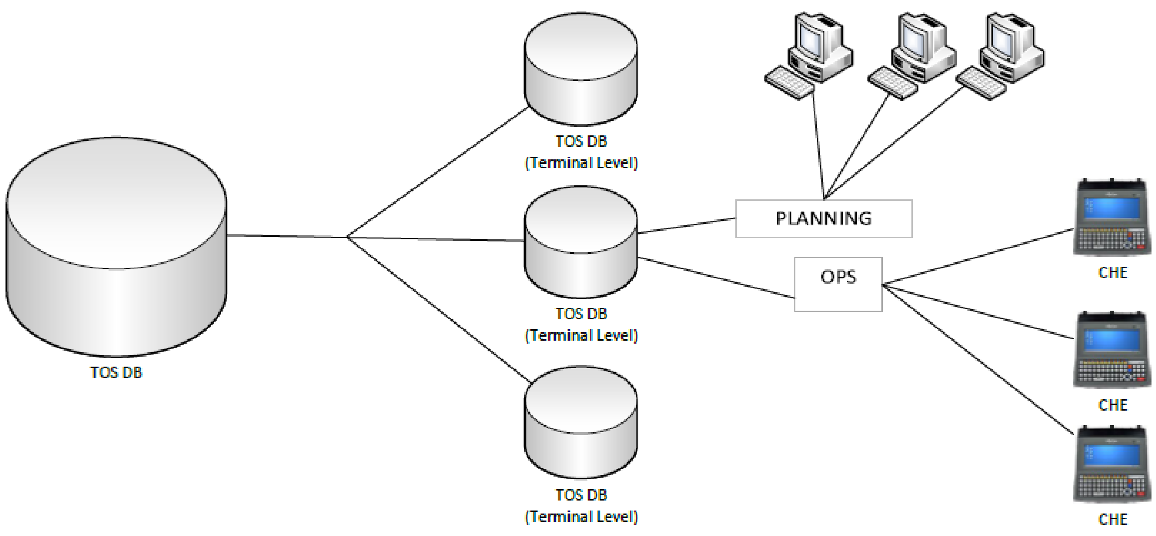

Figure 2.5: TPT Navis system layout (TPT Navis documentation)

2.9 Pros and Cons of the TPT TOS architecture

TPT's six container terminals access the centralised Navis database via WAN links. The local databases each use their own local Gate Operating Systems (GOS) and other subsystems such as radio servers. Navis transactions are completed at local level and then updated to the central database. There are pros and cons associated with this type of TPT TOS architecture setup.

Pros of having a centralised TOS database are:

- Cost effective system due to consolidation of servers and infrastructure.
- The ability to have a single view of the movement of containers through a single source.
- Easy to maintain single database as compared to multiple databases.

Cons of having a centralised database are:

- High dependency on network services adds more variables into play.
- There is always a single point of failure
- Requires expensive resilience architecture.

The current layout of the centralised database at TPT results in the stoppage of operations in the large terminals when the central database becomes unavailable. The architecture documentation for TPT shows that the centralised database architecture that TPT uses is a unique implementation. This design was made unique to TPT because of requirements set forth by TPT in terms of the advantages that it would bring for TPT as indicated in the pros and cons above.

2.10 Cloud Computing

Cloud computing has its roots back from the beginning of computing. The history shows the computing began with mainframe systems that eventually evolved into the modern-day desktop and mobile device computing systems that we have (Rittinghouse & Ransome, 2010). In its basic sense, the cloud consists of hardware and software, storage, services and interfaces for delivering computing over the internet and saves the client from having to host these services themselves (Hurwitz, Bloor, Halper & Kaufman, 2010). Cloud computing doesn't need to be provided only by an outside service provider, it can also be sourced internally or as a combination of both, according to Hurwitz et al. (2010).

The definition, technical specifications and framework of cloud computing are set out by the United States' National Institute of Standards and Technology (NIST). Some studies (Dagleish & Gallagher, 2013; Hurwitz et al., 2010) presented their definitions and frameworks according to the standard as set out by NIST. The standard sets out these four characteristics that all cloud computing must follow to be recognised as such (Mell & Grance, 2011):

- Elasticity and scalability
- Self-service on demand
- Broad network access
- Resource pooling
- A billable and measurable service

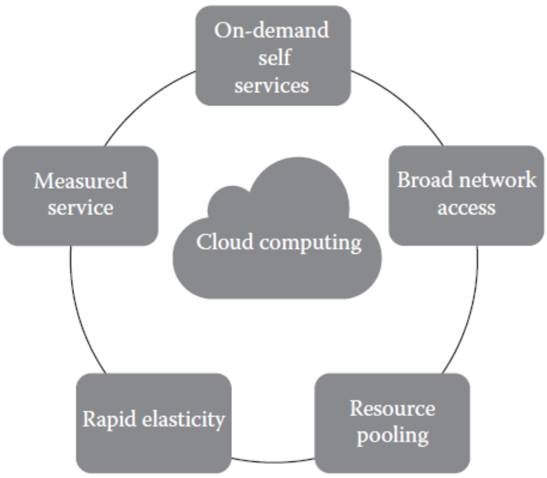

Figure: 2.6. Characteristics of cloud computing (Chandrasekaran, 2014)

2.10.1 Pros and cons of cloud computing

One of the main debates around the use of cloud computing revolves around whether to use the cloud for an organisation's computing needs or not. The debate is usually in the form of a pros and cons that are weighed against each other to come to a conclusion. Rittinghouse and Ransome (2010) see characteristics such as reduction of total cost of ownership and maintenance, scalability, quick development and deployment of software, ease of use and access as some of the main advantages. Security and privacy issues usually come up as the main cons against using cloud computing with many authors and professionals citing it as a concern. Baiju (2014), for example, recommends the use of cloud computing as a backup plan for disaster recovery. In the same article, however, Baiju (2014) is concerned about the safety and privacy of important data stored remotely and commingling with other organisations' data. Other concerns do crop up such as the interoperability and performance issues or the relative lack of understanding of cloud computing as noted by Rittinghouse and Ransome (2010) and the problems with availability as mentioned by Hurwitz et al. (2010).

The underlying issue, it can be argued, is that one needs to view the pros and cons of cloud computing based on their organisational needs. For example, when weighing the pros and cons of in-house cloud computing versus outsourced, one may also need to consider laws governing the handling of public information (Dagleish & Gallagher, 2013). For example, if an organisation wanted to outsource the cloud services because of cost effectiveness, regulations like the POPI Act in South Africa can be restrictive when it comes to processing data outside our borders (Watson, 2015). Chapter 9 of the POPI Act, which deals with trans-border information flow, states that a responsible party may not transfer personal information about a person to a third party that is in a foreign country unless this operator is bound by an agreement that upholds the principles of the reasonable processing and protection of the information (Vester, 2015).

2.10.2 Cloud Service Models

One of the main attractions of cloud computing is the fact that the client only utilises what they want from the cloud (Hurwitz et al., 2010). The three main types of services that the cloud can be used as are when it is being used as a platform, for its infrastructure and for providing software. These three services, professionally known as Infrastructure as a service (IaaS), Platform as a service (PaaS) and Software as a service (SaaS) (Rajaraman, 2014), give a client a wide choice of what they want to get from the service being provided by the cloud.

In the IaaS service, clients bring their own software and make use of the infrastructure, i.e. server hardware, network connection and all the supporting infrastructure such as power and location. PaaS and SaaS are additions on IaaS that are used by IT clients such as developers and end users. Using the IaaS service also serves as one of the main advantages of using a cloud service. In what Rajamaran (2012) terms 'self-healing', the IaaS means that a service is always available through resilience provided by the service provider. With a good service level agreement, a client can be assured of an "always on" service.

Cloud computing is a promising ICT service delivery model that has already had a significant impact on government agencies SMEs and large organisations according to Herrera and Janczewski (2014). This kind of service delivery framework can be used in port environments to improve their operations as well.

2.11 Cloud computing in the operations environment

The versatility brought about by cloud computing has resulted in a considerable number of organisations which are operations-based, such as the manufacturing sector, adopting the technology (Field, 2015). Such organisations are reported as citing ease of IT support from a central location, and greater efficiencies, as their reasons for moving towards cloud computing. According to Field (2015) organisations that have switched to cloud-based solutions such as ERP have been able to get their operations back up to optimal speed from disruption faster than they would have without cloud-based solutions.

2.11.1 XVELA System

A cloud based system called XVELA that was implemented by Hapag-Lloyd, a shipping line, has been touted as game-changing (Mooney, 2016). The system is expected to reduce the number of unexpected changes at short notice and improve waiting times for the container line and terminal. According to Mooney (2016), the system provides visibility into the progress of berth operations and ultimately allows a more efficient deployment of vessels, while also providing more transparency for terminals, allowing them to allocate equipment and staff in a more productive manner. Advances in sensor technology for equipment mean a lot more real-time operational data is becoming available. This can be advantageous for operations equipment that needs to move around while maintaining access to the central IT system.

2.11.2 Business continuity and cloud computing

Although cloud computing is mostly used for efficient delivery of ICT systems to users, it can also be used as a versatile disaster recovery and business continuity platform (Pyle, 2010). This view is supported by several authors including Kleyman (2014) who feels that there are several applications in which cloud computing can be used for business continuity. Both Pyle (2010) and Kleyman (2014) feel that using cloud computing for business continuity would be cost effective since it sets aside ownership and maintenance costs. This view is pertinent considering how the cloud service provider will ensure high availability for their services and connectivity costs can be negligible from an organisation's perspective. However, cloud computing is not being used extensively as a business continuity solution, according to Miora (2011).

Giffin (2015) cautions against using the cloud as a solution to business continuity without fully understanding how the cloud works. According to Giffin (2015), we should never assume that there is complete data protection and retrieval possibility from the cloud. Obstacles such as bad Service Level Agreements (SLA) and service provider stability can present unforeseen problems at a critical time. For example, if a cloud service provider goes out of business without warning, the data could be lost in an instant. However, disasterrecovery.org (n.d) sees benefits such as elimination of maintaining backups, off-site storage, efficient implementation and scalability as strong cases for business continuity and disaster recovery in the cloud. The consensus from these authors (Pyle, 2010; Kleyman; 2014; Giffin, 2015; Miora, 2011) is that cloud computing should be used for business continuity since it offers so many benefits and although there are risks, they can be managed. Data centres are also more than likely to be managed by professional IT people who will ensure that all proper procedures are adhered to, argues disasterrecovery.org (n.d).

2.12 BCM in Container Terminal Operations

In this subsection, we review literature on BCM application for CTO. We review the application of the manual type BCM, which is commonly used when ICT Systems fail, and determine whether that will be sufficient for CTO. We also review what other container terminals around the world use for their BCM during the loss of ICT Systems.

2.12.1 BCM in the context of organisation resiliency

Business Continuity (BC) is defined as the capability of the organisation to continue delivery of products or services at acceptable predefined levels following a disruptive incident (ISO 22301:2012). Business Continuity Management (BCM) is a management process that identifies risk, threats and vulnerabilities that could impact an entity's continued operations and provides a framework for building organisational resilience and the capability for an effective response. One of the major components of BCM is the Business Continuity Plan (BCP). The BCP is a strategic plan that is applied during a disruption to allow a facility to keep producing its critical products or services at an acceptable, predefined level (BCI GPG, 2010; Morganti, 2001). Morganti (2001) emphasises that the cause of the disruption is immaterial and that what matters is how to keep the facility going during any disruption and how to quickly recover. This argument is supported by authors and publications on BCM including the BCI GPG, (2010), ISO 22301:2012 and Kadam (2010) among others.

In an introduction into BCP, Hiles (2007) stresses the importance of having a proper BCP that is not just geared for computers, but for the organisation as a whole. Kadam, (2010) weighs in about the BCP saying that it is meant for all levels and sizes of organisations and that, even at a personal level a person can develop a BCP. Spence, Moyer and Novick (2011) view BCP development as a form of social responsibility that is borne by organisations.

2.12.1.1 BCM vs Resiliency

Many authors (Woods, 2013; Bird, 2007; BCI GPG, 2013) on the subject of business continuity discuss the confusion that surrounds the concept and definition of BCM. The confusion includes among others, defining BCM as a disaster recovery, or as a risk management strategy. However, Woods (2013) offers a very good attempt at clarifying the issue. By placing BCM into the context of organisational resiliency (see Table 3.1), Woods (2013) demonstrates how BCM should be placed amongst and not include the other concepts.

Table 3.1. BCM in the context of organisations resiliency (Woods, 2013)

	BC	Security	Crisis	Emergency	DR (IS)
Anticipate	x	x	x	x	x
Prevent		x			
Protect	x	x	x	x	x
Respond	x		x	x	x
Recover	x		x	x	x

Table 3.1. shows that BCM covers the same aspects that Crisis Management, Emergency Management and Disaster Recovery are responsible for in an organisation. However, as Woods (2013) and the BCI GPG (2013) argue, these are not inclusive of each other, but rather refer to each other. Bird (2007) gives a very interesting discussion of how differently BCM is viewed in different countries around the world. In the USA for example, BCM is seen as being for commercial organisations whereas for its federal government, the USA calls BCM the ‘Continuity of Operations Planning’ (COOP). According to Bird (2007), many countries have tried to separate BCM from risk management or at least define BCM as a subset of risk management.

Although the inter-referencing between BCM and other resiliency methods brings about confusion, it is necessary because BCM can also “borrow” some of the aspects of those methods (Paton & Hill, 2006). In line with this argument for example, BCM can employ some disaster recovery techniques such as mirroring to use during disruptions. Although this may be termed as simply disaster recovery or prevention, they can also be viewed as BCM since they provide a means for continuity. So, for example, although we can have mirroring for many applications such as load balancing, processing speed and disaster recovery, we can also use the same mirroring for BCM. However, mirroring for example, will not satisfy the entire implementation of BCM since it is not immune from other problems such as poor application or architectural designs.

A BCM implementation needs to cover the causes that have been identified as part of the risk assessment strategy. According to Paton and Hill (2006), to create a resilient organisation, business continuity planning requires three core elements namely;

- Availability of Management and Information Systems (MIS) for the facilitation of continuity of core business operations;
- Crisis management systems and mechanisms for managing the transition between routine and crisis operations and,
- The implementation of competencies and systems that will ensure continuity while functioning in atypical crisis operating conditions.

What is notable about these elements is that they are not prescriptive about what methods, processes or systems should be used to attain business continuity. Any method, system or process can be employed if it will help achieve business continuity.

2.12.1.2 BCM in port environments

Business continuity management is widely implemented in port environments such as airports. Airport environments provide many different customer-centric services such as car rentals, restaurants, tourism services, recreation and other businesses which can be affected by a major disruption of the airport itself (Lohn, 2015). When airports fail to function, and do not effectively recover from prolonged disruptions, the cumulative economic risk from the negative multiplier effect on dependent businesses cannot be ignored by airport operators and management (n.a.8, 2014). This may also affect the insurance and liability risk, the contractual and legal risk, airport operators, and state and federal regulations. There have been studies discussing approaches to airport continuity which share some similarities with the goal of ensuring continued functionality of sea ports during crisis situations (Thornton, 2008). In a discussion on the development of business continuity plans for the Australian Customs Service cargo, Thornton (2008) looked at the continued operation of urgent customs clearance in the face of a full or partial loss of key information technology systems. Thornton (2008) found out that since its implementation in December 2006, the new BCP has on all occasions successfully facilitated the reporting and clearance of legitimate cargo until normal services have been restored.

Halliwell (2008) offers an explanation on how to differentiate between normal operations and when there are considerable business disruptions and to plan for those accordingly, by looking at how Air New Zealand used BCM to help ensure its continued survival. Smith (2008) for example, discusses the maintenance of airport operations following natural disasters, as airports are often used as a central location to distribute aid and act as a temporary shelter.

These studies stress the need to have proper implementations of BCM in strategic environments that cannot afford to be stopped by disruptions of any kind. Although they are based on different aspects of the same environment, they still demonstrate that for each type of disruption, there should be a specific and workable BCM. The implementation of BCM in airports (Or any other environment for that matter) needs to provide a usable solution. BCM needs to be implemented across the entire airport environment. In the literature reviewed, Halliwell (2008) looks at disruptions to an airline, while Thornton (2008) looks at disruptions to customs and Smith (2008) looks at disruptions on general operations. All these authors conclude that BCM should be implemented to cover these products and processes. This shows us that BCM can either be considered at macro level or the micro level environments.

2.12.1.3 BCM in the Context of Container Terminal Operations

Literature on the subject BCM discusses BCM in its general sense, for example BCI (GPG, 2013). BCM is usually presented in its holistic form, but never presented in the context of specific causal factors. This top-level approach does not indicate how BCM should be applied in the context of container terminal operations and thus raises the following question: "How do we provide business continuity for operations when ICT systems become unavailable?" which has not been addressed in the literature on BCM that has reviewed. From this question, we can also identify two variables; business continuity for operations and loss of ICT systems. Business continuity for operations is a dependent variable of loss of ICT systems since loss of ICT is what causes the need for continuity of operations. Loss of ICT system is the independent variable since business continuity has no influence on it.

Several authors including Slack, Chambers and Johnston (2010), that mentioned BCM described it as an emerging topic or a growing field. In their brief discussion of BCM, Slack et al. (2010) list power and telecommunications failure, computer system failure and key personnel leaving, becoming ill or dying, amongst others, as some of the events that lead to disruptions in operations. Slack et al. (2010) discuss the subject of Failure Management under the subject of Risk Management, a completely different field of study. Their solution to operations disruption is the utilisation of what they term “replacement offices” as a variation of cold sites. This lack of literature of BCM in operations meant we had to study BCM separately from operations and then marry the two together by evaluating how aspects of BCM can be implemented into operations.

2.12.1.4 Manual BCM at TPT

A review of the BCM for continuity of operations at TPT (Navis System BCM March, 2016) revealed that it is designed to run manually when there is no ICT application availability. This plan calls for both import and export containers to be brought into the terminal. However, on the same token, none of the containers can leave the terminal either with the trucking companies or the shipping lines. Although the BCM is well established and has been distributed to stakeholders, it is never used in a large terminal like DCT. Several reasons account for this (Navis System BCM March, 2016):

- Invocation is scheduled to start after an hour unless the Terminal Manager deems it necessary to start sooner.
- The BCP calls for a declaration that the outage will last longer than an hour.
- Very few outages last for longer than an hour and are hard to predict how long they would last for.
- Operations have to wait for invocation from the Terminal Manager.
- Working manually has many challenges and causes too much communication over radio.
- Containers get lost very easily when container handling equipment operators do not follow instruction on where to place them.

- Work plans need to have been printed in advance which they usually are not since the system is in operation more than 99 percent of the time.

Smaller terminals including the following, make use of the manual BCM method since they handle an average number of containers per day as given in brackets; Cape Town (923), East London (120), Port Elisabeth (279), Ngqura (706). However, at DCT, which currently handles an average of 3800 containers daily, working manually is highly inefficient as discussed in this section.

2.13 Current ICT system setup at TPT

Details and reasons for the current system setup at TPT have been discussed in Chapter 2. Figure 2.5 illustrated the current setup of the TOS at TPT on which this study is partially based.

2.13.1 Challenges with the current setup

In Chapter 2, we discussed the pros and cons of having the kind of setup used at TPT. The cons associated with the setup in Figure 2.5 were the single point of failure, addition of complexity due to high dependency on network services and the requirement of high resiliency which brought higher cost to the setup.

2.13.1.1 Single point of failure

A single point of failure (SPOF) is a potential risk posed by a flaw in the setup – or a system component – that can cause an entire system to stop operating (Oracle.com, 2011). According to Garmany and Burleson (2004), systems become unavailable for three main reasons: application failure, hardware failure, or maintenance. Oracle.com (2011) lists hardware failures, software failures and database corruptions as the major causes of SPOF. These problems listed by the authors sum up the issues that plague ICT systems in every setting. All these failures can be mitigated through redundancy systems, however, they can, despite those mitigations still fail and therefore need to be covered through BCM.

2.13.1.1.1 Application and database as causes for SPOF

With the TPT TOS setup, the fact that there is one central database makes it an SPOF. This is given rise by different major components of the setup i.e. the database itself, networking and the application. As discussed, the TPT setup consists of terminal level database and TOS implementations that update the central database as soon as transactions are complete. The full technical details of how these transactions are carried out are outside the scope of this study, however, it is worth mentioning that transactions need to complete in order for new transactions to start and to proceed to their next steps (Navis product documentation, 2011). Application failure occurs when a request causes the application to fail. This failure includes anything from human errors that crash a system, to program exceptions that crash the application. According to documentation from Oracle.com (2011), application failure can include the following:

- Excessive response time
- Poor storage configuration
- Cache issues
- CPU constraints

These failures can be caused by numerous different problems which include human error and hardware problems. Even if many different kinds of mitigations have been employed, there is still a high chance that some failure will occur and thus render the database unavailable. If the database (server) becomes unavailable, i.e. it no longer accepts and processes end-user requests; it will have resulted in an SPOF.

2.13.1.1.2 Networking as an SPOF

Failure at the network level can be mitigated by having redundant network components. However, despite this, networks still fail from time to time (Anderson, 2012) and thus the need for BCM. Although the entire network may not crash, sections of the network can crash and therefore prevent access to the main application and database server. Therefore, the network, and portions thereof become an SPOF that needs to be covered.

2.13.1.1.3 Hardware as an SPOF

Hardware failures, for example, server crashes, network failures, power failures, or disk drive crashes are major causes for system downtime. Hardware failure is less and less the reason for systems being unavailable. Most large multiprocessor UNIX computers, for example, are fault tolerant and will bypass bad memory or a failed CPU until it is repaired (Garmany & Burleson, 2004). Disk drives have become very reliable, and disk arrays can be configured to tolerate multiple drives that do fail. A disk array that is striped and triple mirrored has a mean time between failures measured in decades according to Garmany and Burleson (2004). These redundant systems however, do not totally eliminate hardware problems and they still occur in the best of systems setup.

2.13.1.1.4 Maintenance as an SPOF

System maintenance can be a complicated problem to overcome as an SPOF. On the one hand maintenance needs to be performed for every type of system, on the other, performing maintenance means temporarily rendering the system unavailable. If the system goes unmaintained it can start to experience problems which they themselves cause downtime, so maintenance needs to be performed! Failure to properly back up the application server to include the Metadata Repository database repository is to risk losing the entire system and having to reinstall the application server and your application (Garmany & Burleson, 2004). Application updates are also another major system maintenance that needs to be performed regularly. Mitigations such as redundancy and scheduled downtimes can be employed to help cover for system downtimes, however, they do not totally eliminate the downtime. Therefore, coverage for system maintenance downtime needs to be provided for through BCM.

2.13.1.2 High dependency on networking

Being part of a system means that networking will always need to be available. The network can act as an SPOF or it can present multiple points of failures. When looking at the broader picture, a network is needed for connection between databases and the main database and also between end-users and their local databases. The network is also needed to connect mobile end user devices such as VMTs and HHTs to the system. This method of operation is what adds to the complexity of ICT systems for CTO and therefore needs to be covered for via BCM.

2.13.1.3 High resiliency demands

As has been discussed in this chapter, major ICT systems need resiliency to be in place to manage or avoid downtime. Many of today's ICT systems use highly resilient technologies to circumvent against downtime. However, using highly resilient systems in an environment does not always provide the best possible protection for workloads, as it's still possible for web servers and databases to go down (Anderson, 2012). An important caveat to factor in is the high cost of highly resilient implementations which according to Desmond (2012) are inescapable. The two main disadvantages of highly resilient systems according to Uvindasiri (2015) and Wilson (2011) are the high cost and the maintenance required to keep them up. Highly resilient systems, while costly, are nevertheless a staple of most major ICT system implementations. However, since highly resilient systems are not a 100% guarantee against failure they need to be covered via BCM.

2.14 Gaps in BCM in the context of ICT systems in CTO at TPT

ICT systems have been widely adopted as an effective and efficient means of controlling operational processes in container terminal operations. Their wide scope of reach means that they are heavily relied on, if not entirely relied on by operations. Large organisations, it can be argued, will have measures in place to ensure that there is little, if any, disruption to their business processes. One of the best ways to ensure this happens is to implement BCM to cover every aspect of their business operations. It would therefore be expected that container terminals will implement BCM that covers disruptions to operations which are caused by unavailability of ICT systems. It would also be expected that such an implementation would be easy to revert to, lest it does not become usable. However, the following gaps have repeatedly been found in the literature on BCM implementations for the unavailability of ICT systems:

- A gap on literature on BCM for container terminal operations. This leaves us with no starting reference when reviewing literature and thus forces us to rely on literature from other industries such as airports etc. which have considerable literature (Lohn, 2015; Thornton, 2008; Halliwell, 2008 & Smith, 2008) for BCM in their contexts. For container terminals Slack et al. (2010) investigated only the factors that lead to disruptions in operations without going into how they can be covered in terms of BCM.
- Non-use of an ICT based method for business continuity to continue with operations in container terminals. There is no discussion of a seamless invocation of BCM when the ICT system becomes unavailable. The BCP for continuity of operations at TPT (Navis System BCM March, 2016) is clearly aimed at running operations manually when there is no ICT application availability.
- Reliance on manual based BCM methods leaves many implementations of BCM not being usable due to inefficiencies. This is a major constraint on the current implementation of BCM. The GPG (2013) emphasises on the ease of use when implementing BCM in an organisation. This can be demonstrated by the constant need to perform practice runs on a regular basis in order to familiarise employees with BCM practices. A manual method, the currently available method, is not viable and usable in large container terminals.
- Little or no adoption of cloud computing for the hosting of the terminal operating system. Some organisations have started using the cloud for hosting the TOS, however, these implementations are still new and not many organisations have adopted the cloud for their TOS implementations. According to Miora (2011), cloud computing is not being used extensively as a business continuity solution when it actually should be getting implemented for it. The view is shared by authors such as Pyle (2010) Kleyman, (2014), Giffin, (2015), Miora (2011) and disasterrecovery.org (n.d) who feel that cloud computing is easier managed and should therefore be used for business continuity.

2.15 Gaps in literature

Table 2.1 summarises the available literature that presents gaps on literature:

Table 2.1. Summary of literature review

Research Study	**BCM Implementations**	**Gaps**
Lohn (2015) Thornton (2008) Halliwell (2008) Smith (2008)	Available for airport environments	BCM for implementations in airport environments is abundant and clear. There is no similar literature for BCM in container terminal environments.
Slack (2010)	Lack of container terminal BCM	BCM solution not included for implementation in container terminals.
Navis system BCM for March (2016)	Lack of ICT based BCM	BCM only planned for manual implementations.
GPG (2013)	Lack of easy to use BCM implementation	Manual BCM not easy to revert to and therefore not widely used.
Miora (2011) Kleyman (2014) Giffin (2015) disasterrecovery.org	Lack of BCM in the cloud	Although BCM in the cloud can be implemented easily, currently, hosted BCM and DR for container terminals is not widely used.

BCM is an important tool in any organisation. Although many organisations do not widely practice it, it is nevertheless highly recommended from an organisational governance point of view. In this chapter, we have through literature review, concluded that BCM can be used in CTO for when there is a disruption in the ICT system. We have also found that using a manual type BCM is not viable for a large container terminal and thus a different method needs to be established.

The following chapter will look at the theoretical framework of the study.

Chapter 3: Theoretical Underpinnings

This chapter explains the theoretical underpinnings of this study. Firstly, we discuss the theoretical background and which theories our study is based on. Secondly, we determine the concepts that guide the study after which we elucidate the conceptual framework that the study is based on.

3.1 Theoretical background

The proper functioning of a container terminal operations system relies on a symbiotic relationship between workers, machinery, processes and technology. When one of these elements is absent, the system ceases to function. The failure of the TOS results in a cessation of operations until the TOS is restored. In a 2017 ransomware attack (Hackett, 2017; Perlroth, Scott & Frenkel, 2017) which attacked global systems by encrypting and wiping out data, the Indian container terminal of Gateway Terminal India (GTI) was affected (Bhuyan, 2017; Jadhav & Rocha, 2017). This attack exposed CTO who, in the absence of ICT systems were forced to stop operations until full system functionality was restored.

There are several theories that look at the gaps above and the gaps presented in Table 2.1. Much of the theoretical work focusses on the presence or absence of elements in a system and conclude how the presence or absence affects the systems. This study seeks to indicate the relationship between the different elements in a system and how by maintaining that relationship, the system can be kept functioning. These elements are addressed by the Socio-Technical Theory, Actor Network Theory and the System Theory as explained below:

3.1.1 Socio-Technical Theory

In Socio-technical theory (STT), organisational systems require the merging of both the technical and social aspects while treating them as interdependent parts of a complex system (Baxter & Sommerville, 2010). This theory argues that it is the fit between the technical sub-system (devices, tools and techniques) and the social subsystem (employees and the knowledge, skills, attitudes) which together makes up the organisation. This interdependency means that relying on one system without the other may lead to the organisation failing to achieve its efficiency and productivity goals. The two main principles of STT are that:

- it is the interaction of the human and technical factors that create the conditions for organisational performance, and that,
- as a consequence of the above, ignoring one to favour the other (e.g. during optimisation or change management) is injurious to the system's performance.

According to Whitworth and Ahmad (2014) socio-technical system (STS) can be viewed as a social system operating on a technical base such as email and other systems-based tools.

In the context of this study, the TOS can also be viewed as the technical base on which employees rely to perform their duties. Thus, STT can support the argument that without the TOS, or with a degraded TOS, the organisation will fail to achieve its goals. In CTO, the goal is to move containers around efficiently and safely. The entire CTO system involves humans, machinery, the TOS etc. If one of them goes missing, e.g. in our context, the TOS, then the whole system ceases to function. The impact of the TOS has already been determined and demonstrated that without the TOS, CTO does not only become degraded, but it ceases to function outright. Although the STT is normally applied during systems design, its underlying principles affect the overall outcome of the functioning system. To support this theory, we can look at two other theories namely the Fit-Viability model, and a Management Theory-based theory referred to as System Theory. These are discussed in the following sub-sections:

3.1.2 Fit-Viability Model

The Fit-Viability Model (FVM) (Tjan, 2001) was used as the analytical framework for this study. The theory was used, in the manner espoused by Ochara (2013), as a linguistic device for inductively accumulating, organizing and synthesizing research findings for the purposes of evolving a new theory/model or framework. The FVM is undergirded by two constructs: fit and viability (Figure 2). The dimension of fit measures extent to which the feature of a technology matches the needs of the task

(Liang *et al.*, 2007). The fit dimension arose from the work of Goodhue and Thompson (1995) on task-technology fit (TTF), in which they contend that a greater fit between technology characteristics, task requirements and individual abilities would result in improved performance.

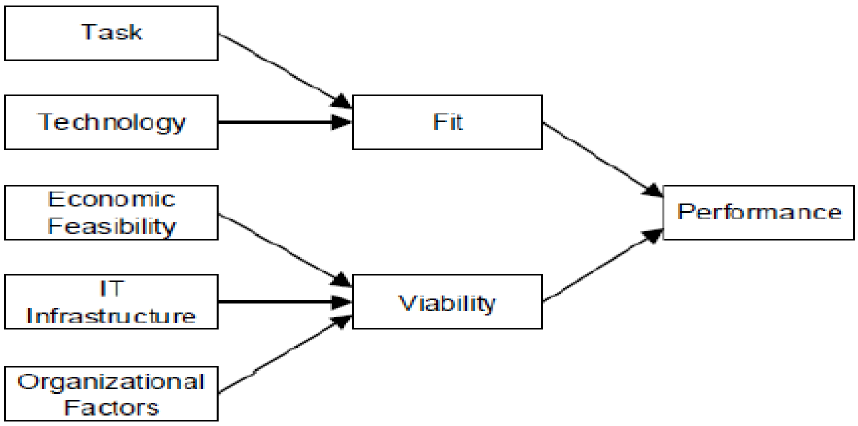

Figure 3.1: Fit-Viability Model (Source:(Liang et al., 2007)

Viability measures the degree of value addition of a new technology's applications, human capital requirements and capital requirements (Liang *et al.*, 2007). Liang *et al.*, (2007) reiterates that the focus viability is the assessment of the extent to which the infrastructure of the organization is ready for adopting the technology by looking at three dimensions: (i) economic feasibility – whose emphasis is on a cost benefit analysis of the technology and the expected returns to determine whether a competitive advantage can be created; (ii) organisational factors relating to top management support, ICT literacy and skill, user readiness and innovation experience; and (iii) ICT infrastructure, whose emphasis is on the physical and virtual ICT requirements, and includes considerations for computing, information management, and ICT services and platforms. In the context in this study, the FVM was employed to assess the "fit' and "viability' of cloud computing as a platform that can be used as the foundation for evolving a BCM framework for container terminal operations in South Africa.

The study considered the various antecedent problems which lead to the loss of ICT systems in CTO. It found that issues including networking, within the Campus Area

Network (CAN) of CTO, was one of the primary reasons for downtime. Other reasons were server crashes, WAN connections and database-related problems. By relying on the FVM, we were able to evaluate the fitness and viability of alternative means of connectivity, alternative server infrastructure and alternative databases. These solutions tie-in neatly to the FVM when looking at cloud computing. We found that the cloud fit the requirement that;

a) The solution be off-premises, Thus, in the cloud,
b) The solution required a separate network for connectivity, thus, adding a 4G (or 5G if available) connection would be fit for the purpose,
c) The solution be seamlessly available, thus, the use of a Hot Site.

While considering the viability of the solution, we were able to conclude that although the usage of a hot site was an expensive option, it would still be economically viable since the losses associated with stoppages would very quickly far outweigh the costs associated with implementing the hot site. The conclusion was, therefore, that a cloud computing platform would be a fit and viable solution to use in the BCM framework.

3.1.3 System Theory

The definition of a system shows many different interpretations which although similar, seem to be based on context. For example, a Google dictionary search defines it as a set of things working together as parts of a mechanism or an interconnecting network. The business dictionary on the other hand defines it as a set of detailed methods, procedures and routines created to carry out a specific activity, perform a duty, or solve a problem (Business dictionary, 2015). So, in general, a system may be defined as a set of interrelated elements which interact with each other. What these multiple definitions reveal is that systems have several aspects in common. In a system all parts must be related (directly or indirectly), if not, then the systems actually become two or more distinct systems. The interrelation of the parts of a system means that if we make a change on one part of the system the other parts are also affected, with predictable patterns of behaviour (Von Bertalanffy, 1972).

System Theory is therefore a theoretical perspective which analyses the abstract organisation of phenomena, regardless of substance, type, or spatial or temporal scale of existence (Mele, Pels, & Polese, 2010). The theory focuses on the interactions and relationships between parts in order to understand an entity's organisation, functioning and outcomes. Authors such as Mele et al. (2010), Cabrera, Colosi and Lobdell (2008) quote Von Bertalaffy's (1956; 1969) General Systems Theory which still holds up to this day, and on which systems theory is based.

Systems theory supports STT and FVM in that it focuses on the need for a completeness of a system. Although systems theory encompasses a wide variety of systems, when applied to management theory it concentrates on organisational systems in general. As in any other system, the removal of one of the constituents of the system leads to a stop in the functioning of the system. Thus, as in CTO, one of the main components, which is the TOS, leads to a stop in operations if it becomes unavailable.

In the context of this study the System Theory was employed to assess the model's dynamics, constraints, conditions, and to elucidate principles (such as purpose, measure, methods, tools) that can be discerned and applied to the new model. It looked at the need for elements of the TOS, the GOS, computers and their interconnections as well as the human element that would be needed to complete the BCM Framework. When employed in combination with the Critical Business Functions of CTO, a BCM framework emerges, and it can be considered to be complete.

3.2 Emerging concepts

The three theories presented above focus on the concepts of systems, availability of elements of those systems and the outcome related to the availability or unavailability of those elements. STT for example, focuses on the merging of technical and social aspects to form a complete system. If either the technical or social aspect, or their subsystems are missing, then those systems cannot function optimally. FVM focuses on the fitness and the viability of the technologies to be used. System theory focuses on the specific types of the elements of a system and argues that if any of the elements is changed or removed, then the system changes its behaviour or function. The concepts that relate to our study are the CTO (movement of containers, keeping of records, utility of space, coordination) and availability of the ICT System that manages CTO.

3.2.1 CTO as a concept

The concept of a CTO is a collection of processes that need to be performed in order to move containers and accurately record their final positions. This is based on the primary function of container terminals around the globe. The idea is that people use machinery, technology etc. to move containers as a means of production. Therefore, for production to occur there should be CTO and available systems that can manage CTO.

3.2.2 Availability as a concept

The concept of BCM is a management plan for availability of the systems used to deliver production through CTO. BCM is a theoretical framework which recognises the importance of the organisation to continue operating through adversity and lays guidelines on how to maintain resiliency from that viewpoint. In practice, a properly implemented BCM ensures that an organisation can continue its operations in the most practical and therefore usable manner (the BCI Good Practice Guidelines or GPG (2013).

3.2.3 The constraint within current BCM practices in container terminals

This study posits that it is currently not possible to provide BCM for operations while removing the optimisation offered by the TOS. The elimination of this optimisation is, according to STT, is a constraint. Without the optimisation, the BCM becomes unusable and without the BCM, operations are forced to stop whenever there is a disruption. It is from these concepts that we assume that container terminal operations need an ICT-based BCM in order to perform optimally in the event of a loss of the TOS.

3.3 Conceptual framework

This study was undertaken in container terminals around South Africa which are operated by Transnet Port Terminals. The study focuses on two concepts; Availability of a centralised ICT system (the TOS) and CTO. In this section, a conceptual framework is presented to guide the study and aid the way it was organised by showing the concepts which are relevant to the study.

In philosophical research, a researcher can construct a process that will allow them to come to their desired conclusion. According to Saunders, Lewis and Thornhill (2016), a research philosophy is a system of beliefs and assumptions about how data is gathered, analysed and used to form knowledge. There are many different research philosophies that a researcher may follow based on their beliefs on how their research should be conducted. Mkansi and Acheampong (2012) argue that classifications such as epistemology, ontology, axiology and doxology and the quantitative-qualitative dichotomy can be confusing to some, especially because there are various debates and schools of thought on which methods are the best to use. There are many different descriptions, categorisations and classifications of research paradigms and philosophies in relation to research methods with overlapping emphasis and meanings which a number of studies (Guba & Lincoln, 1989; Ritchie & Lewis, 2003; Guba, 1990) have shown are being used.

3.3.1 Dependent and independent variables

There are two main variables in a study, the independent and dependent variable. A dependent variable is the variable being tested and measured in a study. An independent variable is a variable that stands alone and isn't changed by the other variables that are being measured. Independent variables can be used to test the effects on the dependent variable (Helmenstine, 2017).

The aim of this study is to develop a BCM framework to cover the absence of the TOS which is used for CTO. This leads us to want to question what would happen if the TOS was (1) available, (2) unavailable or (3) covered by BCM. Therefore, the independent variable for this study will in this case be about the presence or absence of the TOS. Literature (see Stahlbock & Voß, 2008; Notteboom & Rodrigue, 2009; Koumaniotis, 2015) suggests that the TOS is necessary for CTO processes to be conducted. As a control, the TOS can be provided or removed to test its effect on the CTO processes. BCM on the other hand can be used in the absence of a TOS, and therefore represents the TOS (or its absence, if the BCM itself is also absent). According to Helmenstine (2017) if the inclusion or exclusion (i.e. the presence or absence) of an item can determine the outcome of an event, then that inclusion/exclusion is the independent variable.

For this study, the dependent variable is the CTO, that is, the processes for the movement of containers to their destinations in the terminal. The study intended to establish whether the availability of ICT Systems (the TOS) has effect on CTO (Production). The CTO processes can be tested as variables by either being performed or not.

3.3.2 The framework of this study

The two concepts of CTO and Availability of ICT Systems form the basis for the conceptual framework for this study. It is important to study these concepts while applying the FVM, STT and System Theory since the concepts allow us to identify the gaps which we can then find a solution for.

The conceptual framework depicted in Figure 3.2. shows the two concepts of CTO and Availability of systems. These starting concepts are what give rise to the research problem and to the variables that are discussed in this study. The availability of systems can be tested on CTO by using it direct, by using it as a manual or automated BCM, and by removing it completely.

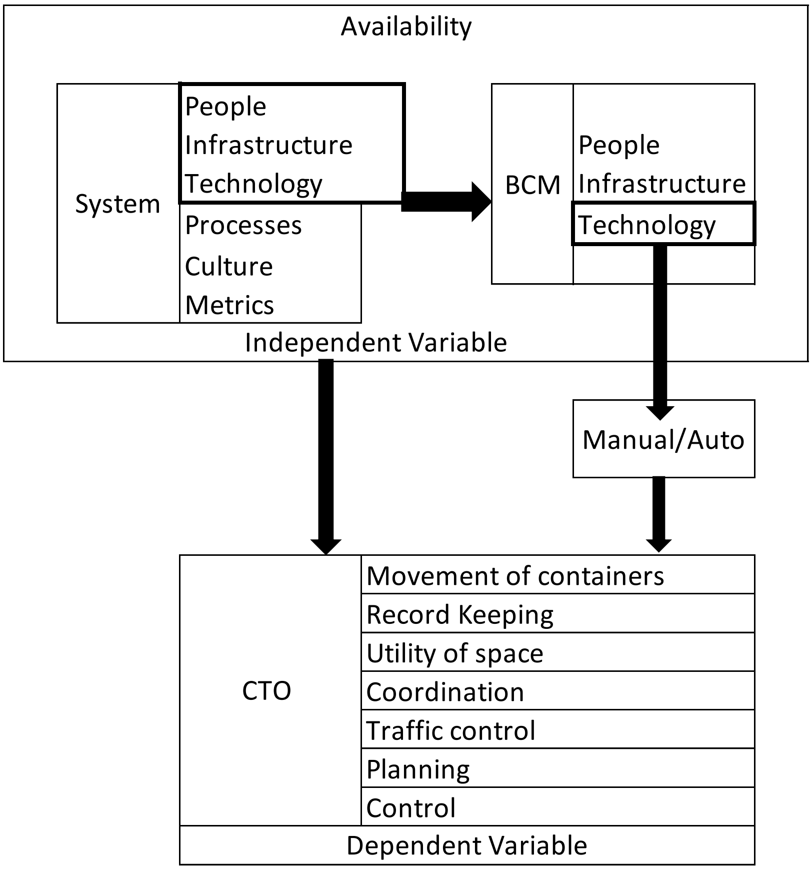

Figure 3.2. Conceptual framework for this study

3.4 Summary

This chapter looked at the theories that this study adhered to. Conceptual and theoretical frameworks were presented that will guide the rest of the study. The next chapter will delve into the research methodology that was followed.

Chapter 4: Research Methodology

This chapter presents the philosophical research approach which was followed in this study. The philosophical underpinnings of this study were drawn from the ontological objectivist tradition. It also discusses the research design and methods which include the population and sampling technique used to select participants; the rigour that was practiced during and after data collection and the ethical considerations. As part of this chapter, data analysis method is also discussed.

4.1 Research paradigm

Research Paradigm is defined based on literature review from several authors including Mackenzie and Knipe (2006), and Kivunja and Kuyini (2017). The description of the word paradigm, which other authors (including Thomas, 2011) also use, has its aetiology in Greek where it means pattern. This pattern is made up of a set of beliefs that researchers use to inform the meaning or interpretation of research data. According to Thomas (2011), a research paradigm presents us with a concept often referred to as a worldview, which concerns the ontological and epistemological aspects of reality. Research paradigms can be characterised through their ontology, epistemology and methodology.

4.1.1 Ontology

Ontology has many different iterations and it can be associated with different research paradigms (Patel, 2015). Though there are various paradigms which have been observed through the different ontologies as discussed by various authors (Patel, 2015; Corazzon, 2016; Saunders et al., 2016; Guba & Lincoln, 1990), this study was guided by objectivist and positivist paradigms, two amongst six paradigms which, according to Patel (2015), include;

- Constructivist, which argues against a single reality or truth. This is a theory based on observation and scientific study about how people learn. It says that people construct their own understanding and knowledge of the world, through experiencing things and reflecting on those experiences (Olusegun, 2015).

- Pragmatism, which argues that reality is constantly changing through renegotiation, debate and interpretation and uses mixed methods approach (McDermid, n.d).
- Subjectivism, which argues that reality is what we perceive it to be. In this theory, perception (or consciousness) is reality, and there is no underlying, true reality that exists independent of perception (Mastin, 2008).
- Critical, which argues that realities are socially constructed entities that are under constant internal influence. In this context, rationality consists of holding all conjectures, positions, beliefs, methods, habits, values, etc. open to criticism, including criticalism itself (Collins & Stockton, 2018)
- Positivism, which argues that there is a single reality or truth. In positivist or scientific research, the researcher is concerned with gaining knowledge in a world which is objective using scientific methods of enquiry. Methods associated with this paradigm include experiments and surveys where quantitative data is the norm (Aliyu, Bello, Kasim & Martin, 2014).
- Objectivism argues that social entities exist in reality and external to social actors which are concerned with their existence (Saunders et al., 2016). The research paradigm that this study follows is objectivist in nature and therefore makes use of social entities. Social entities are an important component of research philosophy since they represent the objects being studied and form the basis of objectivism.

For this study, the objectivist paradigm was followed since the objects of reality is assumed are those which include organisations, management, individuals' working lives and organisational events and artefacts (Saunders et al., 2016). This assumption fits in well with Ratner's (2002) definition of objectivism which defines it as the notion that an objective reality exists and can be increasingly known through the accumulation of more complete information. To achieve an objectivist stance, for this study permission from the participants and the organisation was obtained to ensure there would be no surprises once we started the research. A written explanation was sent to management and participants seeking permission and explaining our intentions and to indicate that the research was about the improvement of critical organisational processes and that it would be conducted in an ethical manner that will not be disruptive to ongoing operations. Assurance was given that the data collected was only for study purposes.

The questions in the instruments were developed guided by discussions with the management of the organisation and line supervisors and, guided by the literature reviewed. Contact with managers assured that the questions included in the instrument were relevant to the container terminal operations. Objectivism argues that objective knowledge requires active, sophisticated subjective processes—such as perception, analytical reasoning, synthetic reasoning, logical deduction, and the distinction of essences from appearances.

We sought to solicit the realities that the individual participants had created themselves through the help of their experiences in their lives. The study looked to find the patterns in the individuals' experiences and asked them to subconsciously predict what was going to happen in the future, based on those real work environment experiences. The use of the objectivist stance was very helpful in the study since it allowed independent, specific realities of the participants to be used to construct questions during questionnaire development. Participants, and hence the organisation, were given a voice, and therefore got to understand the realities in the container terminal operations.

Objectivity presupposes that an independent reality can be grasped. According to Ratner (2002), objectivism is the highest form of respect for the subjects being studied. It respects their psychological reality as something meaningful and important which must be accurately comprehended. Respect through objectivity was demonstrated by questions and actions that were impartial, detached and promoted open-mindedness based on daily work experiences. The questions asked sought to gain understanding from participants on issues related to container terminal operations. By adopting an objectivist approach, we could separate ourselves from the subjects being studied and allowed them to express their feelings of reality without interference.

4.1.2 Epistemology

Epistemology is the study of the nature of knowledge and the extent of human knowledge (Truncellito, 2007) and justified belief (Steup, 2005). The study of epistemology is concerned with the definition of knowledge, what it means to know something. According to Truncellito (2007), knowledge is characterised by belief (one has to believe something in order to know it), truth (the belief has to be true) and justification (how the belief was acquired). The justified true belief (JTB) account is widely agreed to capture the nature of knowledge (Truncellito, 2007; Steup, 2005). However, Gettier (1963) disputes the completeness of JTB and indicates that there are different variations to justification.

For this study, we postulate that CTO needs ICT Systems in order to be carried out. This assumption has been verified through observations, interviews and questionnaires administered to research participants. Literature was also considered in determining the extent to which complex processes in CTO are controlled via ICT systems, thus giving rise to the stated belief. From this knowledge, the question we asked in this study which gave rise to this topic was as follows: “If the ICT system becomes unavailable, how can CTO carry on?” To answer this question, we had to consider the Gettier problem (Gettier, 1963) which points out that the source of the justification cannot be false. Therefore, it cannot merely be assumed that CTO cannot take place without ICT systems through justification made only from generalisations. Our assumption needs to be contextualised into terminals which are large and have their CTO processes fully embedded in ICT systems. Our study observed the four epistemological tenets of intuitive knowledge, authoritarian knowledge, logical knowledge and empirical knowledge (Dudovskiy, 2018).

4.1.2.1 Intuitive knowledge

The study began with the intuitive knowledge which argued that in large CTOs, because the TOS controls the operation, nothing can be done without the TOS. This belief was based on observations of CTO at a live working terminal. It could be argued, however, that manual methods can be used in the situation of a loss of systems, but the counter argument can be that manually, it would not be viable to operate. These arguments are what gave rise to the question that formed the basis of this study, that is how can we carry on with CTOs in the event of a total loss of the TOS?

4.1.2.2 Authoritative knowledge

To gain some authoritative knowledge, we sought information from books and people, i.e. literature review and surveys and interviews. These sources were considered to be strong sources based on their expertise, industry knowledge and experience. With authoritative knowledge we could establish that there was indeed a case to be made for large CTO not to revert to manual methods during a TOS outage. This helped prepare the foundation for an alternative method to manual methods, that CTO would need to adopt to be able to carry on during a TOS outage.

4.1.2.3 Logical knowledge

New logical knowledge was created via information that was obtained from the findings of the data gathering. The findings had indicated that manual methods were not viable; hence an alternative automated system was necessary. It was hypothesised that since there are many variables that lead to the problems that cause the TOS to stop operating, creating an alternative but parallel system can help CTO carry on during a TOS outage.

4.1.2.4 Empirical knowledge

According to Dudovskiy (2018) empirical knowledge relies on objective facts that have been established and can be demonstrated. The framework avoids the pitfalls of a current running TOS and operates in a different manner while still providing the necessary controls that the main TOS provides in order to keep the system running until the main TOS becomes available again.

4.2 Research approach

Saunders et al. (2016) introduce us to their model of a research 'onion' (Figure 4.1.) which helps a researcher navigate through the many different layers or levels of research which constitute philosophical research. This explanation by Saunders et al. (2016) is arguably one of the best approaches to research philosophy since it illustrates visually how the different tenets of philosophy come together to produce a result.

By following this 'onion' research process, we can deduce that this research is Ontologically Objectivist since:

- It follows the view that the world operates a certain way, that is, CTO and BCM have their underpinning tenets (ontology); and
- CTO and BCM exist external to and independent of social actors (objectivism).

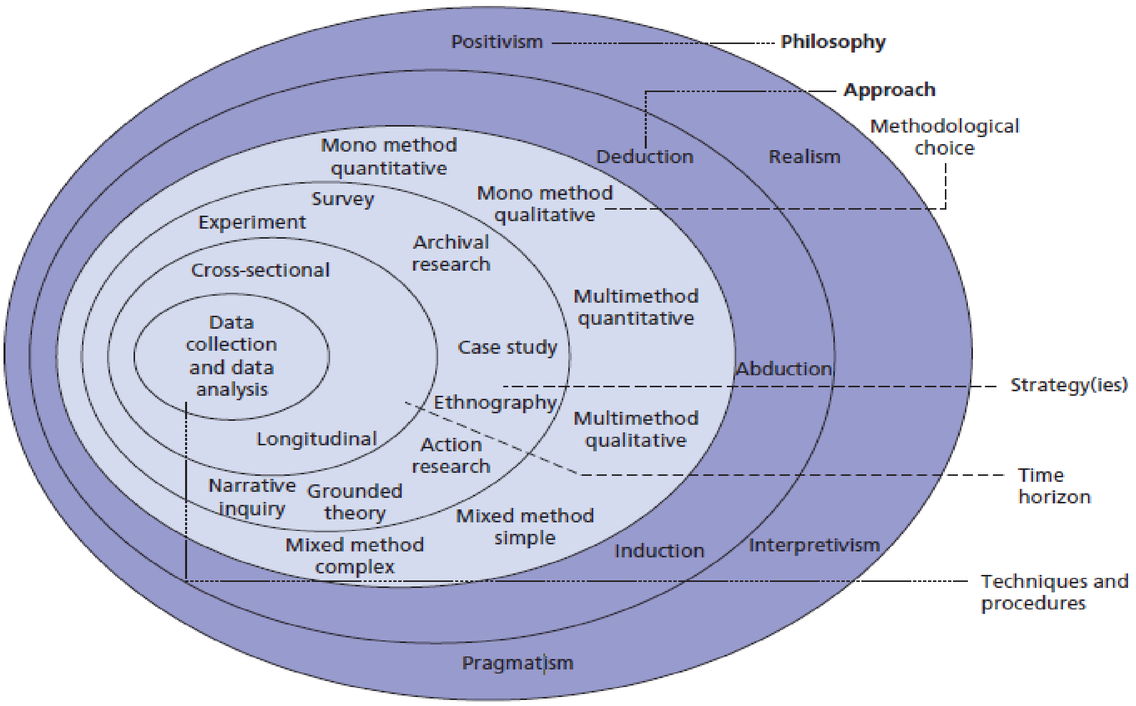

Figure 4.1: Research 'Onion' – Source: Saunders et al. (2016, p43)

The process suggests that a researcher should follow certain rules and processes independently of where they are being applied (Saunders et al., 2016). Although they may differ slightly in their applications, the overall environments in which they are applied do not change the rules which they follow. This ties in well with CTO and BCM because:

- Both have certain rules that they follow (e.g. CTO should move containers on and off vessels into the yard and on to hinterland transport, while BCM has to ensure continuity that covers every eventuality in CTO).
- Both cannot be changed by external and social actors. If they were changed, they would not achieve their goals.

As Mkansi and Acheampong (2012) have argued, there can be other classifications in which our study can fall. Since this study emphasises on processes (BCM; CTO) and objects (ICT systems) which are considered real, it can therefore be classed as positivist (Saunders et al., 2016). By leaning towards a positivist classification, our study combines a logical deduction with empirical observations. As Bandaranayake (2012) puts it, this shows causal relationships that are generally valid with a known probability and which can therefore be used for prediction. The implication is that data would be gathered through quantitative and qualitative means in order to empirically interrogate current norms, practices and processes. To achieve this, this study adopted the traditional mixed methods research methodology which is informed by its combination of two data collection techniques using interviews and questionnaires.

This study focuses on the application of Business Continuity Management (BCM) on container terminal operations if ICT systems are down. The mixed methods provided a better and holistic understanding of a research problem or issue than individual research approach alone. Johnson and Onwuegbuzie (2004) emphasise that sometimes research is best approached when the two methods are combined. Figure 4.2. illustrates the approach taken to lay out the design.

4.2.1 Mixed Methods strategy

The study was guided by the following strategy as postulated by Creswell (2003):

Research methodology is the process of collecting data according to the research design chosen (Cresswell, 2012). For the quantitative design part of our mixed methods design, we used a questionnaire which was distributed online. A link was emailed to the respondents which led them directly to the questionnaire. For the qualitative part we conducted interviews. A sample of the population was interviewed at their workplaces and the interviews were recorded and later transcribed verbatim.

There are various characteristics which are attributed to quantitative studies including using structured instruments, ability to reach large sample sizes, predict outcomes and investigate causal relationships (Regoniel, 2015). The output of quantitative studies is usually in the form of statistics and graphical representations.

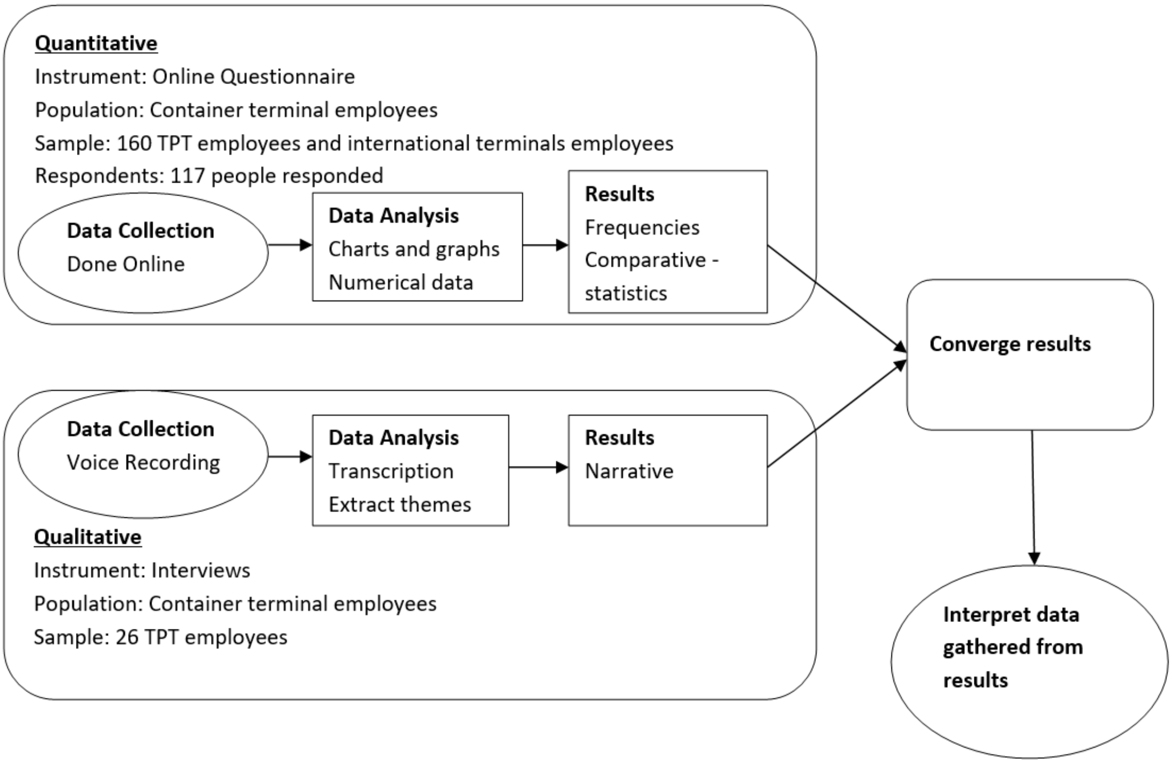

Figure 4.2. Convergent Parallel mixed method design

- Quantitative research in this study was applied through a structured 32 items questionnaire which combined open-ended questions, multiple choice questions and Likert-scale type questions.

4.2.1.1 Advantages of mixed methods

Venkatesh, Brown and Bala (2013) advocate the use of mixed methods research in Information Systems (IS) and warn us against using single method research. Their argument is that single method papers are likely to miss the opportunity to discover, develop, or extend a substantive theory in richer ways than possible with mixed method papers. By using a mixed method research, there are several advantages, namely:

- The weaknesses of either qualitative or quantitative research are offset by combining the two methods. As an example, a qualitative study can only sample a few respondents when compared to quantitative research. This can however, be overcome in the mixed methods research by reaching out to a wider population on the quantitative study. A lack of contextualisation of the setting in which the study is conducted in a quantitative study can be offset by interviewing respondents where the researcher can delve deeper into the mind of the participant;

- The method helps to explain findings or how causal processes work;
- Provides an approach for developing better, more context specific instruments. For instance, by using qualitative research it is possible to gather information about a certain topic or construct in order to develop an instrument with greater construct validity, i.e., that measures the construct that it intends to measure;
- Mixed methods research provides a more complete and comprehensive understanding of the research problem than either quantitative or qualitative approaches alone.

Mixed methods research, which uses both quantitative and qualitative methods, allows researchers to draw conclusions from combined data.

4.2.2 Quantitative design

A quantitative study is a data collection method which emphasizes objective measurements to generate mathematical or numerical data or statistics (Saunders et al., 2016). The most common techniques for data collection for this method are through questionnaires, polls and surveys. A quantitative research study classifies features, counts them, and constructs statistical models in an attempt to explain what is observed (Babbie, 2010).

4.2.3 Qualitative Design

Augustin and Coleman (2012) describe qualitative research as research that requires information to be gathered via interviews, discussion groups and observation. Hammersley (2012) argues that defining qualitative research is not a straightforward process. He notes that defining qualitative research by contrasting it with quantitative research is one method that can best describe qualitative research even though it is lacking in definition itself. The definition of qualitative research is not specific, and this can be best noted on the Sage Handbook of qualitative research editions by Denzin and Lincoln (1994, 2000, 2005, 2011) where it changes and evolves in every edition.

For this study, we used qualitative research to explore the perspectives, feelings, behaviour and experiences of people and draw conclusions based on that exploration. The rationale for using a qualitative approach in this research was to explore and describe the opinion of participants on the effect of ICT on operations. A qualitative approach was appropriate to capture the opinions of managers and staff on what they know, expect and effect of ICT Systems in relation to container terminal operations.

We used face-to-face interviews in collecting data from participants. Using interviews allowed us to ask questions whose responses would guide the follow-up questions, sometimes for clarity, and sometimes because new information would come out that needed further probing. The following methodology was followed in collecting data from respondents:

4.3 Sample, sampling technique and sampling frame

4.3.1 Population

Research projects need to be clear about the participants to whom the research applies (Oliver, 2010). A population is the target group that is representative of all elements whilst a sample is a smaller group of the population that was selected (Sekaran, 2003).

The population of this study consisted of the employees of container terminals in South Africa (Durban Pier 1 and Pier 2, Port Elisabeth, Ngqura, East London and Cape Town), Mauritius (Mauritius Container Terminals), Singapore (PSA), Mozambique (DP World, Maputo) and Hong Kong (HKT). The population consisted of approximately 700 staff members from all these terminals.

4.3.2 Quantitative approach sampling

A simple random sampling technique was used for the quantitative study. Both these methods are explained in the subsections that follow. Respondents that were identified for this study were employees in Operations, Planning and ICT support who were best placed to respond to questions about operations and how much ICT had an impact on operations. Computer users and operational staff working in the operations areas, support staff for operations; e.g. finance, risk and key accounts were also included in the sample.

4.3.3 Quantitative approach sample size

In this study, a sample of 160 participants was targeted. Using the Raosoft sample size calculator we found that with a margin error of 7% and a confidence level of 95%, our sample size of 160 respondents from a population of 700 was adequate.

4.3.4 Qualitative approach sampling procedure

Purposive sampling, which has been followed to select participants for qualitative approach in this study, is a type of non-probability sampling technique where the units that are investigated are based on the judgement of the researcher (Saunders et al., 2016). A purposive sample is a sample in which the researcher deliberately selects participants which they know will be representative of a particular population (Welman et al., 2011). When using purposive sampling, we began with a purpose in mind and selected a sample that included people of interest. One of the main advantages of using this kind of technique is that it can be used if there are only limited numbers of primary data sources who can contribute to the study. This enabled snowballing to occur while we were gathering data.

Participants were selected based on their positions and functions within operations and ICT support as follows:

- Operations supervisors – Those who run operations and are therefore exposed to the day to day functioning of the container terminal were considered. They are the first to experience problems whenever the ICT systems go down. Through snowballing, supervisors referred us to operators who reported to them and would therefore be able to shed further light on our study.
- ICT administrators - These are the people who respond to the day to day support requests for ICT systems. They are the experts who know the functionalities of the system and how the system behaves when it experiences problems.

- Safety officers - These are the people who sometimes have to deal with the effects of ICT downtime on operations since the operations procedures are affected thus changing the behaviour of operations staff.
- BCM and Risk officers – These are the people who manage and dispense continuity practices for terminals. They were able to give insight into how the current implementation came about and why it was chosen that way. When sampling the participants were identified based on their experience and current exposure to the operations environment and exposure to the ICT systems. These participants were to guide the interviewer on the common problems that they experienced and how they were affected by the current BCM implementation. Through snowballing, BCM and Risk Officers were selected based on a recommendation by a Safety Officer.

The sample size for the qualitative phase consisted of 26 participants from the container terminals identified. Adler and Adler (2012) suggest a sample of around 30 for interviews; however, they also argue that a smaller sample can be adequate when studying hidden or hard-to-access populations. Becker (2012) also emphasises the issue that there is no right answer to sample size when interviewing. This number was acceptable considering that they had to be interviewed during working hours i.e. taken away from their workstations. The number of 26 was informed by the various functions in operations around the terminals and by the sizes of the terminals. The sample breakdown is as indicated in Table 4.2:

Table 4.2: Composition of participants

Terminal	ICT	Operations Supervisors	Operators	BCM	Safety	Totals
DCT Pier 1	2	2	2			6
DCT Pier 2	2	2	2		1	7
East London	2		1			3
Port Elisabeth	2	1	1			3
Cape Town	2	1	2			6
Head Office				1		1
Totals	10	6	8	1	1	26

4.4 Research design

The basis for scientific research is a careful research design (Oliver, 2010). When researchers are studying the research from another researcher, they could be interested on how that researcher planned and conducted their research. Thomas (2013) suggests an idea that every research should start by defining a background of what is to be studied, then an issue should be identified and mentioned in a form of a question and then solutions provided or at least a promise made, to find a solution. Using a slightly different method, Welman, Kruger and Mitchell (2011) advise that researchers should start by formulating the problem. However, they also seem to agree with Thomas (2013; 2017) in that they too advise that as a first step before formulating a question, a topic should be identified and described the question formulation as a first concrete step in the research process.

In the mixed methods design segment followed in this study, the background was identified as the use of ICT systems by operations. The idea for the background came as a result of observation of operations in container terminals from an ICT standpoint. Gobo (2011) describes observation as a vestige of ethnography. Gobo notes that ethnography meant that a researcher observed the subjects by actively watching, listening and scrutinising. Eberle and Maeder (2011) further narrow down ethnography into *Organisational Ethnography.* Organisational ethnography, according to Eberle and Maeder (2011), allows us to differentiate from others like gender ethnography (Buscatto, 2011) and anthropological ethnography.

This study is guided by three theories – Socio Technical Theory (STT), Actor Network Theory (ANT) and the System Theory (ST) – which collectively show the TOS as being in an important symbiotic relationship with all the other aspects of CTO. The implication from that was that the functionality of both the technical subsystem and the social subsystem (or actors) needed to be interrogated. Thus, to achieve this, a mixed methods study was necessary whereby both actors could be thoroughly probed.

4.4.1 Survey

The study is a survey using quantitative and qualitative research approaches. Data was collected using questionnaires and interviews. In a survey a researcher selects a sample of respondents from a population and either administers a standardised questionnaire or conducts interviews with the respondents (Shuttleworth, 2008; Jones, Baxter & Khanduja, 2013). This method allows researchers to collect data from large or small populations whereby a sample of the population can be regarded as representative of the entire population. In line with the mixed methods study that was used for this study, we surveyed participants using questionnaires and face to face interviews. These methods were selected due to their ability to gather information, assessing opinions and observing trends. In this study, questionnaires allowed us to gain insight into CTO and interviews managed to delve further into the views and feelings of the participants on daily operations. Information that was gathered from the survey guided us in developing the framework of this study.

4.4.2 Alignment with problem statement

The problem statement detailed the lack of literature on BCM and for ICT systems in the container terminals. The choice of a research design is informed by the nature of the problem. In this study, the problem arises from the operations conducted by the staff of a container terminal and, the reliance of operations on ICT systems. Research design can help us to interrogate the processes followed in operations as well as the structure and nature of the ICT systems. The data regarding most of the processes needed to be based on hard fact and opinions form the operations staff. Although the operations staff can be viewed as an actor in the grander scheme of things, they are only secondary actors to the processes. That is to say, they follow and implement the processes. The ICT systems are also primary actors, though their duty in operations is to deliver the processes to operators and to process the information generated. However, when gathering data, it is the operators who will speak on behalf of both the processes and the ICT systems. Therefore, the best method to probe, in depth, all the information required was to use structured an unstructured question, thus requiring the need for a mixed methods study.

4.4.3 Alignment with objectives

This study gathered data which as informed by the research questions and the objectives which were formulated earlier in the study (Muijs, 2004). The research questions and objectives were aligned such that they informed each other on what was required to achieve the study aim. This study was conducted based on the following objectives:

- ✓ Examine the impact of ICT on operations of intermodal container terminals;
- ✓ Determine Critical Business Functions in operations that must stay operational at all times;
- ✓ Evaluate the current BCM practices at container terminal operations.

To fulfil the objectives required the use of a mixed methods study in order to gather the necessary data. Although some of the information required by the objectives had been acquired through the literature review and observation, more extensive data needed to be collected from more sources to prevent bias and opinion. Container terminal employees were able to provide us with the required information in a manner that was reliable (Creswell, 2011). Qualitative questions were based on how the quantitative question were distributed in the questionnaires guided by the research objectives as indicated in Table 4.3:

Table 4.3: Alignment of survey with objectives and theoretical framework

Objective	**Aligned Questions**	**Aligned Theory**
1. Examine the impact of ICT on operations of intermodal container terminals;	Questions 11 to 21	STT – As the technical subsystem FVM – As the technology aspect ST – As the TOS
2. Determine Critical Business Functions in operations that must stay operational at all times;	Questions 7 to 10	STT – As the technical subsystem FVM – As the processes and procedures
3. Evaluate the current BCM practices at container terminal operations;	Questions 24 to 30	STT – As the social subsystem FVM – As the processes and procedures ST – As the processes

4.5 Data Collection Procedures

Data collection is the process through which we gather information so that we can answer the research questions (Voehl, Harrington, Voehl, 2015). Sapford and Jupp (2006) see data collection as a form of evidence-gathering that produces data which a researcher can use to base his findings on. Data for the study were collected using both quantitative and qualitative procedures. In this section we will discuss the procedures that were followed.

4.5.1 Quantitative data collection procedure

The data in this study was collected through questionnaires which were submitted electronically (Li, Vedula, Hadar, Parkin, Lau & Dickersin, 2015). The questionnaire was built on Google Forms and was distributed among the selected sample. Terminals targeted included the terminals in Singapore, Mauritius and Hong Kong which are full intermodal container terminals.

4.5.1.1 Questionnaire

According to Creswell (2011), an instrument is a tool for measuring, observing, or documenting quantitative data. It contains specific questions and response possibilities that a researcher establishes or develops for the study. Once the researcher has selected a suitable research design, they need to select or develop an appropriate instrument to collect the data (Muijs, 2004; Creswell, 2014).

For this study, we constructed a questionnaire in alignment with the theoretical framework as shown in Table 4.3, and guided by the literature reviewed and by working experiences from CTO. The questions that we asked established how people were involved as we were following the STT which postulates that people and technology must work together. Whilst developing the questions STT and ANT were taken into consideration due to their mandating that the various systems in an organisation must all be present for the organisation to achieve its goals. Working experiences included establishing how managers viewed ICT systems in relation to the most important processes of container terminal operations. The questionnaire consisted of 32 five-point Likert scale questions. Some of the questions were open-ended.

The questionnaire consisted of four sections that collected information on the respondents' perceptions and requested them to provide information and asked them to rate issues regarding CTO and BCM. Information that was required consisted of experience, working environment and, demographics including, country, city and roles they played in CTO. Respondents were asked to rate the perceptions on aspects such as BCM, ICT system implementations.

4.5.1.2 Pre-testing the questionnaire

Testing an instrument is a very important part of social science research (van Teijlingen & Hundley, 2001) to make sure that questions were clear and to the point we started by testing the instrument. We tested the instrument, to establish the extent to which it was valid and reliable as described by Muijs (2004). Validity in an instrument ensures that the instrument measures or gathers the data which it is intended to. Reliability on the other hand ensures that we eliminate errors within our instrument to ensure that we are making valid measurements (Muijs, 2014). Other issues to look out for (van Teijlingen & Hundley, 2001) include testing for adequacy of the instrument and collecting preliminary data.

Pre-testing the questionnaire involved giving it to five colleagues who completed it and gave feedback on their understanding of the questions as described below. By conducting a pre-test, we were able to:

a. Monitor how respondents responded to the questions. We looked at the responses and evaluated how they responded to the questions to see if the answers we got were what we were looking for. This was helpful in determining validity since we could check to see if the information that came out of the questionnaire was the type of data we were looking for.
b. Ask respondents why they answered certain questions in the manner that they did. This helped us see what the respondents thought what the questions were looking for. If they all had the same kind of idea, then we could determine

reliability of those questions because we could be sure that the questions would elicit the same type of response from everyone.

c. Listen to respondent frustrations about some of the questions. By doing this we were able to eliminate ambiguity from some of the questions and ensure ease of use.
d. Test analysis of the results and modify the questionnaire for consistency. This helped us ensure validity and reliability of the questionnaire by looking at the preliminary results.
e. Rework the structure of the questions and request the respondents to try again, and,
f. Identify any other shortcomings of the questionnaire and improve upon them.

The pre-testing helped to reduce errors that could otherwise have been costly or render the data collection invalid due to errors in the instrument. Errors that were identified in the questionnaire included incoherent questions, lack of usable responses and long-windedness. Corrections were made to clear vagueness, confusion and to make it more user-friendly. Errors that we identified included:

i. Questions that led the respondent to choose a specific answer. Those questions were revised and given a wider range of responses. Some of the questions were reworded to sound more like questions without leaning towards an answer.
ii. Some questions assumed that the respondent had prior knowledge to certain terms and colloquial. Proper wording was then used to correct these mistakes.
iii. There were questions which provided inadequate response options. These were corrected by adding more responses and using the Likert five-point scale.

From the pre-test, it was estimated that the time to complete the questionnaire was approximately 20 minutes. Lastly, the questions were loaded into Google-forms which a tool for is distributing questionnaires for surveys.

Since the questionnaires were online, a hyperlink was provided to each participant via email. The hyperlink that was sent (https://goo.gl/forms/sCGEdtMMXt8d23OX2) was generated from the online form and it sent the respondent directly into the form. When sending out the hyperlink, the purpose of the questionnaire was explained in detail. In a letter attached to the email, the researcher was introduced and details pertaining to the study were explained. The importance of participating in the study was explained in that it was to establish the effect of ICT on operations. Participants were notified that the duration of the questionnaire was around 20 minutes and that they were encouraged to complete the questionnaire in one go.

We monitored our Google forms portal daily to check if respondents were participating in the survey. At times, there were bursts of responses that came through and on other days nothing came through. Whenever we saw that responses slowed down, we re-sent emails to remind respondents to participate. This seemed to have a good effect since after each email resend there was a burst of activity. Later in the survey we asked contacts who had connections with potential respondents from outside South Africa to participate as well. We also posted on LinkedIn to ask container terminal industry professionals to participate and encourage their colleagues to do so as well. This ended up prolonging the data collection since those respondents were hard to come by. However, in the end some respondents did participate and indicated that they were from other countries.

4.5.2 Qualitative data collection procedure

The data in this study was collected through interviews with participation from CTO and planning staff.

4.5.2.1 Interview schedule

This study used an interview schedule as the instrument for qualitative data collection to guide the interview. The interview schedule consisted of major questions regarding issues on impact of ICT systems and services on container terminal operations, the interaction with ICT systems by operators in operations, the safety issues involved when not using ICT systems and how participants viewed and used BCM practices on a day to day basis.

Lead questions were structured in such a way that the first question would lead to other questions through probing. Five questions were initially selected as beginning questions for the interviews.

4.5.2.2 Pretesting the interview schedule

Before interviews were conducted, we interviewed some participants in order to test the questions for the interviews. Interviewees were asked to judge the questions being asked to them to ensure that there were no confusing questions or whether questions were relevant or related to what they were doing. We therefore administered the questions as designed.

The research project was explained to all prospective participants and they were asked personally if they wanted to participate in the research. Aspects of what was explained were about the project itself, the reasons behind the interviews which include gathering data from first hand experienced participants, and how their involvement would be kept confidential were explained to participants.

The quality of information obtained is largely dependent on the skill of the interviewer (Patton, 1994). We listened carefully and requested clarity where we did not understand in order to obtain thoroughly tested knowledge. Sometimes we had issues with accents and asked the participants to repeat their words and even use examples. To achieve this, we had to be a good questioner and listener who were sensitive and empathic. We allowed the participants to talk and finish their sentences and agreeing with some of their comments while ensuring the conversation covered the areas we had intended.

4.5.2.3 Conducting the interviews

Unstructured interviews were conducted face to face. Face-to-face in-depth interviews, guided by the lead questions in order to probe while observing the participant's reactions and mannerisms allowed for direct interaction between us and each of the 26 sampled interviewees.

Arrangements were made with participants to meet at specified time suggested by the participants and at their most convenient locations. The interviews were conducted during working hours to avoid engaging the participants during their personal time at home to ensure that they were not inconvenienced. We also held the interviews in non-threatening settings which included quiet offices without disturbances. Most of the interviews were held in the participant's natural habitat or a place of their choosing that felt most comfortable for them. These included offices inside the terminals and areas such as the rail loading areas, offices in the interchange zones and offices in the staging areas. Once the appointments were made with the participants and permission granted for those with supervisors, we met with the participants and went into their interview setting as arranged. Some sat across the table and others sat alongside us within close range to the recording device. All interviews were recorded using a smartphone after obtaining permission from the participants to record them. Reactions and other mannerisms were noted and those also prompted further questioning from the interviewer.

Recording the interviews enabled us to concentrate on the conversation without being distracted by note taking. All interviews were held in English to ensure consistency and clarity, especially for later when we would be transcribing the information. Interviews lasted from as little as ten minutes while some went on to about 45 minutes.

4.5.2.4 Interacting with interviewees

During the interviews, we talked freely about their roles and responsibilities. By starting in this way, it allowed the participants to express themselves in their own words and thus helped us direct the interview in a manner that allowed us to extract information that we felt was of particular interest. In order to avoid some of the pitfalls of unstructured interviews like too much information (Denzin & Lincoln, 1994) we reigned in the interview whenever we felt that the conversation was getting side-tracked. This would prove to be of great help when transcribing and reducing the data afterwards.

During the beginning of the interview, we told participants that we would not mention their names. Care was taken to make sure we did not mention any names of either the participants themselves or their colleagues. We also requested them not to refer to other colleagues by names, but rather referred to them by their roles. This allowed the interview to be one where there would confidentiality and avoided finger pointing and ensure that participants themselves would be assured that other participants would not be discussing them. When the interview started to flow after some initial jitter, it flowed and quickly turned into a conversation rather than a question and answer session. We made sure to be the ones asking the questions all the time, except when the participant needed clarity. Initial questions were read from the prepared questions which were set during the proposal of this study. Participants were also asked to be recorded, to which they agreed.

After the interviews when the recording was turned off, there was a sense of relief by us and the participants and an air of happiness that we both felt something good had come out of the interviews. We thanked the participants and reassured them that their participation would be kept confidential and would be treated such that the information would not be traced back to them. From the above, it seems clear that the method of interviewing was a suitable choice for this study. We were able to obtain a lot of information for later analysis.

4.6 Data analysis

Data analysis was conducted immediately after the survey and interviews were completed. For this we used statistical analysis tools to better delineate the results of the study.

4.6.1 Quantitative Data analysis

Data was captured using the IBM SPSS (version 23) which collated all the information into a spreadsheet. Data captured from completed questionnaires were coded in excel and imported into SPSS. Frequencies, frequency percentages and cross tabulation to establish the level of significance in the results from data collected. Creswell (2014) and Creswell and Creswell, (2017) posit that statistical procedures that the researcher applies to the data are depended not only upon the purpose of the analysis, the way the researcher wants to communicate the finding to the reader and knowledge of statistical procedures, but also on the capabilities of the software. Literature suggests that once the data has been correctly entered according to prescribed instructions, the possibility of errors is vastly reduced. To do this, we read through the responses to ensure that the data was correctly captured.

4.6.2 Qualitative data analysis

A methodical approach set out by Parahoo (1997) was followed in order to analyse the data. This method included categorising the data according to the types of participants, i.e. operators, managers, supervisors and ICT personnel. All interviews recorded were transcribed verbatim and read in order to get used to them.

The following procedure was followed to analyse qualitative data in this study: Documents were analysed comparatively and organised into families according to the type of participants. Once organised, similarly themed quotes were extracted from which we were able to seek out codes. The codes made it easier to categorise similar remarks and cross reference them. The remarks made by interviewees that pertain to crucial aspects of the data collection were coded by noting the themes and meanings within the remarks. Themes were then expanded into subcategories. The themes were also used to provide full descriptions of the experience. Interconnected themes were noted and grouped accordingly.

Once the themes were grouped they were analysed to see how often they agreed or disagreed with one another. When transcribing the information, we made sure to listen to the mannerisms of the participants. Implicit assumptions were recognised and addressed and could be linked back to observations made during the interviews. By the time, we were finished transcribing we knew the data verbatim since during transcription we had to keep rewinding the tape back and forth to repeat some of the words. This was so as to try and work out the organising principles, which naturally underlie the material. Therefore, by the end of each interview we had already identified the themes that were prevalent and were able to pick the themes out of the other interviews as soon as they came up.

4.6.3 Quality and Trustworthiness

The meanings emerging from the data needed to be tested for their plausibility, sturdiness and confirmability. Reference to Guba (1985) is made by Shenton (2004) who favours the four constructs of:

- Credibility: According to Guba (1985), credibility is involved in establishing that the results of the research are believable. By repeatedly going through the interview material and identifying the prevalent themes, we were able to gain some sense of credibility to what the participants were sharing with us. This was because of the fact that some of the participants were not aware who we would be interviewing and yet they were able to tell us similar stories. Furthermore, we noted that despite the vast geographical locations and the different environments, the respondents' attitudes towards the work with or without the ICT systems were mostly the same.
- Transferability: This refers to the degree in which the research can be transferred to other contexts according to Guba (1985). For this study, transferability was ensured by interviewing participants in different terminals which operated under different conditions. For example, at DCT, which is the busiest terminal in South Africa, operations are continuous and rarely ever stop while other terminals can experience stoppages for days without any vessels to work on. However, the ways in which they indicated what the effect of a system downtime was, were similar. Therefore, the unavailability of the ICT systems was transferable despite of the setting in which it occurred. Similarly, this experience can be used for other operations that rely on mission-critical systems.
- Dependability: According to Guba and Lincoln (1989), dependability is the equivalent of the term "reliability" which, in quantitative research terms, means that the same tests should produce the same results across testing situations. In other words, dependability is an evaluation of the quality of the integrated processes of data collection, data analysis, and theory generation. For this study, the description of the methodology followed is an attempt to create dependability for future researchers. Transcripts of the data collected will also be included for researchers to evaluate for themselves.
- Confirmability: This means the degree to which the outcomes could be confirmed or corroborated by other people. The interviews generated a lot of material which had to be transcribed and filtered for useful information and to reduce saturation. For our study, transcripts that were used in the study will be included for audit purposes.

Shenton (2004) however, warns that whether these constructs are accepted or not is dependent on other researchers. There is a debate, according to Loh (2013) that argues about whether the terms of quality and trustworthiness can ever be acceptable to all. The issue that feeds this debate is the fact that data which is collected is subsequently open to interpretation (Auerbach & Silverstein, 2003). The solution that Auerbach and Silverstein (2003) propose is that each coder's interpretation must be transparent (understandable) to other coders. The methods used to analyse the data such as coding, grouping by themes and cross referencing are what are considered standard methods in research (Parahoo, 1997).

4.7 Ethical considerations

In observance of moral standards that are expected of research projects, approval to conduct the study was obtained from the University of Venda who issued out an ethical clearance certificate. Further permission was obtained from senior management at Transnet Port Terminals to collect data at the port terminals. Ethical guidelines that were observed consisted of the ethics for scientific research such as those pertaining to plagiarism, and the treatment of human subjects when conducting research as set out in the Belmont report (Cassell, 2000).

Permission to collect data was granted by the Chief Executive for Transnet Port Terminals after obtaining the ethical clearance for the Research and Publications Committee at the University of Venda. Permission was sought from the respondents on the email that was sent to the sample of the population. On the email we explained the reasons behind the request to respond in the survey.

The letters of approval and the clearance certificate were presented to participants at the beginning of the study to show them that everything we were doing had prior approval. It also helped us explain the reasons for what we were trying to achieve with the research, thereby providing transparency and fulfilling requirements for informed consent. None of the participants were coerced into responding, all participated with their own volition.

4.8 Summary

This chapter described the research methodology which was used to maximise valid answers to the research question. This was achieved by using a non-experimental, mixed method, exploratory-descriptive approach that was contextual to the container terminal environment.

Questionnaires and interviews were used to collect data. Data was analysed using a combination of tabulations and graphical presentations, as well as the use of statistical software such as Atlas.ti. Ethical considerations ensured that we observed the beneficence, human dignity as well as justice principles, to protect participants. Chapter 6 will discuss the data analysis and findings.

Chapter 5: Quantitative Results

5.0 Chapter Overview

This chapter presents and discusses the quantitative results from the survey component of the study. The aim of this chapter was to gather data that would inform us of the internal working of CTO. A wide variety of the demographic of a container terminal organisation was contacted and requested to participate in the survey which dealt with topics regarding operations, disruptions and their impact on CTO and the organisation, alternatives to disruptions and BCM. For the origin of all data presented herein is available please see Annexures A to C.

5.1 Introduction

The first part of this chapter presents and discusses the demographic results of the data collected from the 160 respondents through a questionnaire which was administered in various terminals. The second part of this chapter answers the research questions on whether it is possible to run container terminal operations if there is a loss of centralised ICT systems and whether the use of BCM to carry on with operations can be employed. The data presented and analysed in the second part of this chapter were obtained from online, face-to-face and telephonic administered surveys, completed by 160 (n=160) participants from national and international terminals. The data was used to address the four research questions given below and are discussed in two phases.

RQ1

What is the impact of ICT on operations in the container terminal sector?

RQ2

What are the critical processes and functions that a container terminal requires to stay operational?

RQ3

What are the current BCM practices that are employed by container terminal operations that respond to the loss of centralised ICT systems?

RQ4

What framework for BCM can container terminal operations use in the loss of centralised ICT Systems?

5.2 Quantitative data analysis

A questionnaire consisting of 32 items, was administered online to 160 respondents (See Annexure D). Of those 160 targeted respondents, 117 (73.1%) responded to this survey. The questionnaire revealed the following results which are presented and discussed in the following subsections.

First, the demographic profile and the main trends and patterns are presented and discussed. These demographic variables correlate best with the responses on container terminal operations, ICT systems for container terminals and business continuity management (BCM). The following variables were included in the analysis:

- Country of operation
- City of operation
- Role of the respondent in relation CTO
- Management level
- Experience
- Interaction with operations

These demographics establish the respondent's relevance to this study based on the areas they operate in, their roles within the CTO organisation including their level of management. According to Wyse (2012), demographics should be based on the main topic of the study. Respondents from different levels of management may experience differently the impact of the loss of ICT systems during operations. Appropriate identification of research participants is critical to for assessing the results (making comparisons across groups), generalising the findings, and making comparisons in replications. Furthermore, the precise reporting of methods and demographics is especially important when determining the generalisability of research findings (Sifers, Puddy, Warren & Roberts, 2002) with operational and non-operational staff.

5.2.1 Country of Operation

Ninety percent of the respondents were from South Africa. The high number of responses from South African ports, where the terminals are fully automated and the busiest in Africa, suggests that ICT is being widely relied on for optimum operations. There were also respondents from the United Arab Emirates (UAE) (0.85%), Mauritius (1.7%), Hong Kong (1.7%), Singapore and Mozambique (0.85%) who responded. The country of origin of the respondents will establish the global extent regarding the impact of ICT on container terminal operations. Responses from around the world can also help us establish that this study can also be of high benefit to the international CTO.

5.2.2 City of Operation

Results show that respondents are spread out between different cities which include Cape Town, Durban, Dubai, Mauritius, Hong Kong, Singapore, Maputo, East London and Port Elisabeth (Table 5.1). The majority (71%) of the respondents were from Durban, the largest terminal in South Africa (transnet.net, 2013). Durban also provided the best area for observation since it is the busiest terminal in Africa and relies on automation for moving containers on the terminals.

5.2.3 Functions of computer users in the terminal

Participants were requested to indicate their day to day functions at the terminal to establish how well placed they were to answer the upcoming questions to help us get different viewpoints from the range of computer users in terminals. While our main target has been operations and IT staff, we also wanted to broaden the range of respondents to find out what they too think and to check against bias in selecting answers. This would also help us get different viewpoints from a range of computer users in a terminal. We needed to ensure validity of results by checking whether the same result could be obtained from different respondents' every time.

Table 5.1. Respondents per city

Terminal	Respondents	Percent of Respondents
DCT Pier 2	69	58.97%
DCT Pier 1	11	9.4%
East London	7	5.98%
Port Elisabeth	9	7.7%
Cape Town	11	9.4%
Ngqura	3	2.56%
Port Louis	2	1.7%
Singapore	1	0.85%
Hong Kong	2	1.7%
Maputo	1	0.85%
Dubai	1	0.85%
Total	117	100%

Of those who took part in the study, 29% were Managers who are accountable to business productivity, manage reports regarding any unavailability of ICT. They are the first to know how unavailability impacts on productivity. When verifying statistics, those managers indicate that the ICT has a significant ($p <= 0.00$) impact on container operations as its unavailability is reportedly the worst disruption they ever experienced (Annexure B).

Table 5.2 presents results showing that 46.2% of the respondents were IT staff. These are people in the container terminals who manage ICT availability and are therefore indirectly responsible for terminal activities which are dependent on ICT to operate. Of these, 97.8% indicated that the worst disruption they ever experience in their work environment is when ICT is unavailable, suggesting a significant ($p = < 0.05$) impact ICT has on container terminal operations because all operations stop when ICT is unavailable (Annexure B).

Table 5.2: Roles of respondents

Role	Number	Percentage
Operations	34	29.1%
ICT	54	46.2%
Key accounts	10	8.5%
HR	4	3.4%
Technical	7	5.9%
Risk and Compliance	4	3.4%
Specialist	4	3.4%
Total	117	100%

CTO staff, who are the users who experience the impact of the loss directly since they depended on the TOS to conduct their duties, indicate that the TOS must always be available. This always suggests the need to account for this disruption for container terminals to stay operational. Similar sentiments are expressed by IT managers; all those who took part in the study indicate that ICT has a significant (the worst disruption they ever experienced in the container terminal was when ICT was unavailable. For them, ICT must always be available.

5.2.4 Management level

Managers are responsible for the successful operation of the terminal, from the strategy that is adopted o the day to day running of operations. They are the ones who are accountable to the disruption of CTO and are therefore always informed of any disruptions. Respondents from all management levels unanimously indicated that the Navis systems (the TOS) was what caused the worst disruption to CTO. This consisted of 100% of the executive, senior and supervisor level managers and 97.2% of skilled professionals and 55.6% of middle managers suggesting that the impact is significant ($p=<0.01$) (See Annexure B). The success of BCM is highly dependent on senior management being involved in its implementation. It is also highly dependent on the employees within the organisation practicing and using BCMs offerings. Any break has a negative impact on all CT operations. This links back to the objective of this study to determine the impact of the loss of ICT systems to the terminal. Figure 5.1 shows the breakdown of levels.

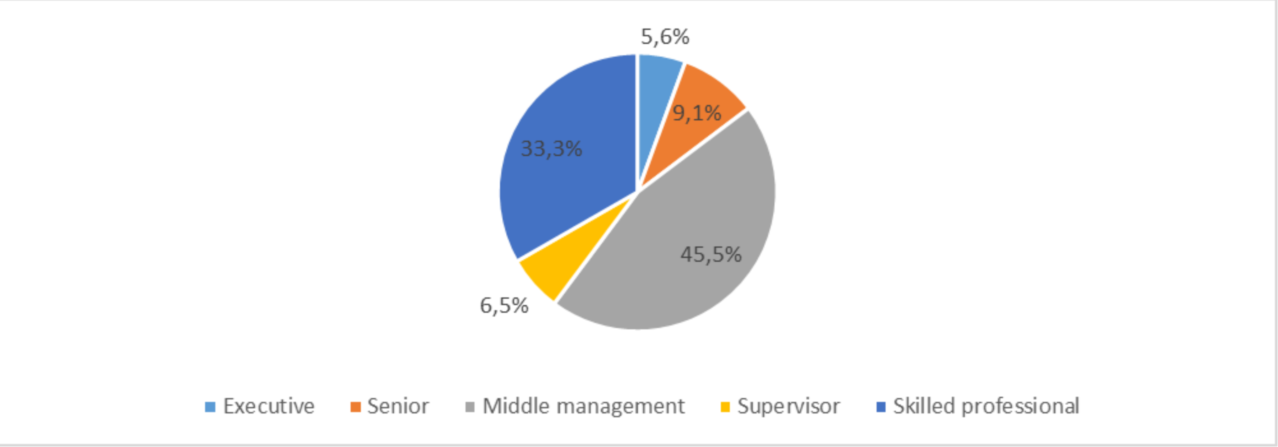

Figure 5.1: Management levels

These results presented a balanced mix of respondents and show that respondents covered a variety of expertise and management levels in terms of viewpoint.

5.2.5 Experience

We assume that having worked in the industry for a period of time may enable to establish the impact of ICT systems on operations. Accumulated experience in the CTO may be the best indicator of what happens whenever the system goes down. Those who have more years in this work environment would have probably experienced what happens when the system is down as this is not something that happens all the time. Most respondents had considerable experience to suggest the level of impact of ICT systems on operations based on lived experience and therefore reasonably reliable. There were 36.1% of the respondents who indicated that they had experience of between 2 and 5 years and 33.3% who indicated that they had 5 to 10 years' experience. Another 30.6% indicated that they had over 10 years' experience and 0% of the respondents indicated having less than 2 years' experience (Figure 5.2).

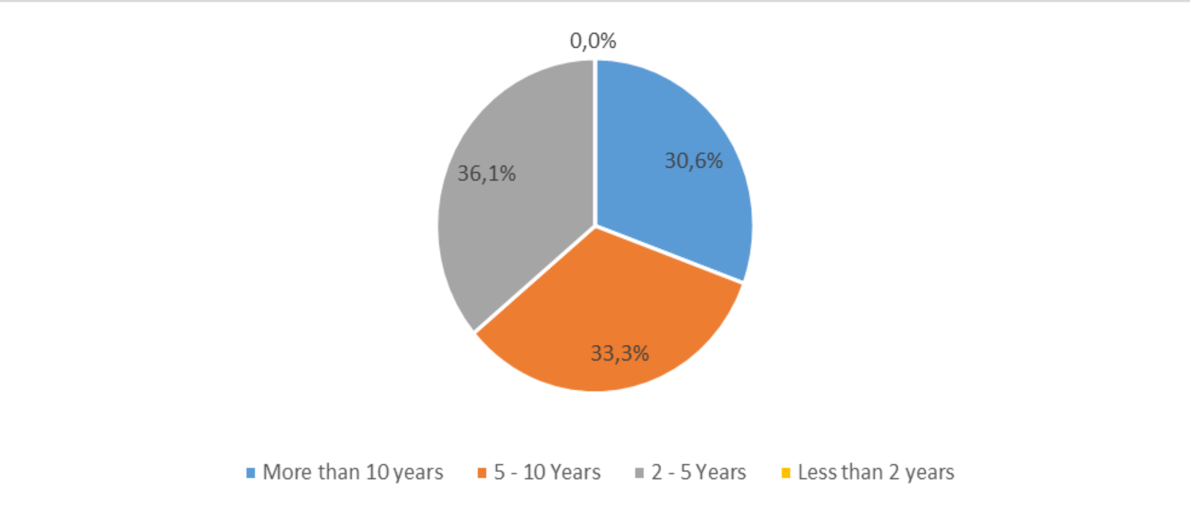

Figure 5.2: Experience of respondents

Respondents with more than 5 years' experience (33.3%) worked at the terminal at a time when the ICT system was not fully automated. They are knowledgeable of the types of consistent problems that plague operations. This suggests that they can their participation in this survey can lend credibility to the study since it comes from a well-informed base. Results show that 30.6% of respondents had more than ten years' experience. This demographic is from those who started during a time when there were manual systems being used in the CTO environment.

Out of the respondents who had more than 10 years' experience, 75.6% indicated that ICT downtime had a very negative impact on customers (p=< 0.009) and 62.2% indicated very negative impact on the business (p=< 0.000) (See Annexure A). This result was similar to that of those with 2-5 years' experience (75.6% very negative impact on customers, but 80.5% on negative impact on business) and therefore indicated that ICT downtime has throughout the years always had a highly negative impact on the business and its customers. This is as a result of the disruption that CTO experienced whenever there is ICT downtime.

5.2.6 Interaction with operations

Figure 5.3 shows the responses relating to the amount of interactions that the different respondents had with operations.

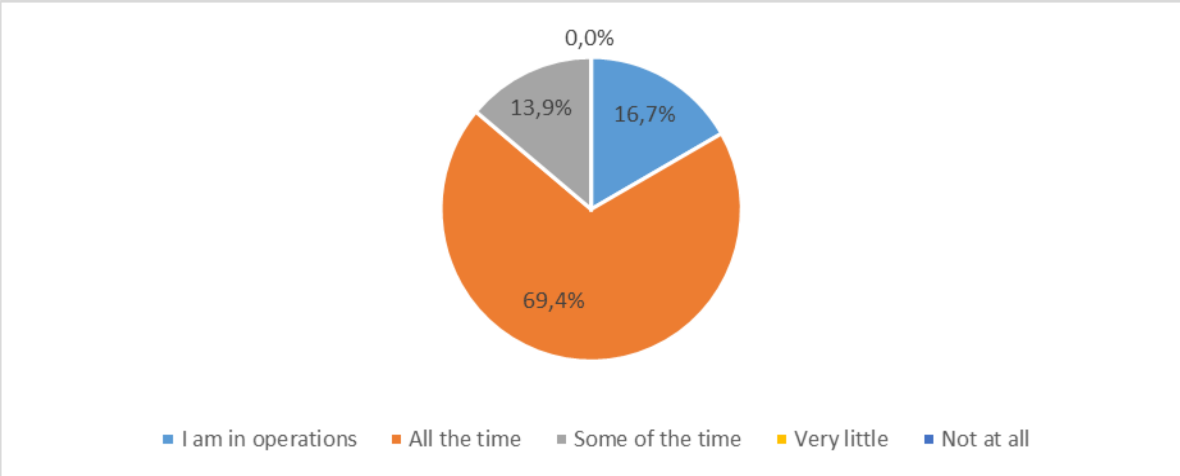

Figure 5.3: Interaction with operations

Most respondents (69.4%) indicated that they worked closely with operations while 16.7% indicated that they were inside operations (Figure 5.3). Having most respondents working closely with operations suggests that they know how operations functions. Their experiences are therefore critical because they provide a knowledge base which is essential for this study

5.3 Quantitative data analysis of the Critical Business Functions in container operations

The responses to the questionnaire (Annexure D) for this research revealed the themes mentioned below and from the data collected were then analysed in terms of these themes. The themes referred to are as follows:

- ICT contributes to worst disruptions ever experienced by operations
- Critical Business Functions that are conducted by operations
- Effect of ICT on CTO functions
- Causes and effect of daily ICT disruption to Critical Business Functions
- Effect of length of average daily ICT disruptions to Critical Business Functions
- Disruptions which completely stop critical operations.

5.3.1 Worst disruption ever experienced by operations

ICT Systems are a contributor to operational downtime, but not the only ones. Other contributors include technical equipment failures, labour action, email unavailability, weather, electrical power supply, traffic congestion and chemical leaks. A comparison needed to be made in order to determine the level of impact that ICT systems has on operations.

Table 5.3: What was the worst disruption that you encountered at the terminal and what was the cause?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Navis system down	94	81.7	81.7	81.7
	Weather delays	5	4.3	4.3	86.1
	Power down	1	.9	.9	87.0
	Strike	4	3.5	3.5	90.4
	Equipment failure/Unavailability	11	9.6	9.6	100.0
	Total	115	100.0	100.0	

The results (Table 5.3) showed that ICT ranked the highest (81.7%) amongst the causes of disruptions in operations. This suggests that the TOS is a key ingredient of CTO and therefore this study should guide what needs to be done when the TOS becomes lost. Operational downtime due to system failures suggest that systems should be protected from being lost since the organisation would not want to experience operational downtime. The remaining 18.3% did not select ICT as a major contributor to disruption which means they probably feel that CTO can continue without the TOS. However, this does not seem to make a substantial argument when compared to what the majority sees. These results show that ICT Systems remained the biggest cause of disruption and have a higher impact on operations.

5.3.2 Critical Business Functions that must stay operational at all times

The determination of Critical Business Functions is crucial when planning for business continuity since it is the Critical Business Functions of the organisation that need the most coverage by BCM (GPG, 2012). In order to define Critical Business Functions, the survey asked respondents to indicate which critical function they felt was the most important one in a container terminal.

Table 5.4: Critical Business Functions that must stay operational at all times

Response	% of Respondents
Loading and off-loading a vessel	101 (86.3%)
Loading and off-loading trucks	98 (83.7%)
Tracking containers within the yard	88 (75%)
Loading and off-loading trains	88 (75%)
Maintain an accurate container inventory of all vessels, vehicles and trains that enter or leave the terminal	89 (77.8%)
Monitoring of hazardous, refrigerated and special instruction containers	87 (69.4%)

Table 5.4 shows that loading and offloading vessels, trains and trucks as well as moving containers around the terminals are Critical Business Functions. The findings concur with literature from Steenken, Voß and Stahlbock, (2004); Brinkmann (2011); and Kim and Lee, (2015), who have presented these are Critical Business Functions that constitute operations within a container terminal.

Table 5.4 established that if ICT systems become unavailable, the Critical Business Functions cannot be performed. The determination of Critical Business Functions in CTO was one of the objectives of the study that would determine the requirements of the BCM Framework.

5.3.3 Functions that require ICT

Results indicate that none of the functions discussed above could be performed without ICT systems. Most of the respondents (61.1%) thought that none of those functions could be performed without ICT systems. Table 5.5 shows the responses for each function. Very few (27.8%) respondents chose any of the functions as being doable without ICT Systems with the highest number being choosing the monitoring of containers as being doable without ICT. The results link the ICT and operational functions by showing that the functions and processes need ICT systems to be performed. Since these functions are (a) critical to the terminal fulfilling its operations; (b) they need ICT in order to take place; and (c) ICT has been pointed out as the main cause of disruption to operations, these functions need assurance to continue operating even during an ICT outage. This would be crucial in determining whether the framework for business continuity should be established.

These results are supported by literature from Lau and Lee (2008), and Vacca et al. (2010) who found that the decision-making process is so complicated that it needs ICT systems for optimisation. Bish et al. (2007) and Boer and Saanen (2012) were more direct in stating that the management of the movement of Container Handling Equipment (CHE) was so complex that it was best handled by the TOS. ICT systems have a high impact on operations and would be highly disruptive if not available.

Table 5.5: Functions that cannot be performed without ICT

Response	% Level of responses
Loading and off-loading a vessel	6 (16.7%)
Loading and off-loading trucks	5 (13.9%)
Tracking containers within the yard	4 (11.1%)
Loading and off-loading trains	6 (16.7%)
Maintain an accurate container inventory of all vessels, vehicles and trains that enter or leave the terminal	3 (8.3%)
Monitoring of hazardous, refrigerated and special instruction containers	10 (27.8%)
None of the above	22 (61.1%)

The distinction between what is possible without ICT determines the scope of the BCM framework that is to be proposed. As discussed, the scope needs to be streamlined so that it focuses on only the most important needs of operations. It was determined that some of the functions, for example discharge functions, were possible without an ICT system. Discharge functions are possible because an area can be set up within the yard and containers placed there without real time inventory. Later on, they can be reconciled when the system comes back online. Therefore, the impact on operations is limited as some functions can still be operated in its absence.

Loading onto a vessel manually can have adverse effects on operations because any wrongly loaded container may be delivered to a wrong destination. The TOS, barring any human mistakes, has high accuracy rates when it comes to moving containers and that assists in avoiding several problems. However, working manually should be completely avoided even on offloading operations. This is because even the task of reconciling later can be beset with problems, especially when working with large amounts of containers.

5.3.4 Causes of daily disruption

The results (Table 5.6) showed that 46.1% of the respondents blamed system failures for causing disruptions daily. Planning around ICT system unavailability should be a priority when compared to other causes of disruption. The next bigger cause of disruption (30.5%) was inefficient planning which resulted in labour issues and slow response, 13.9% blamed it on equipment failures while 7.8% of respondents mentioned weather problems as causers of disruption at terminals. All these issues cause a disruption to operations; however, ICT was identified as having a major impact on operations. This also verifies our need to build a BCM framework to cover the loss of ICT systems.

Table 5.6: Daily causes of disruption

		Frequency	Percent
Valid	Weather	9	7.8
	System failures	53	46.1
	Equipment failures	16	13.9
	Start-up times	2	1.7
	Inefficient planning	35	30.4
	Total	115	100.0

5.3.5 Length of average daily disruptions

Knowing about the daily causes of disruption helps to determine events around which planning for BCM should be conducted. From these results, we can confirm that ICT systems do need to be covered since their unavailability does pose a big problem to operations.

The results in Figure 5.5 showed that 20% of respondents selected half hour and 31.4% of respondents selected one hour which indicated that disruptive problems were sorted within an hour while 31.4% felt that they took two or more hours to resolve. Disruptions of any length will have a very negative impact on container terminals. For example, there can be losses of revenue when operations come to a standstill or there can also be a loss of customer satisfaction some of whom might even leave for the competitors. Respondents also indicated that downtimes had a negative impact on the image of the terminal and thought that an ICT downtime would be detrimental to business.

When checking these results against respondents from across all roles that are played at all terminals we saw that there is a highly significant relationship between availability of ICT and operations. The length of time taken to resolve daily disruptions when checked against the fact that ICT is the main cause of daily disruptions, shows that ICT systems on average take less than an hour to resolve. By determining the length of time, we can then also determine the impact of ICT on operations. Others (17.1%) could not indicate the length of time.

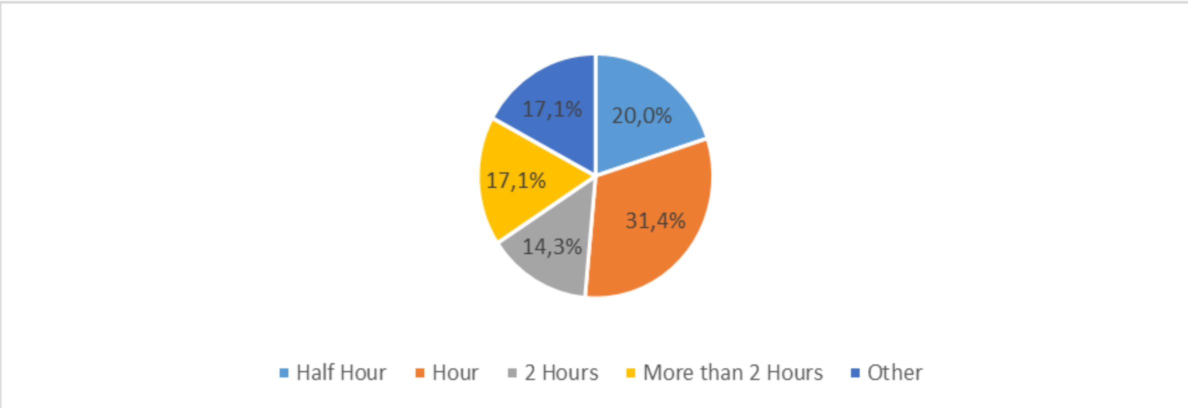

Figure 5.5: Length of average daily disruptions

These results indicate that system problems normally result in downtimes that can last half an hour or more before resumption of operations. For CTO these times are considered disruptions that are too long. Currently, there is a BCM framework that container terminals employ, however, there seems to be an indication that it is not followed every time there is a disruption. Part of the reason is because it is a manual method which is unable to kick in within a timeframe not more than 10 minutes. This impacts highly on operations since it brings a complete stoppage.

5.3.6 Disruptions which completely stop operations

When ICT was pitted with other major problems such as labour, electrical supply and mechanical equipment to determine the impact of ICT on operations, ICT systems were found to have the highest impact. Respondents were almost even on the impact of electrical supply and mechanical equipment (61.1% for either one) on operations. Manpower was chosen by 69.4% of the respondents (Figure 5.6).

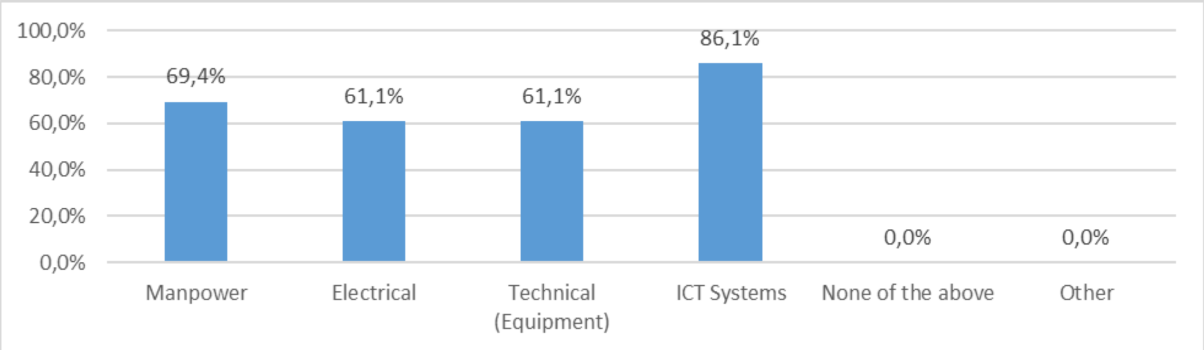

Figure 5.6: Complete stop causers

The results show that in terms of risk, ICT (86.1%) is more likely to halt operations than manpower, electricity and equipment with technical problems. Respondents have indicated that a major cause of disruption was ICT amongst other disruptions such as labour issues, traffic problems and equipment failures. Furthermore, by bringing operations to a complete stop suggests that ICT downtime has a very high and negative impact on operations. The results further suggest that ICT systems needs to have a robust BCM framework to keep operations running. Furthermore, the proposed BCM framework should be able to be invoked within 10 minutes. Invoke, invocation and invocable; are terms used in BCM to refer to the call to begin BCM proceedings (Swartz, 2002; Hiles, 2007).

5.4 Support systems for operations

A series of questions that looked at the various support systems that were provided by ICT Systems for Operations was asked (See Annexure D). The questions focused on the ICT systems other than the TOS to ensure that we were not focusing on just one system. In order to determine the Critical Business Functions that must stay operational at all times in operations, there needs to be a clarification on which functions will be more critical than others. Through the questions, we wanted to determine the impact of ICT on operations when compared to other functions. Other ICT systems that are provided to operations are:

- File sharing
- Printing
- Email
- Telephones
- Data Terminals
- Automated gate (Autogate) system

Respondents were asked to give their opinion on the ICT systems based on their best knowledge of operations. The rating was on a scale of 1 to 5, 1 being '*Can work without it'* and 5 being '*Cannot work without it*'. The reasons for including questions relating to the significance of other ICT systems such as email, telephones, autogate, data terminals, file sharing and printing are:

- It can be argued that these too are ICT systems which provide ICT functions.
- That some of these systems may not need to be included in the BCM Framework.

5.4.1 Significance of the TOS in operations

On this question, 77.8% of respondents rated the TOS at a 5 (Figure 5.7). The rest rated it at less than 4. This shows that respondents have reservations towards working without the TOS.

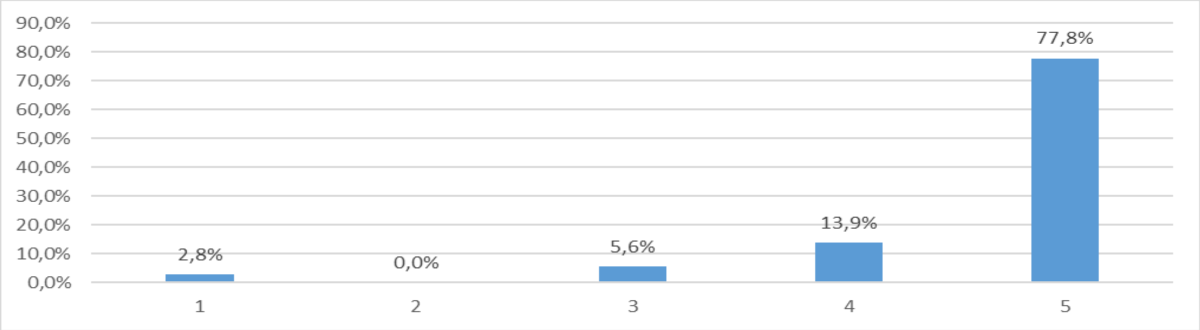

Figure 5.7. Significance of the TOS in operations

The TOS has been observed as highly significantly related to container terminal operations; loss of the TOS has a significant negative impact on operations in container terminal. Work queues, one of the most important and complex Critical Business Functions in moving operations, will not be available without the TOS. Loss of the TOS has a negative impact on operations because operations stop immediately. The stoppage has a high and negative impact on operations since operations must run continuously on a 24-hour basis.

5.4.2 Significance of File Sharing to Operations

Compared to the TOS, file sharing was not rated as highly by respondents, in fact ratings were mixed. Figure 5.8 shows that 38.9% rated it at 5, 19.4% rated it at 4, 27% rated it 3 and 11% rated it 1.

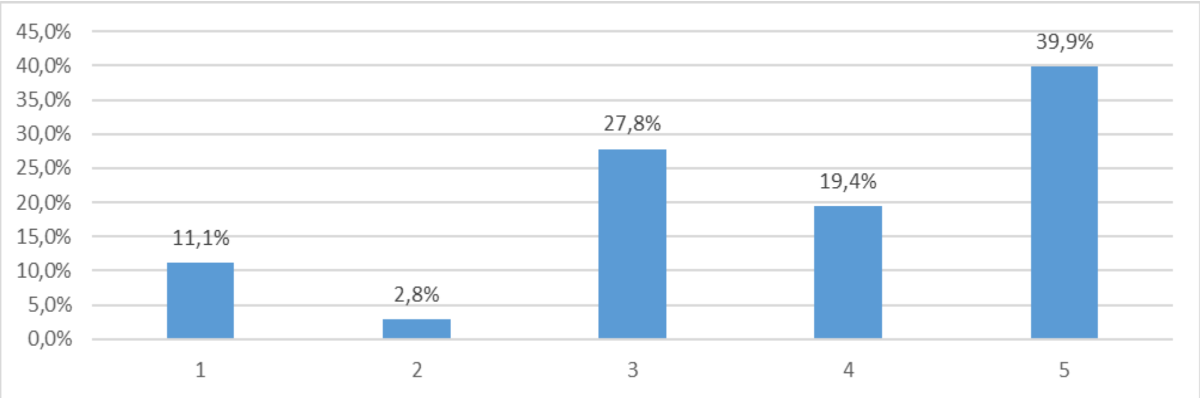

Figure 5.8: Significance of File Sharing to Operations

File sharing is important to operations since it allows the storage and sharing of the necessary files that planning requires for it operational needs. However, as these results show, it is not as critically important to operations as the TOS is. The requirement for BCM is that it is not all the functions of ICT system that need to be included in the BCM, but rather only the ICT systems that have a high impact on operations. According to the BCI GPG (2012), when preparing for the BCM application, all functions that are not critical to continuation of operations need to be eliminated.

The TOS was observed to have positive impact on operations (by choosing mostly a rating of 5 and not including the other ratings) while on this question results were mixed. This indicates that respondents did not consider file sharing as significantly important to operations. File sharing therefore has a minor impact on operations and may not be included in the BCM. This lessens the complexity of the BCM framework that is to be applied.

5.4.3 Significance of Printing Services to Operations

Printing services seem to be important to operations according to respondents, 68.6% of whom gave it the high ratings of 4 and 5 (Figure 5.9). The rating rose gradually from 2.9% giving it a rating of 1, 11.4% giving it a rating of 2 and 17.1% a rating of 3.

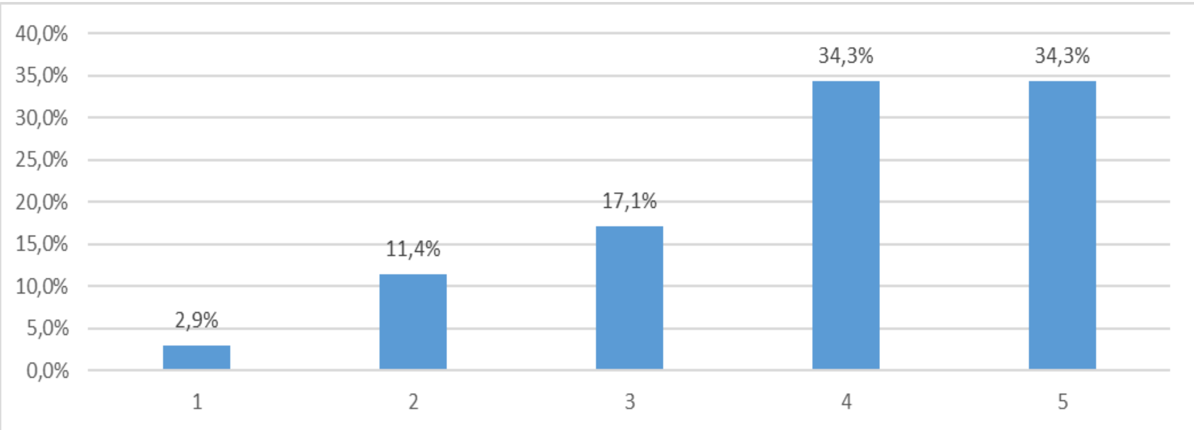

Figure 5.9: Significance of Printing Services to Operations

Printing services are critical to planning and operations. Work plans, berthing schedules and job allocations are printed and referred to during berthing meetings and before shifts begin on a daily basis. However, since printing services are not required throughout the rest of the operation, they too are not as critical as the TOS. The results show that should printing services on their own experience problems, they would not be detrimental to operations. Therefore, they don't really need to be included in the BCM Framework. The printouts however, will need to be always available should the need arise to work manually. As discussed, working manually is not to be considered as a workable BCM Framework.

5.4.4 Significance of Email to Operations

Responses to this question were varied, with 36.1% of respondents giving email a rating of 5, slightly higher than the 25% of respondents who gave it ratings of 4 and 3 equally (Figure 5.10). Again, a rating of 1 was given by more respondents (11.1%) that the rating of 2 which was only 2.8%. The conclusion that can be drawn from this is that email is not considered critically important to operations.

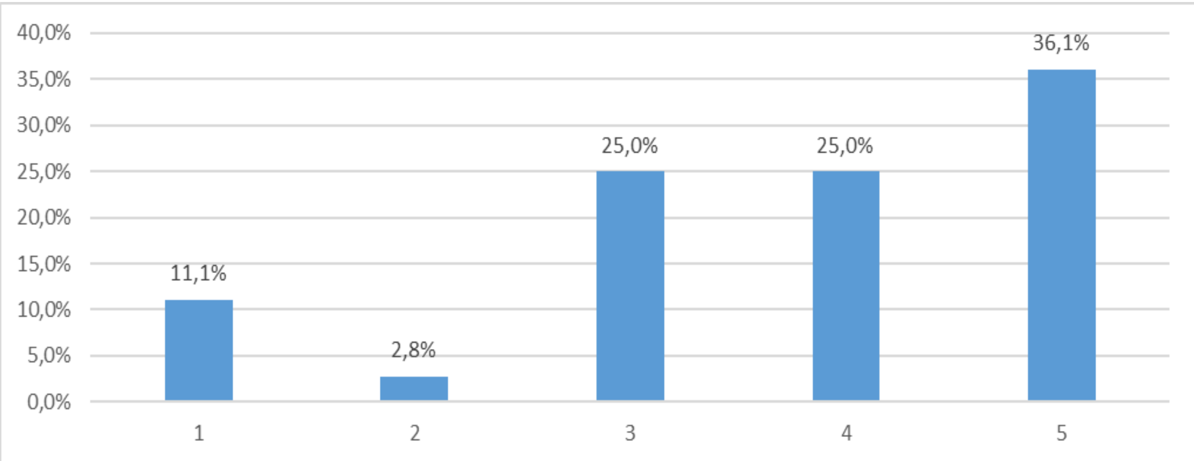

Figure 5.10: Significance of Email to Operations

During normal operations, email is a heavily used tool by the planning department. However, once initial planning has been conducted, the need for email becomes less realised. This is because the functions that require email will have already been executed. Because unavailability of email will not cause operations to stop, it too will not need an extensive BCM plan to cover its unavailability. This finding therefore suggests that the scope of the BCM framework that will be covered in this study should not cover email availability. A reduction in the scope of the BCM leads to a reduction in complexity. In relation to the literature reviewed, the use of ICT systems in every form is essential to the smooth operation of container terminal operations. However, according to these results, email is not a critical function to operations.

5.4.5 Significance of Telephones to Operations

There was a mixed feeling on the significance of telephones with 47.2% of the respondents, indicating that operations cannot work without telephones (Figure 5.11). A further 30.5% felt slightly less the same by giving this question a rating of 4 and 11.1% rated it at 3, meaning that they neither agreed nor disagreed. These results suggest that telephones have little meaningful impact on operations. The results therefore suggest that even if left out, operations may still run smoothly.

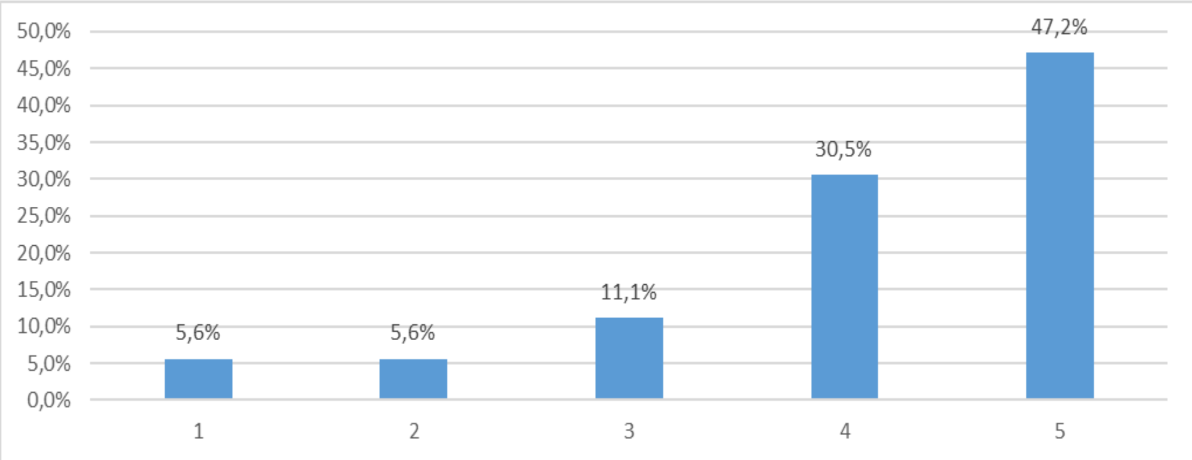

Figure 5.11: Significance of Telephones to Operations

The mixed feeling on these results can be understandable because of the fact that operations don't entirely require telephones since they also rely heavily on radios. For operations most of what can be communicated via telephone can also be communicated via radios. The BCM scope will therefore not need to cover telephones should they become unavailable. This lessens the scope that the BCM framework should cover and therefore reduces complexity.

5.4.6 Significance of Data Terminals (Vehicle and Hand Terminals) to Operations

An overwhelming number of respondents at 83.3% rated data terminals as being important to operations, with the rest of the respondents evenly selecting the rest of the ratings. This therefore indicates that data terminals are very important in operations (Figure 5.12.).

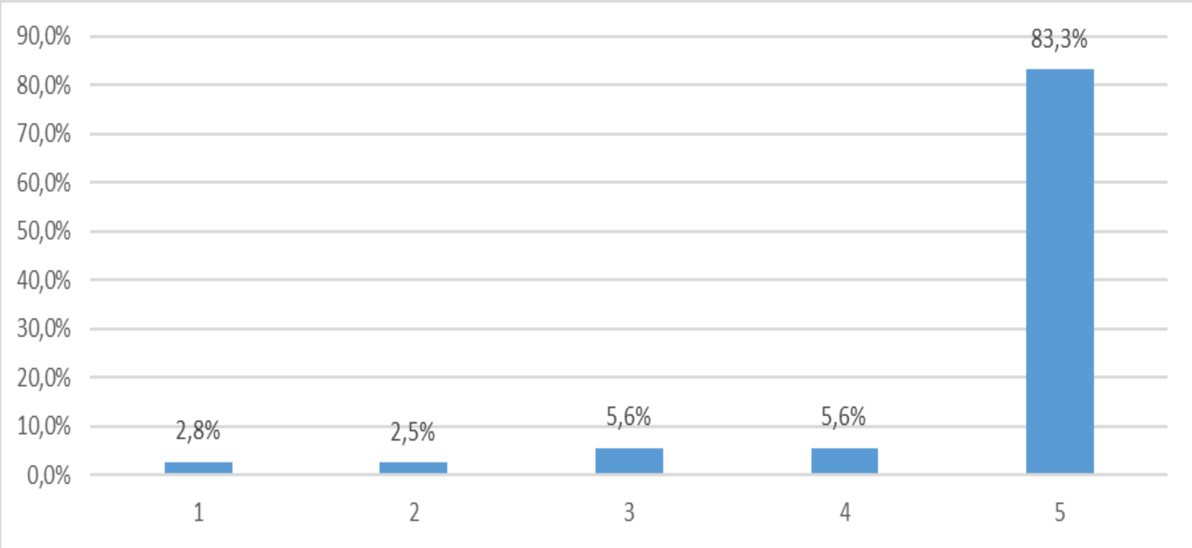

Figure 5.12: Significance of Data Terminals

Data terminals are the medium on which operations interface with the TOS (Rintanen, 2011; and Dematic, 2009). Since data terminals eliminate the need to communicate work instructions to operators over the radio, their loss would bring operations to a stop. These results suggest that data terminals have a positive impact on operations they also need to be included into the BCM scope. This finding is of crucial significance since radio channels need to be kept free of chatter. Too much and unnecessary chatter on the radios creates an unsafe working environment since CHE handlers cannot communicate amongst themselves to look out for each other.

5.4.7 Significance of the automatic gate (autogate) operations

The gate operating system is an important function in operations as it handles the movement of trucks in an automated fashion. However, respondents (61.1%) did not rate the significance autogate as highly as the data terminals with another 19.4% rating it even lower at 4 (Figure 5.13). However, this still means that a combined 80.5% of respondents saw it as being important.

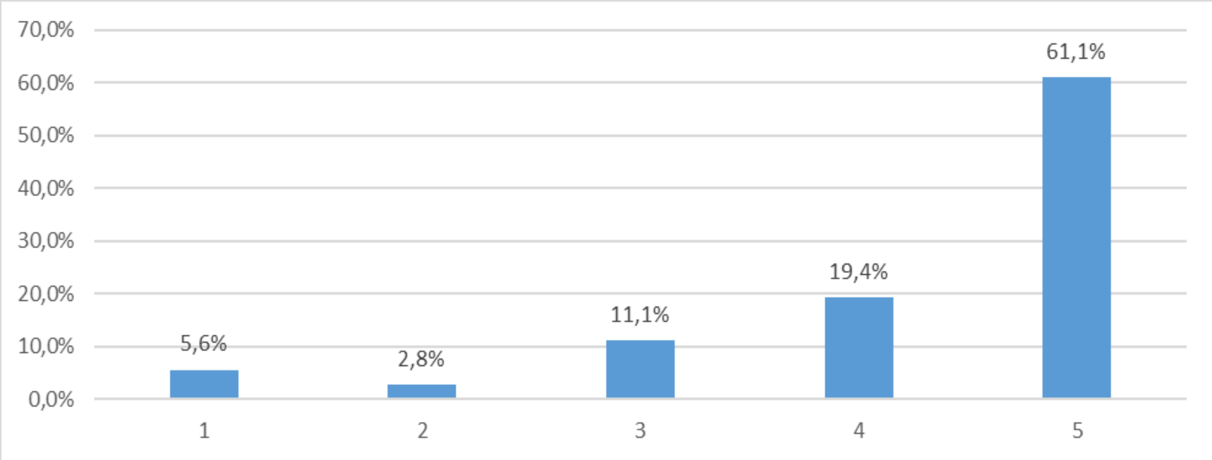

Figure 5.13: Significance of the autogate to Operations

The results indicate that the autogate has a high impact on operations and must therefore be kept running in the event that there is a loss of ICT systems. The gate function and the TOS operate simultaneously in moving containers in and out of the terminal as observed elsewhere in literature (Lun et al., 2010; Kim and Lee, 2015). Further literature by Zehendner, (2013) and Way (2009) gives a breakdown of enhancements that can be added by autogate such OCR cameras and RFID infrastructure. These enhancements are what eliminate the need to operate gates manually and also assist in handling considerable truck movements a day (depending on the size of the terminal)

From the literature reviewed, we can confirm that the unavailability of the autogate will be detrimental to operations. Without the autogate in an automated terminal it would require that all trucks be stopped from moving. This has a highly negative impact on operations; once all trucks stop moving; there is no movement of containers which may result in blockages inside the terminal and loss of revenue to clients. Working manually for gate transactions can be fraught with problems like fraud, lost containers and inefficiency (Zehendner, 2013). Although gate transactions can technically be handled manually, working manually is to be avoided in container terminals because of inefficiency and openness to fraud. Therefore, the scope of the BCM framework will have to cover gate transactions in their entirety.

5.4.8 Support systems conclusion

Results from the past seven questions were able to confirm that ICT systems have a high impact on container terminal operations. The TOS and applications related to the TOS (i.e. Autogate and data terminals) were found to be critical and would therefore have a negative impact on operations if they became unavailable. From this, we can conclude that the BCM scope can concentrate on the TOS and its supporting applications including the autogate and data terminals. The questions in this segment were meant to determine the functions that if disrupted, would bring operations to a stop. Operations can continue even if emails and telephones were offline. Command centre participants can use cellular phones and operations can use radios if there are disruptions to communications. Although the other ICT functions which include email, printing, file sharing etc. have an impact on CTO, their impact is low, and they will therefore not need to be included in the proposed BCM Framework.

5.5 BCM practices at container terminal operations

Responses were sought to determine current BCM practices at container terminals operations. Respondents were asked to indicate the need for BCM practices at container terminals in relation to each of the following issues:

- Working manually, which is a common BCM practice in environments that rely on ICT systems;
- BCM practices which would best fit a particular environment.
- BCM maturity level which would determine the BCM practice that can reasonably be practiced in container terminals.
- Downtime timeframes which would determine the timeframes required to be applied in the BCM Framework.

5.5.1 Working manually

Results show that 41.7% of respondents think that in extreme cases, operations could be carried out if ICT systems were unavailable (Figure 5.15). However, 58.3% indicated that it couldn't be done no matter what the situation. These results suggest that full operations cannot be carried out in the absence of ICT systems.

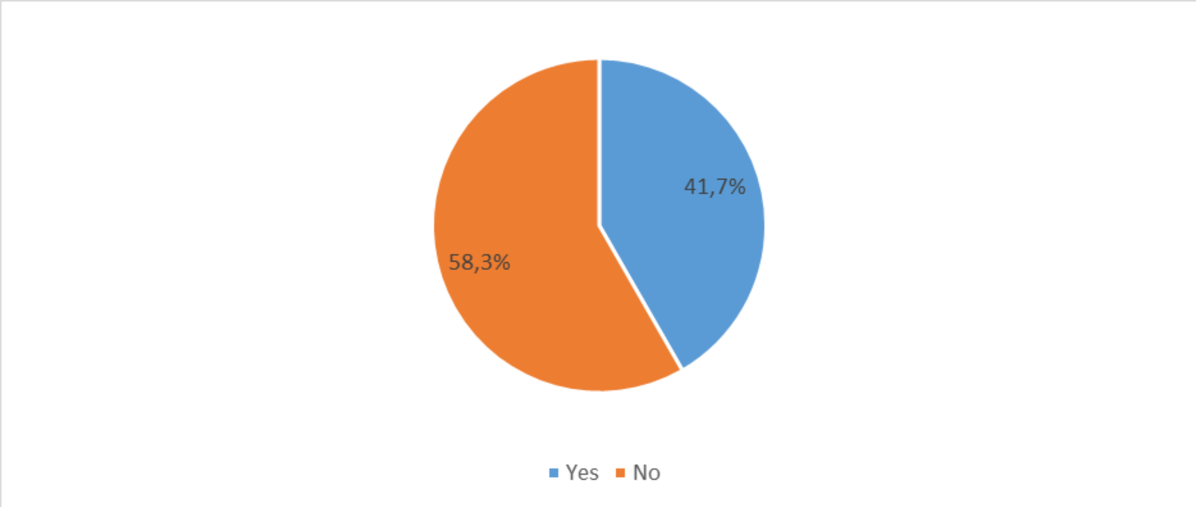

Figure 5.15: Working manually

Working without the TOS would mean that operations may need to be performed manually to cover the functions that are normally handled by the TOS. Working manually involves operations being run without an ICT system in place. This would require all work queues to have been printed beforehand, suggesting that all container movements would have to be communicated via radio to the CHE handlers. In a large container terminal, this would require a lot of communication via the radio as tens or hundreds of CHE are instructed to move around the terminal. Given the conditions on terminals, operating in this manner would be highly inefficient and may even be dangerous as the rate of human error may be considerable. Literature by Dotoli et al., (2010); Kamwela and Kampelewera, (N.D.); and Pilat, (2004) indicated the impact that ICT systems have on operations. The results also indicate the level of significance of implementing a BCM solution: if unavailability of ICT Systems means that operations cannot be carried out, then a BCM solution becomes necessary.

These results suggest that ICT has a positive impact on CTO; there are no operations without ICT systems. These results are in agreement with the finding that working manually while using paper based systems should be avoided. These results have a profound impact on the type of BCM framework that may be employed in the absence of ICT systems. The implication of this finding is that the BCM solution for the absence of ICT systems should not be one where manual methods are used.

5.5.2 Applying BCM practices

The majority (82.9%) of respondents indicated that they knew what business continuity planning was. The other BCM practices were less well known with 51.4% indicating that they knew what contingency planning was and less than 40% knowing what crisis planning, continuity of operations planning, and scenario planning were. These results establish there are BCM practices which are used in container terminals. Respondents selected the given choices from the multiple-choice question in the following manner in Figure 5.16:

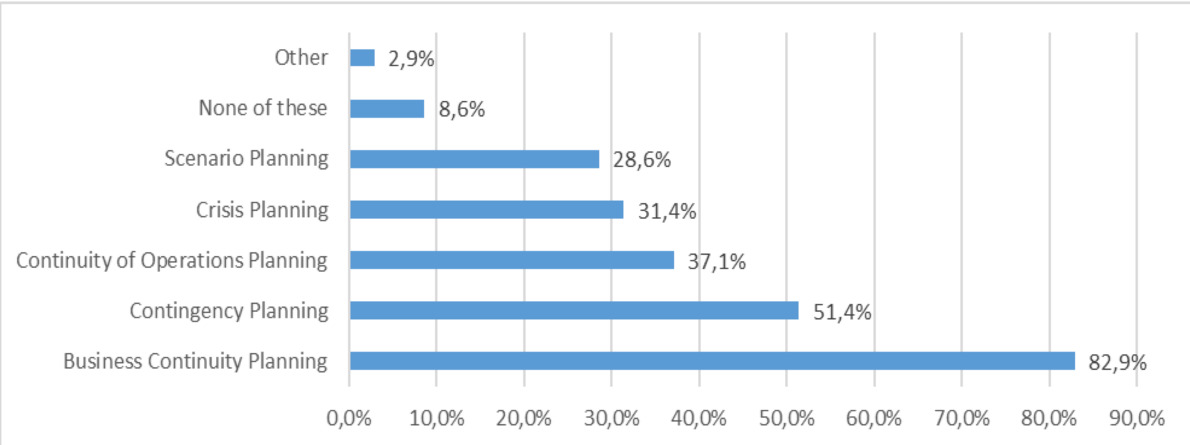

Figure 5.16: BCM practices

These results (Figure 5.16) show that respondents are aware of what BCM is and can even describe the types of BCM that they are aware of. It was critical to establish respondents, knowledge on BCM in order to establish the direction in which our solution of a BCM framework will take. The significance of BCM needs to be emphasised to employees; as pointed out by Duroseau (2015) and Snedaker and Rima (2014). Emphasising and inculcating BCM practices to employees helps maintain and ensure that the BCM that is in place can be practised by the employees should the need arise. This is normally achieved by communication and practice runs performed by the organisation to educate the employees. It is also one of the fundamental requirements of BCM implementation which seeks to ensure that BCM becomes part of the company culture.

5.5.3 BCM maturity for Operations for all events

Respondents were mixed; 28.6% indicated a maturity level of 1; 22.9% indicated a maturity level of 2 and 31.4% indicated a maturity level of 3. Only 2.8% of respondents felt that the maturity level was 4, and 14.3% of respondents felt that the maturity level was at 5 (Figure 5.17). The maturity level of an organisation is a method used to provide a way to characterise an organisation's performance by focusing on process improvement on a manageable number of process areas. It can be used to assess an organisation against a scale of five process maturity levels. Each level ranks the organisation according to its standardisation of processes in the subject area being assessed (Paulk, Weber, Garcia, Chrissis & Bush, 1993).

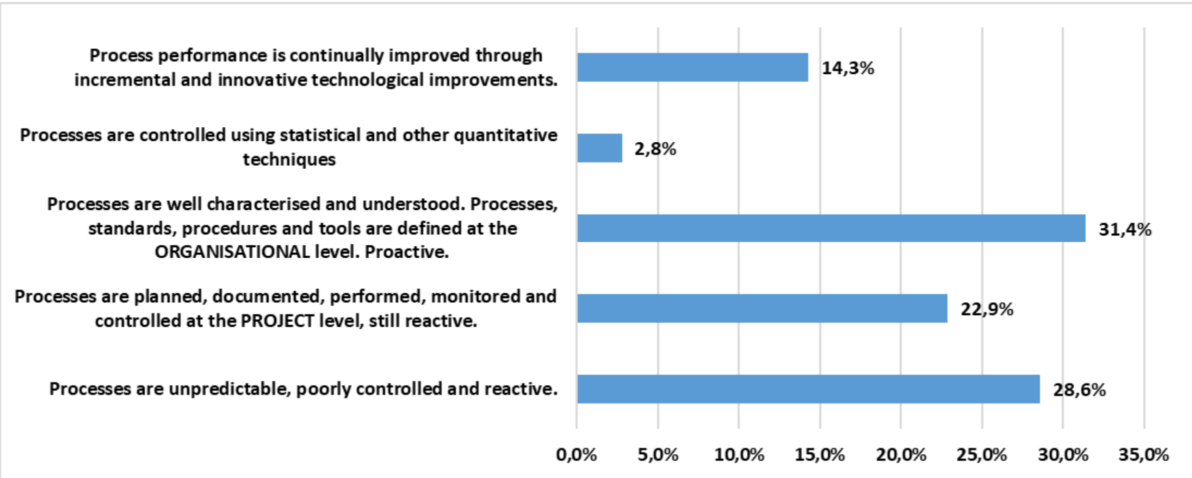

Figure 5.17: BCM for OPS for all events

The results indicate that for overall BCM, terminals were not fully covered in terms of business continuity. They assist in determining the level of effort of the implementation that will need to be conducted. Although BCM works best when it is fully implemented, not all organisations need to implement it fully. This is because of reasons such as the size of the organisation, or the costs of implementing an all-encompassing solution.

5.5.4 BCM specifically for IT

The results established respondents' knowledge of the level of BCM implementations in their terminals. The majority (74.3%) of employees knew that there was a BCM specifically for IT, only a few (25.7%) did not know. These results suggest that BCM for IT is critical for operations in container terminals.

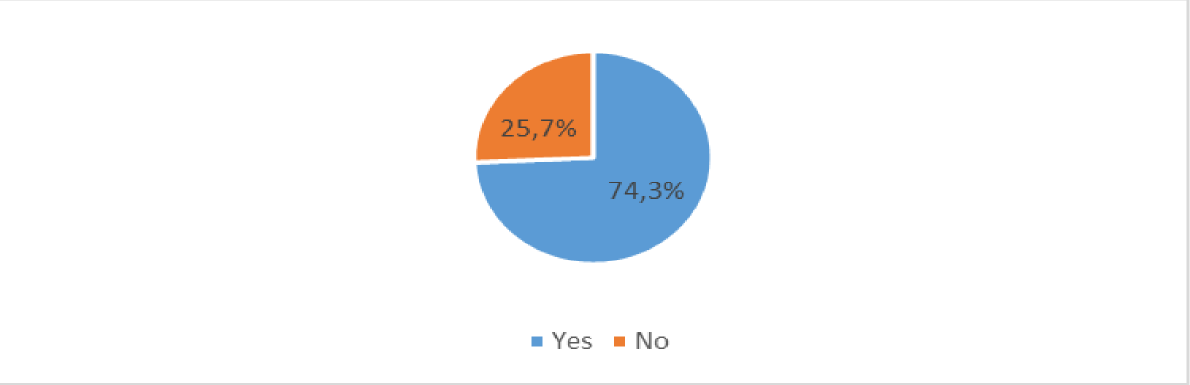

Figure 5.18. BCM specifically for IT

The results also confirm what has been discussed that BCM for the absence of ICT systems is in place and is being used as well. However, the method that is followed is the manual and paper based. As already indicated, working manually at the terminal is to be avoided.

5.5.5 BCM maturity for operations in case of ICT Systems loss

Respondents were asked about the maturity level of BCM in their terminal operations and 42.9% felt that there was a medium level of BCM implementation while 25% felt that it was low (Figure 5.19). Some respondents (21.4%) felt that there was continual improvement while another 21.4% selected the lowest option which suggested that they thought it was poorly executed. Only 10.7% felt that it was well matured and advanced. None of the respondents chose the maturity level of 4. None of the respondents felt that there was a controlled BCM which used quantitative techniques.

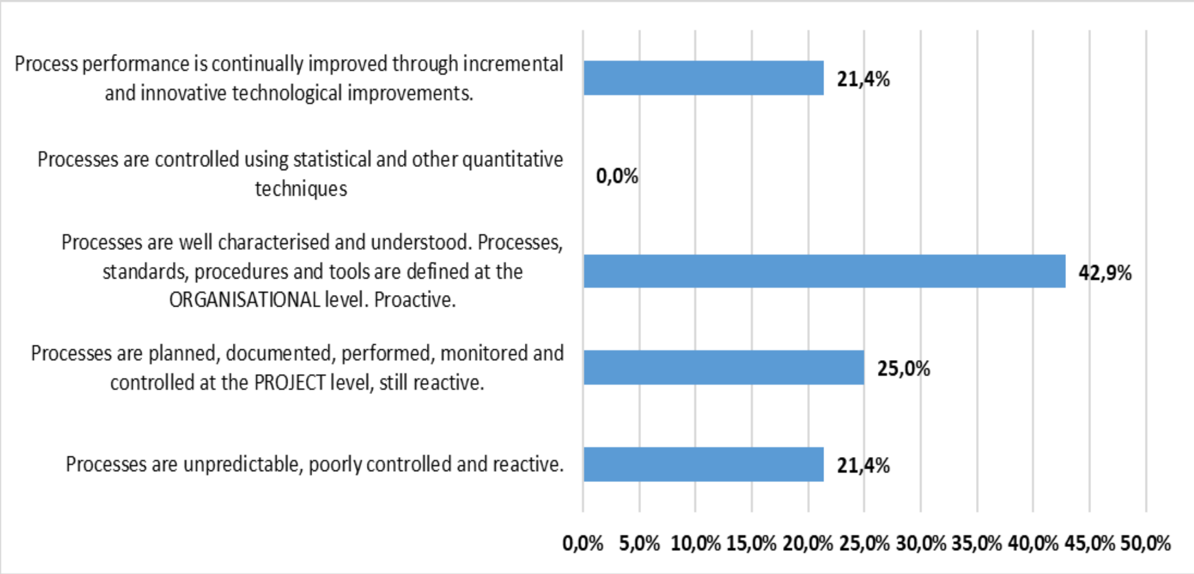

Figure: 5.19: BCM maturity for operations in case of ICT Systems loss

Based on the maturity level indicated, these results show that even though respondents thought that there was a BCM implementation, it wasn't effectively implemented. Results may also indicate that some respondents did not understand the meaning and concept of BCM. From the results we can conclude that (1) BCM is in place and (2) that it is understood by employees.

5.5.6 No BCM for operations in case of ICT Systems loss

Those who responded "No" to question 24 above, were asked to elaborate on their choice of answer. There were 6 respondents who responded to this question. For this question, 43.8% of those respondents said they weren't aware of BCM while 25% said they didn't know why there wasn't a BCM specifically for IT but felt that it was needed (Figure 5.20). 18.8% did not indicate why they thought there was no BCM for IT. Equally, 6.2% each felt it was not necessary and 6.2% thought it would never work.

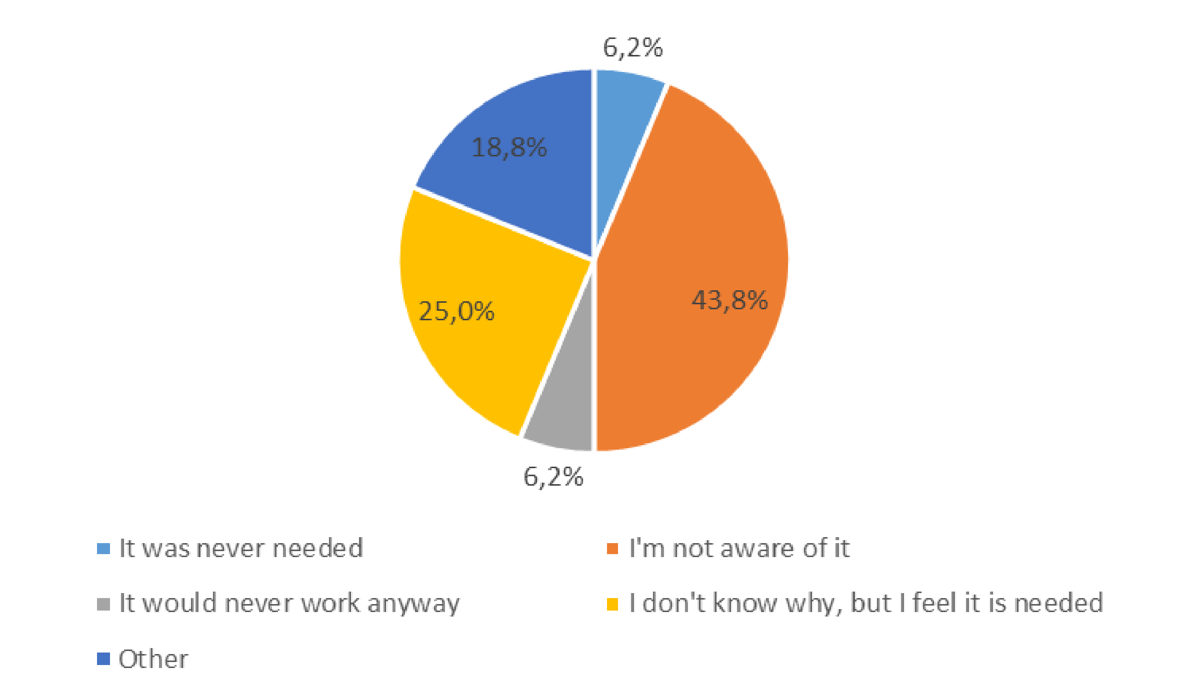

Figure: 5.20: No BCM for operations in case of ICT Systems loss

Indication from this is that while there is talk of BCM, few, if any, have ever witnessed it being implemented. This confirms the finding that the level of BCM should be enhanced and implementation should be more widespread. The results therefore indicate that (1) some employees do not have knowledge of the functions of BCM and (2) that there were some very few who were unaware of BCM. However, the majority of the respondents had knowledge of BCM.

5.6 ICT Availability

The BCI GPG (2012) recommends that lengths of downtime that organisations can afford must first be determined when developing a BCM strategy. They can be determined by conducting a business impact analysis which produces the Recovery Time Objective (RTO). Results from earlier questions indicated that ICT systems were one of the major disruptors of operations. In this question respondents were required to indicate how they dealt with disruptions caused by ICT system unavailability.

5.6.1 Maximum downtime that operations can afford

This question aimed to find out the tolerance level of total shutdown of operations due to any factor. Of the respondents, 23.5% felt that operations can only tolerate a downtime of 10 minutes, while 35.3% indicated half an hour as the maximum (Figure 5.21). Around 32.4% felt that an hour was tolerable and the rest indicated a period of 5 hours to a whole day. Only 2.9% thought it was 5 hours and 5.9% thought operations could afford all day to be down.

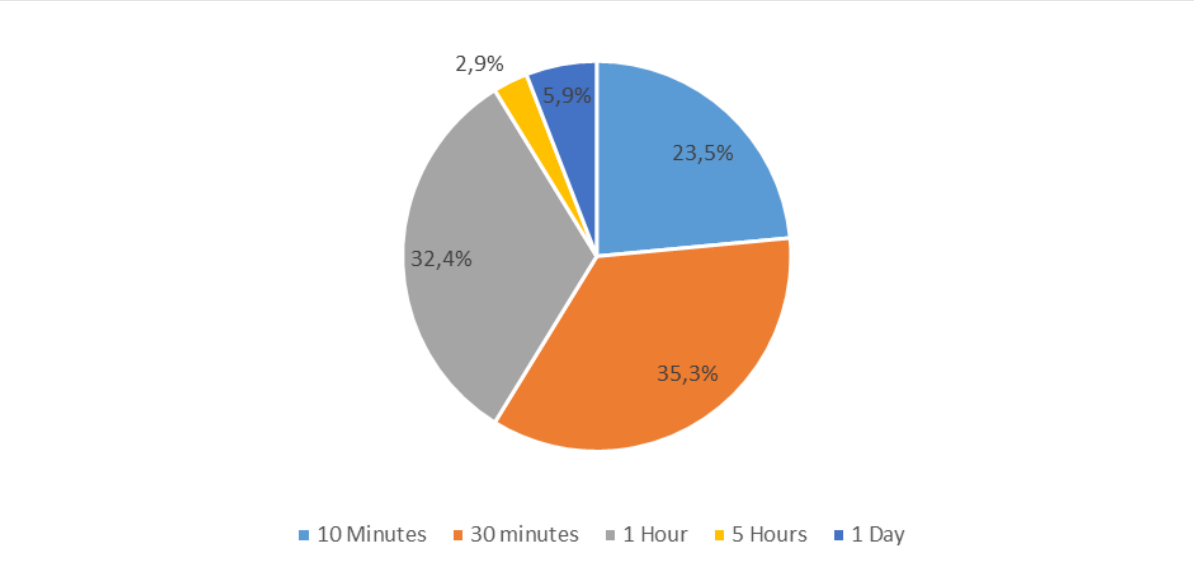

Figure: 5.21: Maximum downtime that operations can afford

The responses indicate a sense of urgency in container terminal operations which means that disruptions are completely intolerable. By selecting 10 minutes' minimum downtime (by 23.5% of respondents) and 30 minutes' minimum downtime (by 53.3% of respondents), the combined majority of the respondents were indicating that disruptions should not take more than 30 minutes. Hence, continuity is of paramount significance to container terminal operations and downtimes of more than 10 minutes should be avoided.

The determination of downtime is important when conducting a business impact analysis (BIA). For instance, by determining the downtime that operations can afford, we are also determining the tolerance level for downtime by operations. According to

Tammineedi (2010), the determination of tolerance levels is one of the key objectives for a BIA which in turn, is one of the key components of a BCM.

5.6.2 Level of uptime for ICT in the terminal

When queried about the level of IT uptime, 31.4% thought it was up all time while 65.7% indicated that ICT was up, most of the time (Figure 5.22). The other 2.9% felt that IT availability was intermittent at best.

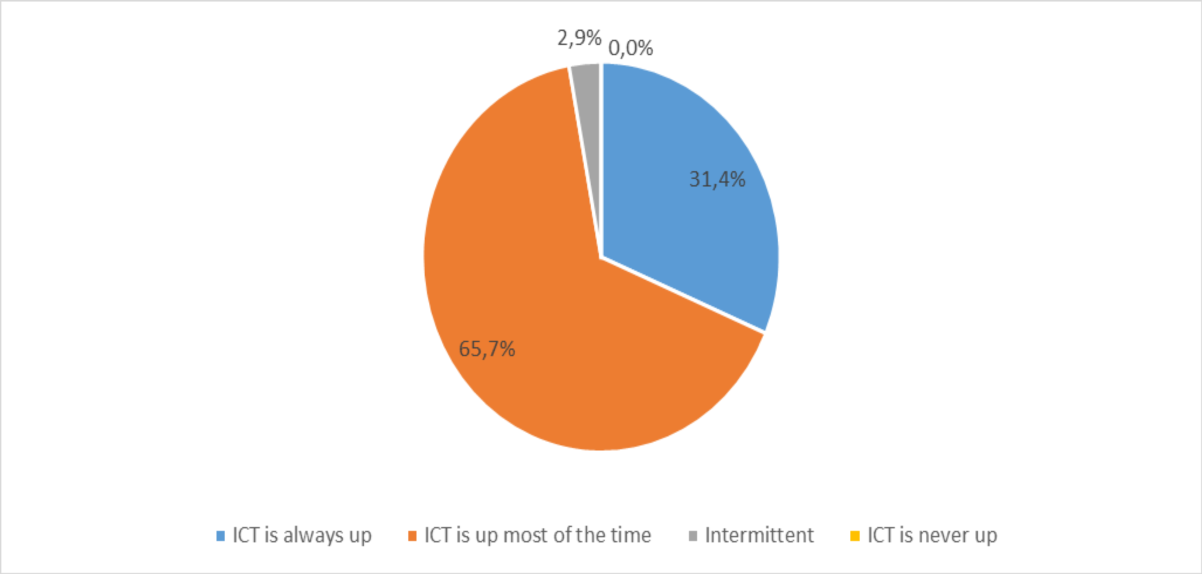

Figure: 5.22. Level of uptime for ICT in the terminal

The fact that ICT is available most of the time indicates why terminals have always been able to work despite ICT downtime not being fully addressed. BCM implementation has never been that big at container terminals and this finding shows why. However, as the 65.7% indicated, ICT is up MOST of the time. This shows that despite the resiliency measures in place, there are times when ICT systems experience downtime. This finding has a further implication, that the BCM framework should be one that can be implemented within a short space of time. In relation to this study, these results help us investigate the BCM practices at container terminal operations.

5.6.3 Steps which Terminal Operations take when ICT Systems go down

The question on what operations do when ICT systems go down yielded some interesting facts because respondents were asked to write in their own words. Their answers however, were mostly the same, with 80% indicating that nothing was done and that operations were stopped until the system was available again (Table 5.7). Around 20% indicated that operations were able to continue. One respondent indicated that it depended on the size of the terminal; in that large terminals have to stop while the smaller terminals could in effect be run in a manual mode. The results are confirmed by considerable literature (Dotoli et al., 2010; Kamwela & Kampelewera, N.D.; Pilat, 2004). In their contributions to literature, these authors also conclude that ICT systems have taken over operations so much that operations will have to stop if ICT systems become unavailable.

Table 5.7: Currently, what does Operations do when ICT Systems go down?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Stop operations	92	80.0	80.0	80.0
	Go manual	23	20.0	20.0	100.0
	Total	115	100.0	100.0	

These results show that although business continuity is practiced in CTO, operations employees do not practice it and therefore they stop operations. This is because working manually at the terminal is normally avoided. Furthermore, the need for a BCM framework that is ICT based is further demonstrated.

5.7 Impact of ICT downtime on business

For container terminals to operate, ICT systems must always be available. The impact of ICT downtime was indicated to be high and negative by respondents.

5.7.1 The impact that ICT downtime has on the business

Most of the respondents (63.5%), indicated that ICT downtime would be very negative as it would lead to a loss of revenue since operations would come to a standstill (Table 5.8.). 27% of the respondents indicated a lower level of negative as they were worried about the delays that downtimes caused. The remaining 9.6% indicated that they were unsure of what the impact would be.

Table 5.8: The impact that ICT downtime has on the business

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very negative	73	63.5	63.5	63.5
	Negative	31	27.0	27.0	90.4
	Not sure	11	9.6	9.6	100.0
	Total	115	100.0	100.0	

Khalfay's (2011) labelling of ICT systems as an enabler for operations confirms these results. Since ICT systems enable operations, unavailability of ICT systems therefore disables operations which negatively impacts on business. ICT downtime leads to a complete standstill in operations. Working manually should be avoided because of added complexity, reduced safety, and fraud.

5.7.2 Effect of ICT downtime on the perception of the terminal

An overwhelming 95.7% of the participants felt that downtimes had a negative impact on the image of the terminal (69.6% indicated "Very negative" and 26.1% indicated "Negative"). The other 4.3% percent only indicated that they were unsure. This finding indicates that due to its high impact on CTO, the ICT system causes a highly negative influence on the image of the organisation when it becomes unavailable. It is for this reason that unavailability of the ICT system needs to be covered through business continuity.

Table 5.9: Effect of ICT downtime on the image of the terminal

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very negative	80	69.6	69.6	69.6
	Negative	30	26.1	26.1	95.7
	Not sure	5	4.3	4.3	100.0
	Total	115	100.0	100.0	

5.7.3 Consequence of ICT downtime on customers

This question solicited answers that were unanimous in that the impact would also be negative to customers. Respondents mostly thought that it would have very negative consequences and some also thought that customers will eventually leave for competitors. For the same reason as on the previous question, when the ICT system becomes unavailable, customers become negatively affected. This negative effect comes in the form of inconveniences from lost time caused by long waiting times which also result in lost productivity. A robust BCM will therefore help improve how the organisation's obligation to its service delivery is fulfilled.

5.7.4 Summary on quantitative section

Results indicated that ICT systems have a high impact on CTO. The ICT systems used in container terminals cover a variety of functions other than the TOS. Results further indicated that the TOS, gate operations and data terminals had a high impact on CTO. Results indicated that (1) container terminals already had a manually conducted BCM implemented and (2) that it was not being followed. Other information obtained from the results also indicated that stoppage of CTO would have detrimental effects on the image of the organisation and its ability to satisfy its customers.

The questionnaire used to collect quantitative data was closed ended, therefore it did not give respondents an opportunity to provide reasons for all their choices. They were also not able to provide any further unsolicited information. Pre-determined choices from the questionnaire might not have been able to cover every possible reason for certain behaviours by employees

Chapter 6: Qualitative Results

6.0 Chapter Overview

This chapter presents the findings from data collected qualitatively through interviews with respondents in CTO and ICT support (See Annexure F). The sample consisted of participants from around the globe and from levels of operations and management including ICT support.

More information needed to be gathered from respondents which included their reasoning, feelings and individual approaches to CTO. This information, which needed to be solicited through interviews, would allow us to improve the quality of the quantitative data collected, data free from errors and bias arising from subjectivity that may have creeped in during development of the questionnaire, thereby increasing their reliability. Information gathered through interviews would provide personal experiences of respondents regarding ICT systems, their role in CTO and how the absence of ICT systems would need to cover through BCM. Quantitative methods helped us determine the system being used and qualitative methods would be needed to explain the reasons why the system was in place.

6.1 Analysis

The discussion in this section is presented showing the main trends and patterns in the data with reference to the research questions in relation to the objectives of the study and the literature review in Chapter 2.

6.2 Demographic background

The demographic composition of the sample consisted of purposely selected senior operations managers, operations workers, ICT support analysts, a BCM specialist and a safety manager. Their experience ranged from four years working with container terminals to over twelve years.

6.3 Analysis of Results

In line with deductive research approach, the qualitative analysis relied on theoretical thematic analysis to analyse and interpret the qualitative data. The following sections presents the analysis of the data and the emerging interpretations.

6.3.1 Critical Operations in a Container Terminal

In order to understand the nature of operations of container terminals, response was sought to determine Critical Business Functions that require the use of computerized Information Systems (IS) (Table 6.1), as well as the typical causes of disruptions to operations. Results revealed that that respondents were spread out between different cities South Africa (Cape Town, Durban, East London, Port Elisabeth Dubai, Mauritius, Hong Kong, Singapore, Mozambique (Maputo) (Table 5.1). The majority (71%) of the respondents were from Durban, the largest terminal in South Africa. Durban also provided the best area for observation since it is the busiest terminal in Africa and relies on automation for moving containers on the terminals.

The determination of Critical Business Functions is crucial when planning for business continuity since it is the Critical Business Functions of the organisation that need the most coverage by BCM. The respondents indicated that that none of these Critical Business Functions could be performed without ICT systems. Most of the respondents (61.1%) thought that none of those functions could be performed without ICT systems. Since these functions are (a) critical to the terminal fulfilling its operations; (b) they need ICT in order to take place; and (c) ICT has been pointed out as the main cause of disruption to operations, these functions need assurance to continue operating even during an ICT outage. This would be crucial in determining whether the framework for business continuity should be established.

Table 6.1: Critical Business Functions in CTO

Function	% of Respondents
Loading and off-loading vessels	101 (86.3%)
Loading and off-loading trucks	98 (83.7%)
Tracking containers within the yard	88 (75%)
Loading and off-loading trains	88 (75%)
Maintain an accurate container inventory	89 (77.8%)
Monitoring of hazardous Materials	87 (69.4%)

6.3.2 Current BCM Practices

In order to develop a rationale for a cloud based BCM, the research sought to understand what the current practices of BCM were. Before delving into the responses that emanated from the case study in South Africa, an online survey sought to understand if the respondents were conversant with terminologies or concepts linked to BCM and whether the organisations they worked in practices aspects of BCM. The majority (82.9%) of respondents indicated that they knew what business continuity planning was (Figure 6.1). The other BCM practices were less well known with 51.4% indicating that they knew what contingency planning was and less than 40% knowing what crisis planning, continuity of operations planning, and scenario planning were. These results establish there are BCM practices which are used in container terminals. It was critical to establish respondent's knowledge of BCM before carrying out in depth interviews related to current practices in the Durban port in South Africa. Emphasising and inculcating BCM practices to employees helps maintain and ensure that the BCM that is in place can be practised by the employees should the need arise. This is normally achieved by communication and practice runs performed by the organisation to educate the employees. It is also one of the fundamental requirements of BCM implementation which seeks to ensure that BCM becomes part of the company culture.

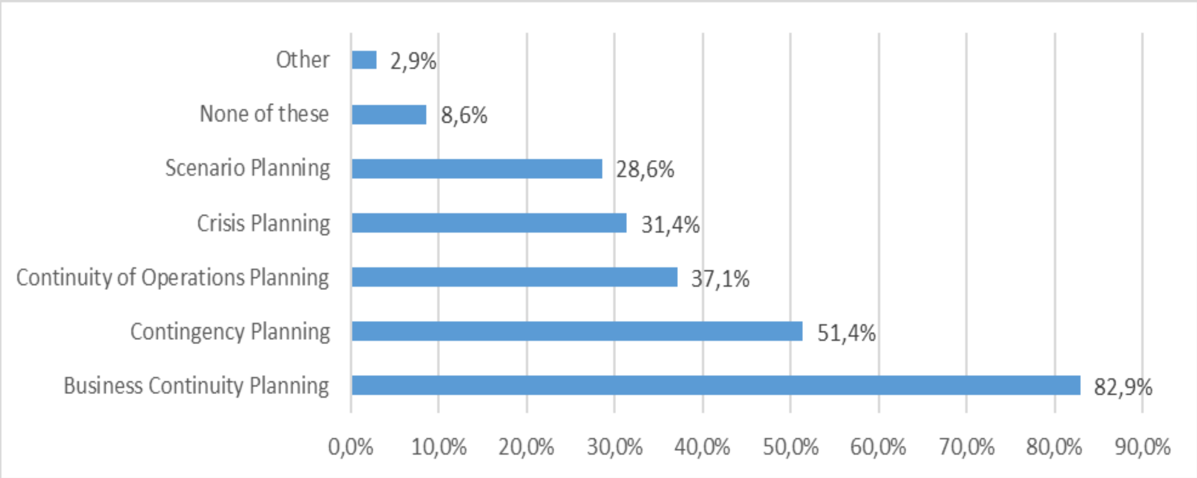

Figure 6.1: BCM Practices

For in depth case study, interviewees were requested to indicate how BCM was handled at their terminals. Since BCM practices normally encompass the entire organisation, respondents were asked questions that related specifically to BCM in the context of the loss of ICT systems. The findings indicated that there was no viable BCM planning in place, with majority of the respondents pointing a finger to the low level of maturity of BCM implementation in their organisations. Results further indicated that although the maturity level was low, some basic foundations for BCM at container terminals were in place. The respondents indicated that there were some ideas on how BCM could be conducted including operating the gates manually, segregating the terminal into sections that can be operated on separately, and by requesting more manpower. The entire BCM planning is currently based on manual and paper-based methods.

Interviewees were requested to indicate how BCM was handled at their terminals at the time of the interviews. Since BCM practices normally encompass the entire organisation, respondents were asked questions that related specifically to BCM in the context of the loss of ICT systems. Several sub-themes (Table 6.2) that capture their responses related to: performance impact of BCM (Ref 1); labour substitution (Ref 3) and silo operations (Ref4).

Table 6.2: Current BCM Practices

Ref	**Text: Excerpts**	**Discursive Analysis**
Ref 1	[…] When we have got a continuity issue, performance will get affected. However, always remember when you have a continuity issue, you will not operate, at the optimum that you usually operate when there is no continuity issue.	Performance Impact
Ref 3	[…] also, when the system comes back up, probably need to get people to input the data so that it doesn't mess up, the planning configuration. […] You have to get more cargo coordinators. You need to get more cargo coordinators, ehh, plan more manual, ehh, stack sheets. Also, when the system comes back How can we maybe... if there is an issue of manpower that we need more, get more manpower.	System Failure and Labour Substitution
Ref 4	[…] How can we split the terminal. We can actually make it work.	Silo Operations

BCM rests on the recognition that its implementation results in organisational resilience (Niemimaa et al., 2019). This view was captured in Ref 1, under the theme christened as "performance impact", recognising that organisations that experience disruptions cannot operate optimally. This sentiment captures the notion of resilience, thus giving credence to the view that the respondents are aware of the critical impact BCM has in the organisation. However, even though there is an understanding of the criticality of BCM for the organisation, the additional responses reveal a sense of disregard of BCM in actual practice as captured in responses Ref 3 and Ref 4. Ref 4 and Ref 5 elevated the notions of "labour substitution" and "silo mentality". The response related to "labour substitution" had a connotation that people can play the role of restoring the business to normal operations while bereft of ICT systems; while the "silo mentality" advances the perception that segregating the organisation into independent operational entities can replace the need for BCM.

These findings indicate that either there is no viable BCM in place, or there exists a low level of maturity of BCM implementation the organisation, exacerbated by an apathic culture towards BCM as exhibited by the responses (Ref 3, Ref 4). However, some basic foundations for BCM at container terminals are in place revealed through an affirmation of an existing BCM system as well as awareness of the impact BCM can have on organisational resilience (Ref 1).

6.3.3 Current Architecture

The logic for proposing a framework requires that the current architecture for BCM systems be understood. In the ensuing sections, the aspects of the current architecture are reported before delving into the details of the proposed architecture from the viewpoint of the interviewees. This reporting is done in order to unearth the critical challenges related to the current architecture that can provide a motivation for a new system relevant for BCM. Even though this was the focus, respondents still recognised that the current system had certain benefits. Some of these benefits related to the robustness of the system are minimal space requirements and the ease of integration with other programs. However, the critical impediments of the current architecture revolved around two themes: "*Unproductive and "Opaque" Cluster of System*s" and "*Ineffective Load Balancing*". These two themes are further discussed below, with support of interviewee excerpts.

6.3.3.1 Unproductive and "Opaque" Cluster of Systems

Five sub-themes (Table 6.3) capture the essence of the current unproductive and "opaque" cluster of information systems found at the container terminal: poor user centred interfaces (Ref 5), lack of information sharing (Ref 6) lack of seamless integration (Ref 7), ineffective disaster recovery (Ref 8) and issues of server configuration (Ref 9).

Table 6.3: Unproductive Cluster of Systems

Ref	**Text: Excerpts**	**Discursive Analysis**
Ref 5	[…] Little to no graphics, you know, a graphical user interface, where the planner could see exactly what they were planning and things like that. […] And also, it was text based so it had a bit of a dated look.	Poor HCI
Ref 6	[…] with cosmos, each terminal had their own installation of cosmos. So, the information was not shared across all the terminals.	Lack of Information Sharing
Ref 7	[…] The system also had to upload its information into the cosmos database. So, there wasn't a seamlessness between the different planning […] […] We've got different systems in place for that so, we've got our main database, which is hosted at Durban main station	Lack of Seamless Integration
Ref 8	[…] where every transaction was saved to a separate server. In the event of something going wrong it automatically cut over to a redundant server […] these guys were maybe updating their modules and then they'd just cut over, change the IP address for the server and you'd, working on clients that you wouldn't even know	Ineffective Disaster Recovery
Ref 9	[…] Whatever instruction or transaction was being done in production environment; it wrote it over directly into the redundant server	Server Configuration

The theme was considered as "Unproductive and Opaque" since the responses converge towards a view that the existing disparate cluster of information systems are unsuitable for implementing an effective BCM for CTOs. This image evolves from respondents Ref 5, 6, 7, 8 and 9. For instance, Ref 5, capturing the sub-theme of "Poor

HCI" elicits a poor design of user interfaces that is "legacy" in appearance, which tends to frustrate IS usability, functionality and experience (Frantiska Jr, 2019; Paavilainen, 2020). Thus, in the manner envisaged by the analytical framework, the issue of "fit" becomes problematic since the task of using the technology (through the user interface) is frustrated by the poor design.

The second sub-theme underlying the theme of 'Unproductive and "Opaque" Cluster of Systems' focuses on lack of information sharing (Ref 6) in various business systems and units of the organisation. By acknowledging lack of information sharing between organisational units and systems, the respondents point to a general lack of organisational and systems preparedness in cases of disaster events. Prior research recognises that information sharing is a critical antecedent for the adaptive capacity of organisations and infrastructure in instances that require disaster recovery (Chhetri et al., 2020).

Lack of seamless integrations (Ref 7) of systems and ineffective disaster recovery emerged as core impediments for BCM in the case study. A BCM is predicated on not only processes that are seamlessly integrated (from an IT perspective), but also systems that support seamless integration of organisational transactions. The contention in prior research is that seamless process and organisational integration allows for early detection of disasters, error tolerant design of disaster recovery plans and effective disaster recovery(Jain et al., 2018); as well as better anticipatory risk management and a risk-aware business process management suitable for BCM (Lamine et al., 2020; Wagner & Disparte, 2016). What is evident in the local context under consideration is an inadequate process and organisational integration (Ref 7) which makes disaster recovery ineffective (Ref 8).

Lastly, the response elicited in Ref 9 regarding how the production server relates to the redundant server reveals that the way the servers for Disaster Recovery (DR) have been configured maybe unresponsive during disaster recovery scenarios. How data and transactions are stored critically depends on server configuration. Recalling that the nature of storage is at the heart of disaster recovery, the current practice of transactions from the production environment written directly into the redundant server is antiquated and does not assure fault-tolerance and high availability for effective

BCM implementation. Particularly for a large port scenario, where there are multiple production environments, losing any part of the storage infrastructure is catastrophic to the organisation. Thus, poor redundancy assures low fault tolerance, unpredictable resilience, reliability and availability of server (Akpinar et al., 2017); an infrastructure scenario unconducive to BCM. Best practices require that storage systems need to be configured to protect data against single and multiple simultaneous disk failures, thus assurance high redundancy, particularly when virtualisation and cloud computing is integrated (Syrewicze & Siddaway, 2018).

6.3.3.2 Ineffective Load Balancing

The theme of "ineffective load balancing" was captured under three sub-themes: project scalability (Ref 10), poor failover (Ref 11) and sequential load balancing (Ref 12). Project scalability recognises that in large organisations such as the port under study, there are multiple sites and such environments requires having a scalable model that assures a responsive disaster recovery. Past research urge the need for highly available and scalable organisational infrastructure for effective disaster recovery (Machiraju & Gaurav, 2019; May, Vingerhoets & Sigrist, 2015; Coles, Zhang & Zhuang, 2019) and for maintaining business continuity (Powell, 2020). In developing a business continuity model for a multi-site environment, the scalability assures confidence of organisational response to disasters. The current environment does not inspire a scalable response in case disaster recovery demands it. Thus, when project scalability is viewed as part of "ineffective load balancing", the interpretation is linked to the overall dexterity of organisational infrastructure. Hence, the issues that arise bring to the fore the ability of the organisation and its units to plan and respond effectively to disasters that may face the organisation. Organisational dexterity is therefore seen as a critical antecedent to effective BCM development.

Table 6.4: Ineffective Load Balancing

Ref	**Text: Excerpts**	**Discursive Analysis**
Ref 10	[…] Navis, owned by zebra technologies did not have, did not ever do a project on a national level. They just operate one berth, or one warehouse or they try to link a warehouse to a berth	Project Scalability
Ref 11	[…] but, the types of servers use a distributed cache environment that wasn't really working for us. There was *no failover*	Poor Failover
Ref 12	[…] I don't think we use the right type of load balancer because the load balancer was, was... every new client that logged on to Navis the load balance was just going in, it's a sequential load balancing	Sequential Load Balancing

The second sub-theme of "poor failover" points to the state of distributed cache environment currently deployed in the organisation. The organisation has adopted a distributed cache management (DCM) strategy which the respondents assert is not currently working for them (Ref 11). The core features of a DCM strategy relate to the maximisation of (network) traffic volume from the caches, while minimising bandwidth cost. Although bandwidth costs remain prohibitive in Africa (Teer-Tomaselli, 2019), and in an environment where there are multiple sites, with disparate systems and network capability, achieving optimal load balancing /failover should not be an issue for major corporations such as Transnet. Such organisations can afford dedicated high bandwidth networks with 1:1 contention ration and can therefore achieve optimality by balancing between traffic maximisation (from the caches) while minimising bandwidth. Failover implementation is at the heart of disaster recovery and any strategy adopted has a significant impact on the performance of network cache critical for retrieving data on demand (Alkhazaleh, Aljunid & Sabri, 2019).

The last sub-theme, dubbed "sequential load balancing" (Ref 12) is linked to the former and focuses attention on how workload is spread amongst the digital devices in the network of the port under consideration. The challenge in sequential load balancing is that each user (device) seeks to minimise latency (delay) while optimising response time and resource availability. However, given the constraints related to Internet speeds in South Africa, minimising latency remains a problem, particularly when a sequential approach is adopted. Optimising latency in a physical or wireless network that depends on constrained bandwidth and Internet speeds cannot bode well for BCM and disaster recovery that depends on the availability and responsiveness of these resources. Li et al., (2020) concludes that the latency of cloud computing is high because it is far from terminal users; hence providing a viable alternative for entrenching a BCM strategy in Internet-constrained environments. Thus, in the next section, a motivation for a cloud based BCM strategy is laid out to mitigate against the challenges set out in this section.

6.3.4 Proposed Architecture

The responses captured in Table 6.5 and Table 6.6 are the basis of the discussions that follows. The presentation is organised around two main themes: digital infrastructure and organisational infrastructure. The section then ends by proposing a "cloud based BCM Framework" based on analysis that has been done.

6.3.4.1 Digital Infrastructure for Cloud BCM

Responses related to the proposed digital infrastructure for BCM were categorized into four sub themes as follows: Unreliable National Information Infrastructure (NII) (Ref 13), Cloud Computing Robustness (Ref 14), Smart BCM (Ref 15) and Rent vs. Buy decision (Ref 16) of cloud computing technologies. The respondents were emphatic that cloud hosting various forms of infrastructure (PaaS, SaaS, IaaS) was preferable to the current setup in which the digital infrastructure is dependent on the South Africa's National Information Infrastructure (NII), which is sometimes reliable.

Reliability of the South Africa NII, as it relates to continuous availability and security is in question. Prior research supports this assertion by the respondents. For instance, Manda and Backhouse (2019) partly grounds the realisation of smart governance on having a responsive digital infrastructure for realising digital transformation. Lazanyuk and Revinova (2019), in their analysis of the telecommunications infrastructure of BRICS countries, found that telecommunications index for South Africa is still in its infancy, making it difficult for her to participate effectively in the digital economy. Thus, the respondents claim of an unreliable NII finds supports in the literature.

Table 6.5: Digital Infrastructure of BCM

Ref	**Text: Excerpts**	**Discursive Analysis**
Ref 13	[…] the better way to go for us is to **host in the cloud** because then you're not relying on South Africa's infrastructure	Unreliable NII
Ref 14	[…] Because you're connecting to a database that's hosted on the cloud, **each site would be dependent on their own ISP** […] And you can go wireless as well as wired connections. You know, so I think that the *robustness of having, or the availability will be much more*,	Cloud Computing Robustness
Ref 15	[…] was around business continuity […] They're now introducing apps. […] here's companies that are introducing these IT solutions into business continuity. […] When you have a business continuity issue, you should have technology that should be reactive, to that process.	Digitalising BCM

The sub-theme of ‘cloud computing robustness’ (Ref 14) emphasized the ability of Internet Service Providers (ISPs), not only to support the cloud infrastructure in different locations of the port entities, but also an assurance of high availability of both wired and wireless networks of the organisation. This is in line with the contention that cloud computing can support scalability, elasticity and self-provisioning (Tripathi, Agrawal and Gupta, 2020). The third sub-theme of ‘Digitalising BCM’ (Ref 15) places the spotlight on the trend where the process of BCM can be automated and supported by applications without relying on processes that are manual.

Digitalisation of BCM have been realised in countries such as Japan and China that are frequently faced by disasters; thus, when building future cities, they adopt the smart BCM strategy (Hu & Tanaka, 2019).

Table 6.6: Organisational Infrastructure for Cloud BCM

Ref	**Text: Excerpts**	**Discursive Analysis**
Ref 17	[…] Break DCT down. Erm, when you say something is big it’s a matter of have you broken it down? […]So the issue of running business continuity manually, is actually an issue that’s actually gonna die.	Managing Organisational Complexity
Ref 18	[…]It’s around looking at the issue of the business strategy right now, called Intelliports. Intelliports is around the IT working for the business. […]By enhancing digitalisation of our operations, we intend to optimise operational performance and reliability through technologies such as the Internet of Things, Machine Learning and Artificial Intelligence (AI).	Intelliport Strategy
Ref 19	[…] gone are the days, that you can’t, you can afford not to be resilient. […] It’s the maturity level. One port in Ngqura versus this port. That’s why I can’t treat this as the same. The maturity level is different.	Business Continuity Maturity

6.3.4.2 Organisational Infrastructure for Cloud BCM

Three sub-themes characterized the theme of organisational infrastructure for BCM: “Managing Organisational Complexity” (Ref 17); “Intelliport Strategy” (Ref 18); and “Business Continuity Maturity” (Ref19). The sentiments expressed by respondents on managing organisational complexity points to the current structure of CTO in South Africa, in which there are multiple sites operated by different entities. Under the umbrella parastatal of Transnet Port Terminals (TPT), there are container terminals in the cities of Durban, Ngqura, Port Elisabeth and Cape Town. All these ports are in different locations, different organisational cultures, different capacities and digital architectures.

The recognition of the need to handle organisational complexity for effective BCM by the respondents is well founded in prior research. For instance, Bongiovanni et al., (2017) reports that organisational complexity, actors’ vulnerability and temporal and spatial constraints hamper BCM responsiveness to disasters. Organisational complexity is also seen in difficulties in resource allocation and activities synchronisation during recovery efforts (Opdyke et al., 2015); while achieving organisational resilience continues to be linked to complexity factors related to size (Smojver, 2014); weak inter-agency coordination (Chen et al., 2020); and challenges in expanding the scope of business offerings through servitisation (Calabrese et al., 2019). Thus, to move beyond the current challenges of BCM at DCT, managing the complexity of the organisation should be emphasized. The second sub-theme, dubbed as “Intelliport strategy” (Ref 18) continually reinforced the need to re-think port strategy by embracing advanced technologies such as Internet of Things (IoT) and Cloud Computing (CC).

The third sub-theme of “Business Continuity Maturity” (Ref 19), when viewed from the lens of the first sub-theme of “Managing Organisational Complexity” (Ref 17), recognises that the different entities of TPT are at different levels of organisation maturity. The connotation implied by “business continuity maturity” points to differentiated levels of business continuity maturity for the different entities of TPT (the case study). Thus, within the TPT port ecosystem, the different entities in different locations are at different levels of the business operation capability. The differences in organisational and entity characteristics implies that there are inefficiencies in BCM implementation, with those entities that are more 'stunted' in terms of maturity struggling with realising effective disaster recovery compared to much more mature entities (Ref 19). This has overall implications for the operational excellence of the TPT port system, as entities that are more stunted in terms of business continuity maturity predominantly depend on manual back systems, heavy dependence on out-of-date information and sensitivity to data quality.

6.4 Assimilating Cloud Computing in BCM

The analyses above focused on what the respondents proffered as elements of a proposed architecture that should be the basis of a "cloud based BCM Framework". The prior analyses also provided a snapshot of the current architecture as it relates to the current practices of BCM in CTO in South Africa. Given the analyses above, the question that remains is: is cloud computing a fit and viable strategy for BCM to ensure effective container terminal operations in constrained resource environments? The evidence presented is solid and calls for an urgent redesign and reconfiguration of BCM to move away from "manual" approaches to a cloud-based computing model.

The synthesis of the findings, which draws from the qualitative analyses above and literature are summarized in Table 6.7 and Table 6.8 below. In table 6.7, a discussion of whether the BCM task characteristics (Bajgoric and Moon, 2009) fits or is enabled by the affordances of cloud computing technology.

The first affordance of cloud computing, which links to the BCM characteristic of "continuous data processing" is "rapid elasticity". Rapid elasticity of cloud computing is the ability to scale up computing resources up and down easily in correspondence to users' demands (Shawky & Ali, 2012). In a multi-site environment, this capability is core, particularly when cloud computing can avail continuous data processing capability, despite occurrence of disasters.

Table 6.7: The 'Fit' of Cloud Computing

Construct	BC Needs	Current Gaps	CC Features
Fit	Continuous Data Processing	Silo operations, systems cut out, labour substitution	Rapid Elasticity
	Continuous Data Access & Delivery	Poor Failover	Broad Network Access
	Multi-Platform Data Access	Lack of Information Sharing; Bandwidth Constraints	Resource Pooling
	Always – On IT Services	Labour Substitution; Ineffective Disaster Recovery; Poor HCI	On Demand Self-Service
	Better Decision Making	Performance Impact	Measured Service

The pattern of responses in the analyses above showed that the case study under consideration (TPT) currently lacks this capability. However, the possibilities afforded by cloud computing, through the feature of "rapid elasticity" provides an opportunity to enable continuous data process as a critical anchor to realise BCM. The second characteristic of "broad network Access" of cloud computing aligns with the characteristic of "continuous data delivery and access" for BCM. Broad network access enables access to cloud resources from anywhere using any medium, a feature that can address several of the bottlenecks that TPT is facing. For instance, having "broad network access" can address the challenge of "poor failover" that was identified to be characteristic of current BCM practices. Broad network access feature addresses the problem of poor failover by ensuring increased availability and reliability since redundancy and failover are inherent features of a cloud computing cluster (Osman and others, 2019).

The requirement of “multi-platform data access” of BCM is enabled by “resource pooling”, a multi-tenant cloud computing model that allows for sharing of data storage services, processing services and bandwidth (Sehgal, Bhatt & Acken, 2020). This resource pooling model can address the challenges of lack of information sharing and bandwidth constraints that were identified earlier. Resource pooling has also been linked directly to cost efficiencies based on economies of scale that provides a motivation for investing in cloud computing for BCM, as well as providing network flexibility and responsiveness (Haag & Sandberg, 2020). The cloud computing affordance of “on demand self-service” maps directly to the BCM characteristic of “always-on IT services”, which allows users to use cloud services according to their demands, using an online customisable control panel (Chiang et al., 2020). In terms of addressing the challenges of the current case study, enabling the “always-on IT services” of BCM will address issues related to labour substitution, ineffective disaster recovery and poor HCI design. The last BCM characteristic of “better decision making” is linked to the cloud computing affordance of “measured service”. Measured service focuses on automatically measuring resource usage (CPU, storage, bandwidth, etc.), thus optimising resource use by incorporating metering capabilities for better decision making (Mishra, Gupta & Gupta, 2019). Thus, given this aspect of measurement, the fit to better decision making in BCM is unmistakable and is likely to have an overall impact on the performance (resilience) of the organisation.

The findings related to the ‘viability’ construct was evaluated by focusing on economic viability, ICT Infrastructure (Technology Readiness) and organisational factors. Depending on the service model adopted (SaaS, IaaS, PaaS) and based on an extensive review of literature (see Aggarwal & McCabe, 2009; Singer et al., 2010; Truong & Dustdar, 2010; Martens, Walterbusch & Teuteberg, 2012, Makhlouf, 2020) surmises that economic viability can be linked to the following cost areas: management, delivery, quality, price, service and community. The results captured several of these costs from various perspectives expressed by the respondents: delivery, quality and price.

Table 6.8: The "Viability" of Cloud Computing

Construct	BC Needs	Current Gaps	CC Factors
Technology Readiness	Robust BCM	Cluster of Systems	Robustness
	Scalable BCM	Load Balancing	Scalability
	Service Orientation	Poor Redundancy	Server Configuration Management
	Planning for Consequences	Dispersed Automation	Virtualisation
Economic Viability	Organisational Dexterity	Project Scalability	Delivery
	ICT Resilience	Unreliable NII, Systems Failure	Quality
Organisational Viability	Complexity	Size and Structure	Smart BCM
	Business Continuity Maturity	Different ICT Levels	
	Intelliport Strategy	Synergy of Units	

According to Martens, Walterbusch and Teuteberg (2012), delivery is exemplified by the following cost areas: implementation, configuration, integration, migration and support costs. These are typical costs linked to various domains of project management; and in assessing viability, it is paramount to align these costs to project scalability. Project scalability was linked to the ability of the organisation to handle complex projects. Thus, the notion of organisational dexterity was employed to capture this form of organisational ability. Thus, for organisational dexterity, project scalability needs to be entrenched for delivery costs to be kept down. The ‘quality’ costs were evidenced from responses that pointed to an ‘unreliable NII’ and frequent ‘systems failure’. The infrastructure of a multi-site organisation such as TPT depends on outsourced network services. In cases where the NII is unreliable resulting in frequent system failures, the resilience of BCM and the ability of the organisation to recover becomes uncertain. This is further exacerbated by an unreliable electricity grid, a complimentary infrastructure characterized by frequent load shedding and power blackouts that continue to cost the country trillions of Rands (Lawrence, 2020). An unreliable digital and power infrastructure affects quality, the key focus of a resilient BCM system. Pursuing the cloud computing model will allow the organisation to use economies of scale linked to size to drive down the costs of connectivity, especially if virtualisation and multitenancy technologies are adopted (Mishra et al., 2014). When ‘price’ factors are considered in conjunction with the ‘quality’ and ‘delivery’ factors, renting, through adoption of cloud computing becomes a viable option for evolving BCM systems in CTO.

Technology readiness as a measure of viability, focuses on the resources that influence the organisation’s decision to adopt a new technology (Mohammed *et al.*, 2017). The focus of the analysis was on several technology readiness factors (Table 6.8). The first relates to a ‘robustness’ of the current ICT infrastructure; and its suitability for a robust BCM. The responses evinced demonstrated that the current architecture provides an unproductive cluster of systems evidenced through reduced throughput and response times of computing resources in the organisation’s networks. Thus, moving to a cloud computing framework can allow the organisation to transcend current challenges to evolve a ‘robust’ infrastructure that can allow ICT-based BCM. ‘Ineffective load balancing’ was also linked to the current ICT infrastructure; implying that there is sub-optimal utilisation of computing resources in the current ICT architecture. The current architecture is therefore not ‘scalable’, a property of cloud computing that allows investing in ICT resources as needs arise (Margherita & Braccini, 2020).

‘Server configuration management’ aligns to the BCM feature of ‘service orientation’. The current architecture has ‘poor redundancy’, a pointer to an ICT infrastructure that is unlikely to ensure integrity and consistency in functionality of the networks during a disaster. Realising consistent functionality in ‘silo’ based networks is problematic, except if automation anchored on service-oriented architecture (SOA) model is incorporated in server configuration management. Adoption of SOA, as the bedrock of the service orientation model results in several benefits including: increased response times, enhanced services, streamlining of business administration, improved information sharing and increased transparency, resiliency in operations (Pirnau, Botezatu et al. 2017). However, more effective service orientation, using SOA, is typically implemented using 'virtualisation', a trend that is attractive to cloud computing environments since it is an alternative premised on lower costs and higher flexibility of servers (Lu et al., 2018). Effective BCM requires a better framework that plans better for consequences, yet the current environment suffers from this weakness due to extensive, uncoordinated and dispersed automation in the port.

The sub-themes of 'managing organisational complexity', 'business continuity maturity' and 'Intelliport strategy' are used as the basis to assess organisational feasibility. Organisational feasibility focuses on whether the firm is ready to accept the new change and whether an appropriate strategy to manage the change in the organisation exists (Joshi, Islam & Islam, 2017). The sub-theme aptly illustrates this since the respondents recognised the difficulty of change associated with organisations that are large, public and with multiple units. Therefore, to deploy an effective BCM, how to manage complexity as part of daily management is a key concern. The case study is inherently complex due its multi-site, multi-unit structure, with diverse organisational cultures. Realising a resilient BCM in such a complex environment requires a greater focus on greater sense making for resilience measurement (van der Merwe, Biggs & Preiser, 2019); embracing the paradigm of system-of-systems for better management of complexity; considering leadership as emergent and influenced by context, and cultivating adaptive leadership (Hallo et al., 2020); and revitalising processes that got locked by earlier forms of simplification management (Joosse & Teisman, 2020). 'Business continuity maturity' was linked to the level of BCM maturity and its influences on ICT. Currently, the different units of the case study are at different levels of BCM and business growth. However, emerging propositions in the context of complex entities require better successful integration of Collective Intelligence (CI) in resilience, capacity building and mitigation so that occurrence of adverse events can be better managed through effective BCM practices (Diakou & Kokkinaki, 2015; Odhiambo, Ochara & Kadyamatimba, 2019). Better use of

CI may promote a circular economy in the ports, where the port ecosystem circular business model in which the organisational logic creates, captures and delivers value with – and within – closed cycles of all the business entities. Such an organisational logic is best supported by a cloud infrastructure, especially since the entities geospatially dispersed (Jabłoński & Jabłoński, 2020). Integrating technologies that capture the overall CI of such a complex organisation can have a positive impact in BCM.

The last sub-theme of “Intelliport Strategy’ is linked to current trends for adoption in “smart technologies” in society. The metaphor of the “Intelliport strategy” fits well with the notion of intelligent ports or smart port management characterized by adoption of advanced digital technologies that continues to impact port terminal operations, warehousing, logistics, yard and port transportation (Li et al., 2018). Some of the identified technologies, particularly when incorporated with IoT and CC include: RFID, sensors, WSN, wireless communications, cloud computing and 3D virtual reality for intelligent management of ports (Xisong & Gang, 2013). The commitment to an “Intelliport strategy” was confirmed from pronouncements in strategic documents that entrenched the drive towards implementation of these technologies, including Artificial Intelligence (AI) and Machine Learning (ML), within the context of a cloud computing framework.

6.5 Summary on qualitative results

This chapter represented findings from data that was collected qualitatively using interviews with respondents from container terminals around South Africa. Interviews were necessary to gather information that included reasoning behind work processes and reactions to the environment as the respondents experienced it. Findings were drawn and concluded following a thematic analysis of the responses that were received. These concluded that current BCM practices were inadequate and the current architecture was opaque and unproductive due to ineffective load balancing and unproductive clusters on information. A proposed architecture was produced and suggested that the digital infrastructure and organisational infrastructure be amended.

Both these were assimilated into the cloud which would then be used as the basis for the BCM framework. The following chapter will be to design the proposed framework.

Chapter 7: A Cloud-BCM Framework for Container Terminal Operations

7.0 Chapter Overview

In this section, we present a cloud based BCM framework for CTO. It should be noted though that the business is responsible for setting their RPO and RTO and also for identifying potential risks and changing levels of risk over time. The goal of this framework is to have a flexible adaptive BCM framework that allows for seamless integration and failover, yet is applicable and practical with very little management overhead. This framework should be vendor independent applicable to various TOS applications and cloud service providers. Thus, the design that will be applied will lean towards a generic framework that can be tailored to the specific needs of container terminals.

7.1 Synthesis of Findings

The digital transformation of business continuity management (BCM) in CTO is viewed as a source of future organisational resilience due to the potential of digitalisation to unlock new value creation and business model innovation opportunities. To realise effective organisational resilience using BCM, three insights, as underlying mechanisms for assimilating cloud computing in BCM can be inferred: the first is that a digitalised BCM architecture 'fits' the cloud computing model. And, in line with Bajgoric and Moon (2009), the specific BCM characteristics that befits cloud computing are continuous data processing; continuous data access and delivery; multi-platform data access; always – on ICT Services; and better decision making. Secondly, the cloud computing model is a 'viable' model that can contribute to managing complex organisations characterized by business units that are highly differentiated in terms of size, structure, ICT and investment levels. For such complex organisations, viability is visible in terms of how the multi-units can harness collective intelligence (CI) for more effective BCM. Collective intelligence, as a form of universally distributed intelligence that is constantly enhanced, coordinated in real time, and which results in effective mobilisation of organisational competence (Suran, Pattanaik & Draheim, 2020), is a core organising metaphor for achieving BCM in a complex organisation. Lastly, to realise BCM, underpinned by greater digitalisation of BCM and harnessing of CI; there is need for rethinking strategy towards adoption of an 'Intelliport strategy' or 'smart' BCM for ports, currently intertwined with the notion of the 4IR. That the 'smart' nature of BCM require the assimilation of 4IR technologies that enable ubiquitous presence and real time information regarding organisational processes (Bayarçelik and Doyduk, 2020). Adopting an 'Intelliport strategy' is likely to have two main implications for BCM and practice: the first is linked to the development of a circular economy, in which aggregation of BCM activities can enhance sustainable development of the seaports; and secondly, adoption of a cloud computing framework that can result in the enhancement of business growth of the units promote collaborative problem solving and decision making in BCM.

7.2 The Proposed Framework

The framework takes into account (1) a disaster recovery solution; (2) a failover solution for databases and IoT systems; (3) network failover on an active line; and (4) dependency between distinct components (i.e., failover mechanisms and disaster recovery solution) and combines those into a feasible BCM strategy. Guidance can be found in the three theories presented in this study. The STT argues for achievement of organisational goals through the use of technology by humans. The Fit-Viability Theory allows for the transition of BCM for CTO from a manual based method to an ICT-base one. System theory deals with the elements that may be included to build a complete system. In Table 7.1 we lay out the response to the problems and themes that were extracted from the analysis of data and interviews.

Seven sub-themes that were extracted from the interview results were considered as crucial to the building of the model. The design of the framework seeks to solve challenges relating to the digital infrastructure and the organisational infrastructure. These infrastructure solutions were then mapped to the critical functions that were identified (Table 7.1). These functions had been identified as those necessary to continue with operations in container terminals.

Table 7.1. Solution design based on themes

<table>
<tr><th>Sub-Theme</th><th>Problem</th><th>Solution</th><th>Design</th></tr>
<tr><td>Intelliport strategy</td><td>IoT</td><td>Camco Alternative</td><td>Already exists</td></tr>
<tr><td>Organisational complexity</td><td>Large system</td><td>Break it down</td><td rowspan="2">Smaller system that will cover only critical functions. Hot site.</td></tr>
<tr><td>Scalability</td><td>Multi-site environment</td><td>Low complexity</td></tr>
<tr><td>Poor failover</td><td>Unreliable NII</td><td>Disparate networks</td><td>Use 4G (5G future) technology</td></tr>
<tr><td>Cloud computing robustness</td><td>Unreliable ISPs</td><td>Disparate networks with different ISPs</td><td>Switch between wired connections and GSM connections</td></tr>
<tr><td>Digitalising BCM</td><td rowspan="2">Manual processes</td><td rowspan="2">Smart BCM</td><td rowspan="2">ICT Cloud-based BCM</td></tr>
<tr><td>Business Continuity Maturity</td></tr>
</table>

As per STT, these functions necessitated the need for humans to use technology to achieve them. System theory's requirement that we choose the elements that will satisfy the basic requirements for a complete system also means that we appoint only the elements that will enable the critical functions to be undertaken. Those elements - the TOS, which caters for container movement and planning, the GOS (Camco) which caters for external transport logistics and external human computer interaction, and the ICT infrastructure that binds it all together - need to be included, at a minimum, as per Podaras, Antlová and Motejlek (2016). According to Podaras, Antlová and Motejlek (2016, p171) " A system or application which is used locally, is not connected with other applications, and does not perform critical transactions, (...) and its immediate recovery is not required." An effective BCM, in other words, should place emphasis on the instantaneous recovery of the operations that have been determined to be the most important of the enterprise, defined by the ISO 22301:2012 as Minimum

Business Continuity Objective, briefly stated as MBCO (BSI, 2012). Thus the design of the framework may result in a minimalist system that can still attain the goals of the critical business functions.

7.3 Main considerations

The main elements that will be taken into account in this design will be to overcome the inherent BCM considerations of Critical Business Functions (CBF), Risk levels, Disaster Recovery Tiers and Cost.

The 1st item to consider is critical business functions, which can be used to determine the level of importance of the data or an application that supports that function. The CBF has already been determined during the business analysis and the subsequent survey and interviews.

The 2nd consideration is risk level. Connolly and Begg (2015) determine that the threats to databases and ICT systems can come from multiple major sources including humans, hardware, Database Management Systems (DBMS), databases and communication networks. Chapter 2 discussed the current ICT system flaw which is the Single Point of Failure (SPOF). These threats pose a high risk to the ICT systems that are employed for CTO and therefore the solution must address them as part of the deployment.

The 3rd consideration is the disaster recovery tier. There are several disaster recovery tier schemes previewed in (Abdel & Mohamed, 2014; Firdous, 2014). We can use Firdhous' classification of Disaster Recovery as a Service (DRaaS) when considering going into the cloud. The four levels of DRaaS: No DRaaS, CDDRaaS, WMDRaaS and HTDRaaS, as proposed by Firdous have been further described and linked to BCM requirements on Table 7.2.

Table 7.2. DRaaS classification (Firdhous, 2014)

DRaaS Level	Description	RTO	RPO
No DRaaS	No disaster recovery	-	-
Cold site (CDDRaaS)	Data is backed up and ready; infrastructure needs to be installed and configured and, data needs to be loaded	Hours to days	Hours to days
Warm site (WMDRaaS)	Site has infrastructure that is installed and preconfigured; however, data is not fully or partially ready	Minutes to hours	Minutes to hours
Hot site (HTDRaaS)	Entire site is fully duplicated with the original system and fully synchronized and ready to take over operations	5 minutes or less	5 minutes or less

The 4th consideration is *cost.* Cost has been considered as a major factor by some authors. According to Alhazmi and Malaiya (2013), 40-50% of small businesses do not implement DRP and have neither any plans to ever implement it. However, that may be, for large corporations, which tend to be the ones operating large container terminals, ICT and disaster recovery are just part of the cost of doing business.

7.4 Disaster Recovery as a Service

In IT Disaster Recovery scenarios, one of the most effective and immediate solutions is the implementation of a Hot Site. Abdel and Mohamed (2014) elucidate the tiered system of recovery options that start from a level where nothing is done to recover, up to a level where a Hot Site is deployed to enable zero downtime. This is a type of a failover system where a mirror site of the main site is maintained off the physical premises and a heartbeat connection is maintained via a high bandwidth connection. In this type of configuration if there are problems with the main site, an immediate failover occurs which may be so seamless that the end user may not notice the occurrence. In the context of CTO BCM, a Hot Site will be a useful option to consider, owing to the aforementioned features. With it, during a disaster, continuity will be instant and there will be no loss of data. This setup therefore provides a solution on two main fronts. First, there may be zero time spent for the Recovery Time Objective (RTO), and second, zero data loss for Recovery Point Objective (RPO). Likewise, returning to the main system – also known as a "Failback" – after disaster recovery will be a seamless affair.

7.4.1 In the cloud

During the analysis phase it was determined that a cloud-based solution would be a crucial requirement for the design of the model. In synthesising the findings (see table 6.7) it was found that cloud computing would bring rapid elasticity, broad network access, resource pooling and provide a measured service.

In the context of the BCM framework design, using the cloud will satisfy the requirements for a Hot Site, i.e. separate physical site and access via a high speed bandwidth connection. Using a Hot Site resolves all of the issues identified in the Fit and Viability outlook table in Chapter 6 (Table 6.7). In this section (Table 7.3.) we can see how using a Hot Site can further strengthen the fit of our solution by adding a Hot Site column.

Table 7.3. How a Hot Site strengthens BCM

Construct	BC Needs	Current Gaps	CC Factors	Hot Site
Technology Readiness	Robust BCM	Cluster of Systems	Robustness	Instant availability
	Scalable BCM	Load Balancing	Scalability	Full replica; up- or downscaled
	Service Orientation	Poor Redundancy	Server Configuration Management	Mirrored active site
	Planning for Consequences	Dispersed Automation	Virtualisation	Mirroring
Economic Viability	Organisational Dexterity	Project Scalability	Delivery	High quality, highly available infrastructure ready by service provider
	ICT Resilience	Unreliable NII, Systems Failure	Quality	
Organisational Viability	Complexity	Size and Structure	Smart BCM	Easy access for all organisational units
	Business Continuity Maturity	Different ICT Levels		
	Intelliport Strategy	Synergy of Units		

7.4.2 Cloud Architecture

The overview for our design is based on the NIST cloud computing reference architecture. Figure 7.1. defines the five major actors that have been standardised for the cloud: cloud consumer, cloud provider, cloud carrier, cloud auditor and cloud broker (Liu et al., 2011). The actors represent entities who are either persons or organisations that participate in transactions or processes and/or perform the tasks involved in cloud computing.

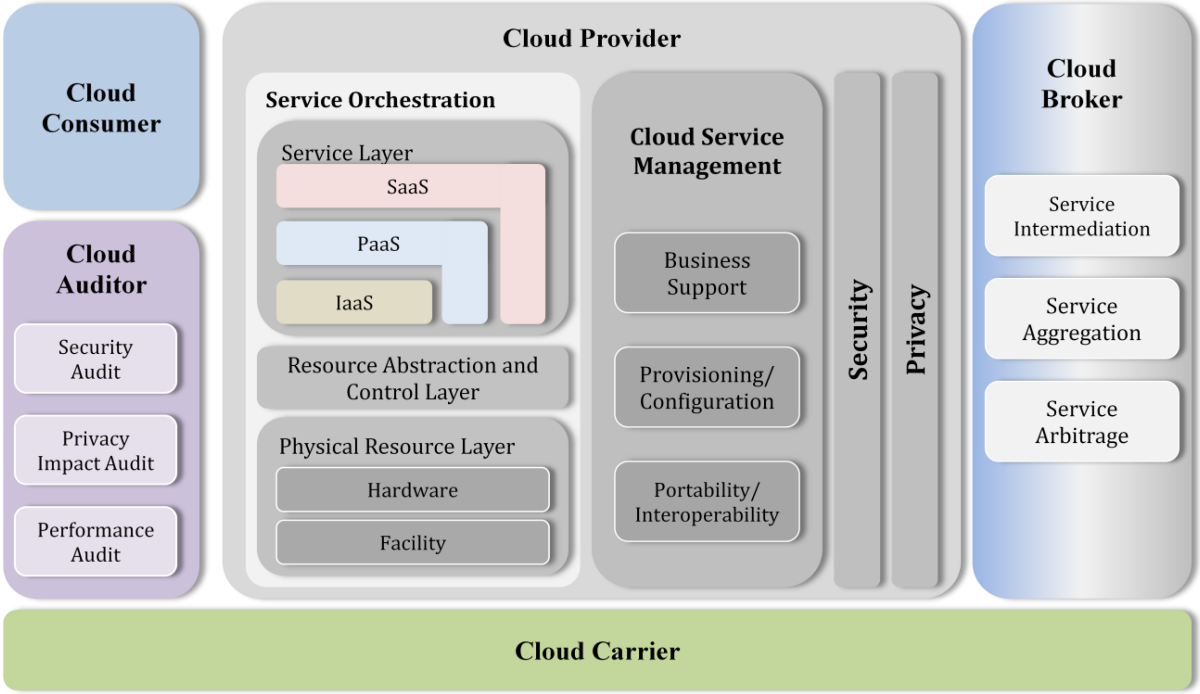

Figure 7.1: Reference Model for cloud computing (Liu et al., 2011)

7.4.2.1 Cloud Consumer

The reference model acts as generic reference for all types of cloud deployments. For the purposes of this study, the requirements will be drawn from the cloud consumer, cloud provider and cloud carrier actors. In this scenario, as a cloud consumer, the container terminal IT services (or custodian thereof) will maintain a business relationship with, and use the service from a cloud provider. The cloud consumer will have selected the service from the cloud provider service catalogue (Figure 7.3), request the appropriate service, set up service contracts with the cloud provider, and use the service (Figure 7.2). (The services of a Cloud Broker and a Cloud Auditor may be required if that is what governance stipulates for the particular organisation. For this study and for the sake of simplicity, these will not be required.)

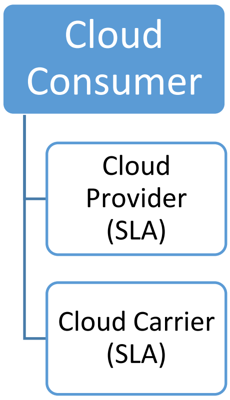

Figure 7.2: Usage Scenario

7.4.2.2 Cloud Provider

As the entity responsible for providing cloud services, the Cloud Provider, who already maintains a portfolio of services, can work with the container terminal to select the best DRaaS solution for the terminal. The Cloud Consumer can expect from the following from a Cloud Provider; a computing infrastructure required for providing the services and running the cloud software that provides the services.

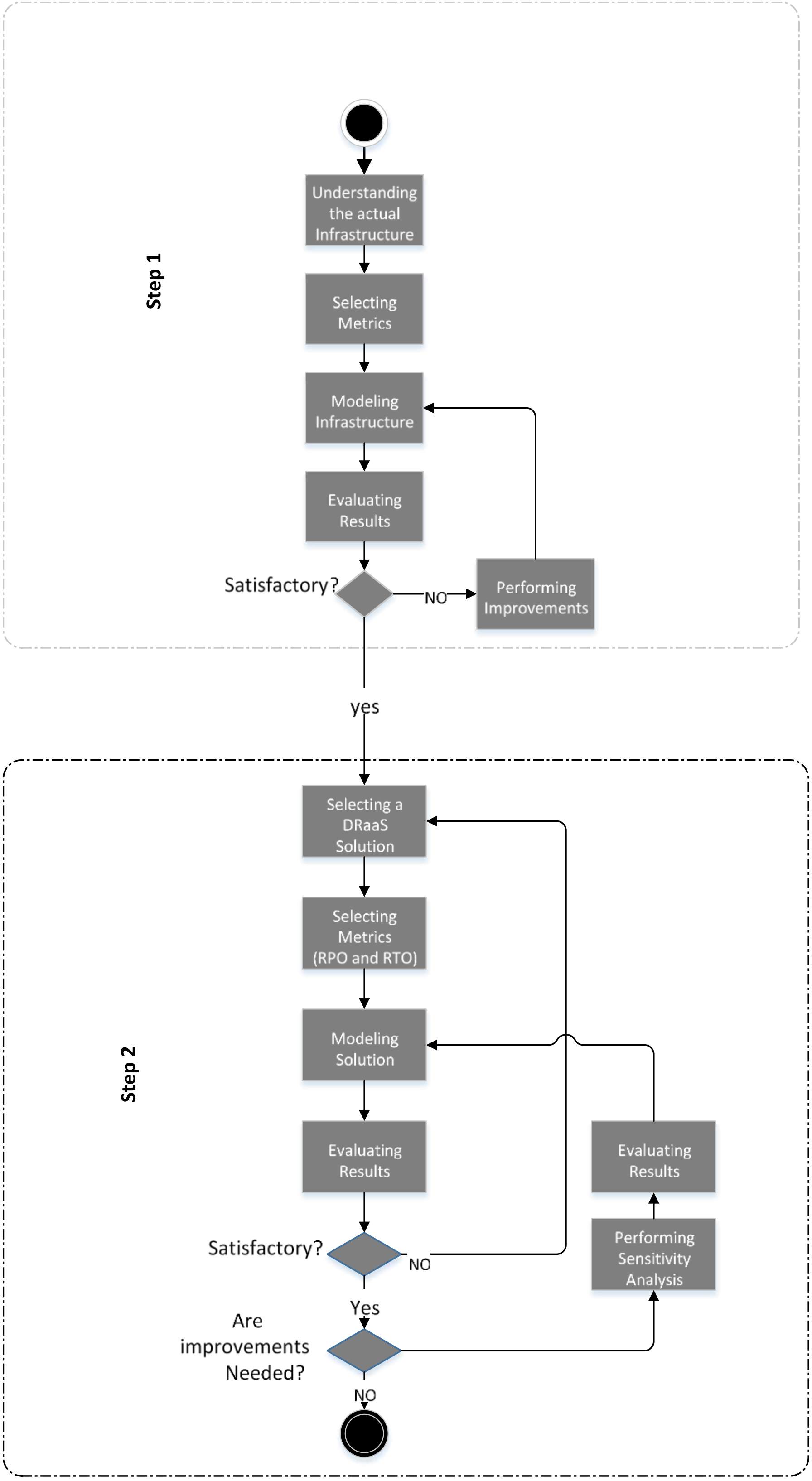

Figure 7.3: DRaaS Migration Strategy

7.4.2.3 Cloud Carrier

The Cloud Provider can also make arrangements to deliver the cloud services to the Cloud Consumer through a preferred Cloud Carrier. This will be a great option to consider since the Cloud Consumer in this context will be requiring a separate network that is safely quarantined from their regular network. A two tiered network will be necessary for this system to work. First there would be the Cloud Carrier network that will allow for connection between the two data centres (Figure 7.4: Data Sync). A second connection will thus be necessary to conduct CTO requests to the Cloud Provider (Figure 7.4: CTO Request after disaster). CTO requests to the cloud will be made via a wireless or 4G connection.

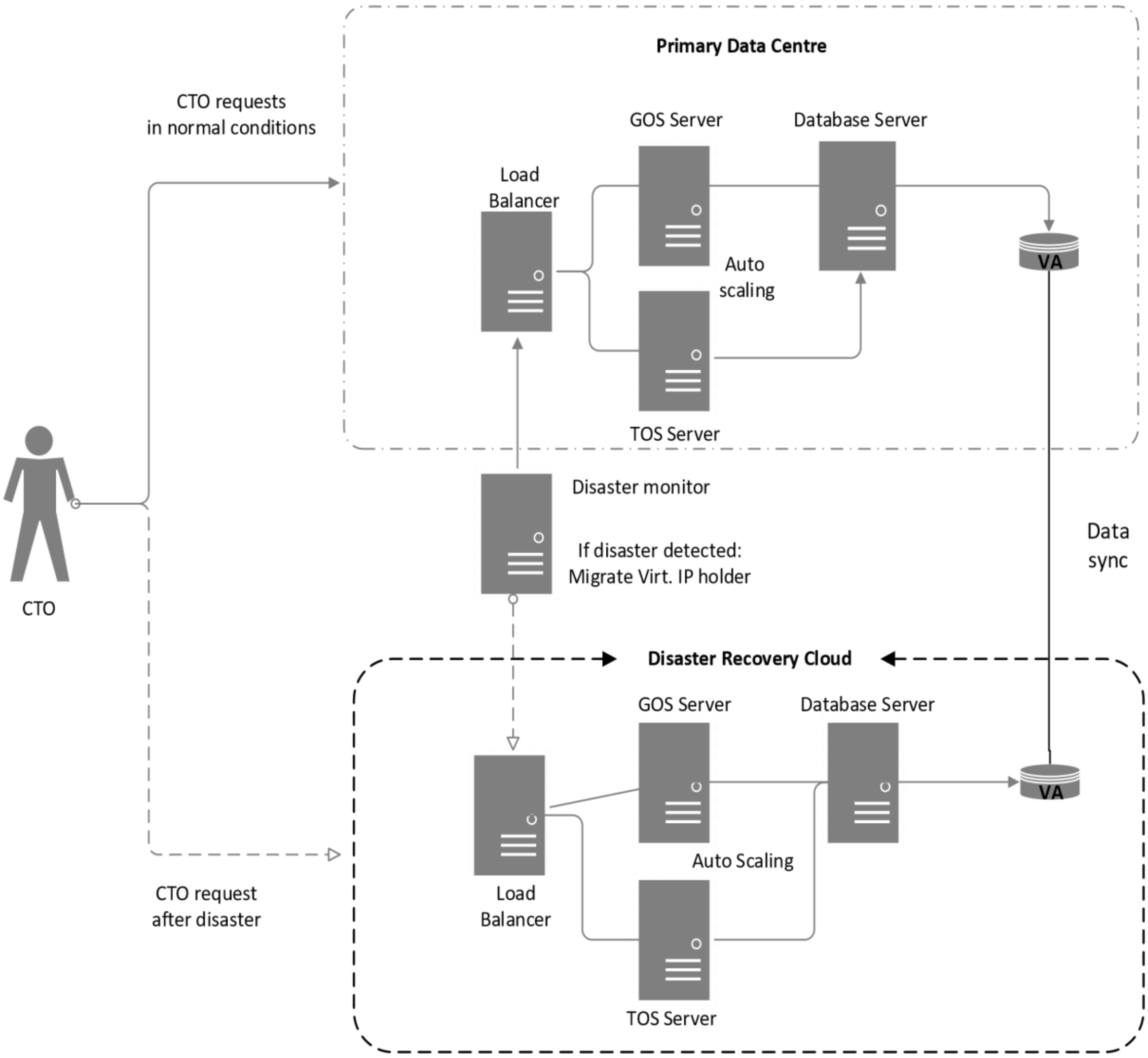

Figure 7.3: Hot Site configuration

7.5 Conceptual model for BCM

A conceptual model is an abstract representation of an idea to represent and demonstrate a system Robinson, Arbez, Birza, Tolk and Wagner (2015). In conceptual modelling aspects of the physical and social world around us are formally described for the purposes of understanding and communication (Mylopoulos, 1992). The model should convey the fundamental principles and basic functionality in order to facilitate the ease of understanding (Kung & Solvberg, 1986). According to Robinson et.al (2015), physical existence of the system is not a prerequisite; the system in question may simply be a concept, idea or proposal. There are four fundamental objectives that a conceptual model should satisfy (Kung & Solvberg, 1986):

- Enhancement of the understanding of the system being represented
- Facilitation of an efficient conveyance of system details between stakeholders
- Provision of a point of reference which system designers can use to extract system specifications
- Documentation of the system for future reference and as a means for collaboration

There are several different techniques for conceptual modelling including data flow modelling, entity relationship modelling, event-driven process chain and many others (Powell-Morse, 2017). These different types of models share a common purpose of representation, simplification, design and communication. Based on the discussion above and guided by the results of this study, we developed a conceptual framework of the ICT-based BCM solution.

7.5.1 Conceptual framework of the ICT-based BCM solution

The technique that we employed to develop our conceptual framework was that of system modelling which describes and represents a system. It represents multiple views such as design, implementation, structure, behaviour, input data, and output data views. The conceptual framework is not system or software-specific (Robinson et.al. 2015), although its idea was generated from the Navis N4 implementation at Transnet Port Terminals (TPT). The basic common feature of the framework is a transaction. This is because in operations procedures are there for the fulfilment of some type of transaction. Transactions can include those to move containers, search for containers or confirm delivery of containers.

7.5.2 Transaction

In a container terminal operation, a transaction involves the basic transfer of a container from point to point (Kim & Lee, 2015) and the concomitant actions that lead to and result from the container transfer. For example, a container drop-off transaction (typically an export transaction) will involve a truck entering the terminal gates, proceeding to the drop off interchange area, where a straddle carrier transfers the container from the truck to the yard and the truck exiting the terminal. A transaction is triggered by an input event such as a truck announcing its arrival at the gate. The transaction commences and directs the truck via different contact points such as gates and interchange areas. Within the transaction more input events such as VMTs add work instructions that facilitate container movement.

Figure 7.5 illustrates the concept of the framework represented as a use case. In the use case, the trucker begins the transaction, acts within the transaction at various stages and finishes by getting out of the transaction after it closes.

7.5.3 Performing a transaction in the BCM framework

In our transaction model, we add a cloud based TOS DB which is updated in real time as per the Hot Site configuration. The database architecture is a Standby Database (Lightstone, Teorey & Nadeau, 2007) which is a type of failover system in which there is minimal activity from the standby database.

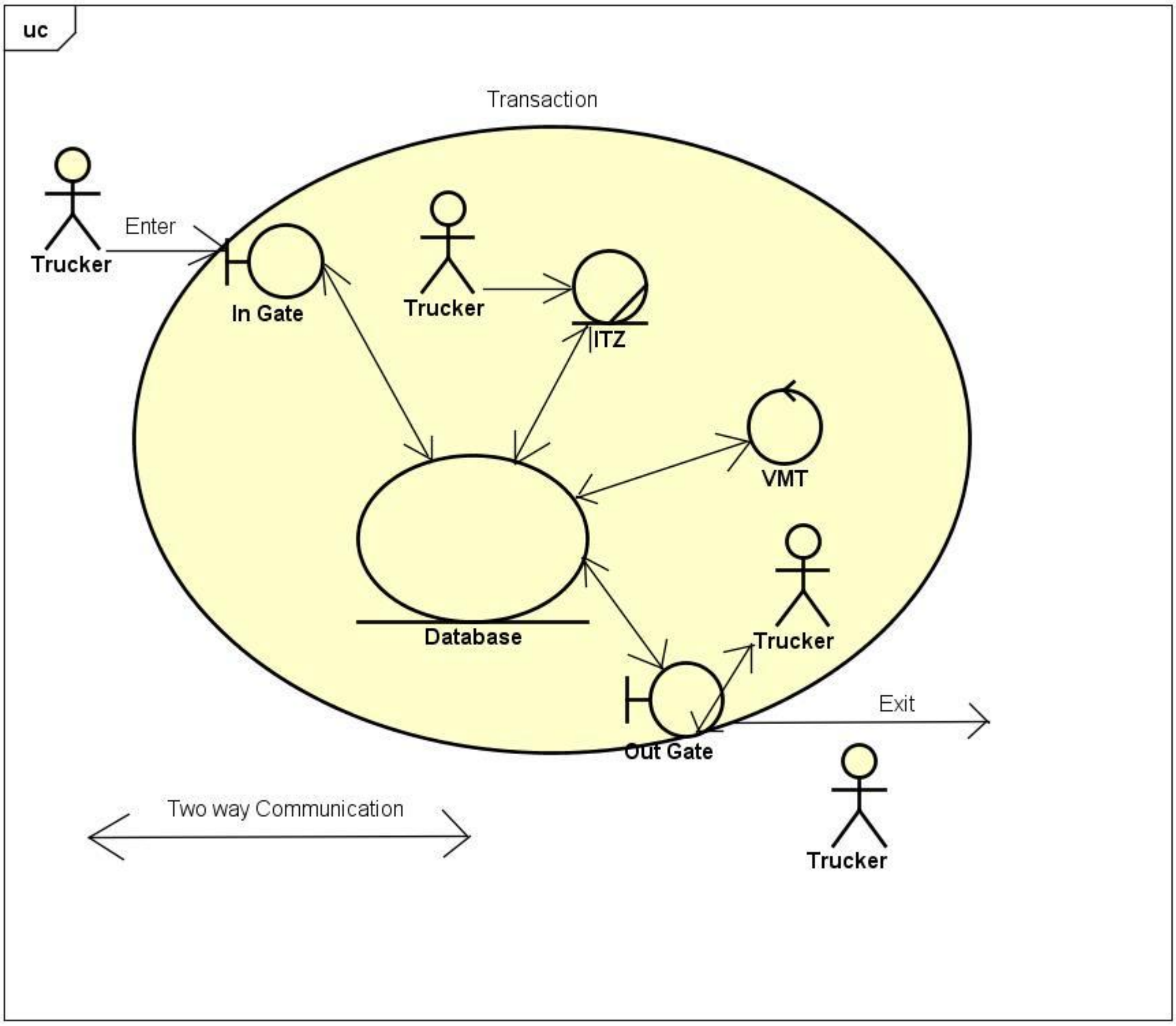

Figure 7.5: Conceptual framework of a transaction

7.5.4 Communication within the transaction

Currently, the communication in the system flows from the input event which is triggered by a user, to the local TOS DB and then to the central TOS DB before being saved and closed. When we add the cloud TOS DB, we add an alternative path in which the input event can access the cloud TOS DB directly and then save and close the transaction. Figure 7.6 illustrates the communication links configured in an Active-passive (HSDA) configuration showing how information will flow from the beginning of the transaction until closure. In the illustration, we can see that if any of the LAN and WAN links fail, the transaction can still be completed by directly going into the cloud. An 4G (Also known as a LTE connection) connection is used for this connection due to its high bandwidth capability. The input event in Figure 7.5 represents all inputs (gate transactions, OCR and sensor information, VMTs, HHTs and PCs used by equipment controllers) that feed information to the databases. For full redundancy all the devices will need to have a separate connection from the regular one which is used under normal circumstances.

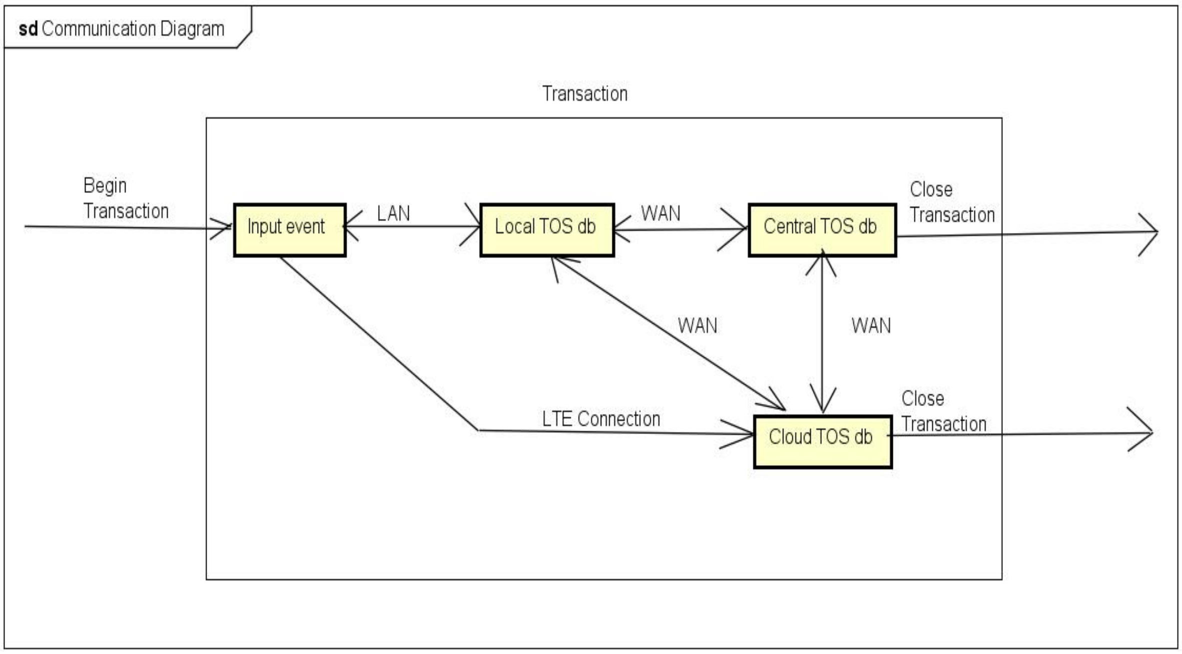

Figure 7.6: Conceptual framework for communication

7.6 Summary

This chapter designed and presented the BCM Framework. The framework that was designed based on ICT systems covered some of the major problems that a manual-based BCM would encounter. These included communication, ease of use, safety, container losses etc. The framework also provides a solution to ICT problems which include redundancy, RTO and RPO reduction, and availability. The detailed framework can also demonstrate how the system would work, how any problems that can be introduced into the systems can affect the system and how those problems can be handled. Robust implementation of BCM in Container Terminal Operations (CTO) continues to be a challenge, despite increasing digitalisation. The results of this study confirm that using an ICT Cloud-based BCM implementation is a necessary antecedent to CTO during systems failures. When implemented, the Cloud BCM framework provides an alternative and robust DRaaS architecture which is critical for

CTO. The implications of such a Cloud BCM are twofold: the first relates to the implications of the increasing pervasiveness of 4G networks, and the increased pace of development of 5G networks. These developments, and the concomitant affordability of digital devices will make Cloud-Based BCM the primary disaster recovery strategy for CTO, particularly in Africa where communications platforms are increasingly mobile-based (Van Rensburg, Telukdarie, & Dhamija, 2019). Further research can explore how these developments can help in refining the proposed Cloud BCM in specific CTO, not only in specific regions only, but also globally.

Chapter 8: Conclusions

8.0. Introduction

This chapter presents a summary of the findings, followed by recommendations for both the context of the study and future research study in this field. The chapter is presented based on the objectives of the study. First the quantitative method was used to gather data on the role of ICT systems in container terminals, how their absence affects CTO and how BCM is used to cover that absence. The qualitative methods gathered further detailed information on the ICT systems infrastructure, CTO functions that are impacted by ICT systems, how BCM is used in CTO and why.

8.1 Summary of the results

The summary of results is presented based on the objectives of the study as below:

Objective 1: *Examine the impact of ICT on intermodal Container Terminals Operations (CTOs);*

Both quantitative and qualitative results indicated that ICT systems have a high impact on CTO. Results from data collected through both methods indicated that various ICT systems in place in CTO which include the TOS, data terminals and the automatic gate (or Gate Operating System) have a significant impact on CTO. This indicates that ICT systems should therefore be covered for continuity during a disruption event. It also serves to determine the scope of our business continuity planning. By looking at the impact of ICT on CTO, were able to implore the respondents to indicate what the loss of ICT systems would result in. The finding was that the current architecture presented with problems including unproductive and opaque cluster of systems and ineffective load balancing. These findings would later be used in conjunction with FVM to design the proposed architecture.

Objective 2: *Determine the Critical Business Functions in Container Terminal Operations:*

Results from both the qualitative and quantitative data indicated that functions that are conducted in operations including the movement of containers, the tracking of containers, loading and offloading containers into vessels and communication to operators were the most Critical Business Functions in CTO. The quantitative results further showed that although it was possible in the past to conduct operations without the ICT systems as they are currently implemented, the workload was demanding in terms of labour, the system was open to fraud and was generally inconvenient, unsafe and inefficient. Therefore, a more comprehensive TOS was required that would ensure that all these problems were eliminated.

The respondents indicated that that none of the Critical Business Functions could be performed without ICT systems. Most of the respondents (61.1%) thought that none of those functions could be performed without ICT systems. Since these functions are (a) critical to the terminal fulfilling its operations; (b) they need ICT in order to take place; and (c) ICT has been pointed out as the main cause of disruption to operations, these functions need assurance to continue operating even during an ICT outage. Results indicated that stack-checking, reefer-checking, container movement, housekeeping and planning, were Critical Business Functions in container terminals. These functions, which were deemed important, also have their own modules in the TOS and are therefore an indication of what the BCM scope should be covering.

Objective 3: *Evaluate the Current BCM Practices at Container Terminal Operations*;

Both quantitative and qualitative results established that the BCM practices that are currently in place in container terminals with regards to the loss of ICT systems were not widely practiced in CTO. Results showed that although continuity plans were in place, they mostly involved reverting to manual operations, that is, running CTO without the ICT system and instead using paper-based methods and communicating to operators over the radio. Results indicate that this was inconvenient, unsafe and inefficient. The resulting effect of this was that operations were stopped whenever the ICT systems became unavailable. Results further showed that it was safer and more convenient to wait for the ICT systems to be brought back online irrespective of the length of time it would take to bring the systems back online. This affected CTO negatively due to loss of revenue caused by stoppages, inconveniencing customers and having a negative impact on the image of the organisation. These results therefore indicated that a more usable BCM method needed to be developed which would benefit CTO at all terminals.

The findings further showed that hat there was no viable BCM planning in place, with majority of the respondents pointing a finger to the low level of maturity of BCM implementation in their organisations. Results further indicated that although the maturity level was low, some basic foundations for BCM at container terminals were in place. Results were able to show that the basic foundations for BCM that were employed at the terminals were inadequate for such an operation. The discursive analysis concluded that the BCM deployment resulted in a negative impact on performance, system failures which in turn required labour substitutions and promoted silo operations. These issues meant that indeed the current deployment of BCM was inadequate and would therefore need to be restructured. This was therefore also part of the reason why this study was necessary since it deals with the design of a framework that would address these inadequacies.

Objective 4: *Develop a Cloud-Based Architecture for BCM for Container Terminal Operations*

Results established the gaps that are currently in place in CTO BCM for loss of ICT systems. A major gap that was established was that the current manual method for BCM is impractical, inconvenient, unsafe and inefficient. Further, the critical impediments of the current architecture revolved around two themes: “Unproductive and “Opaque” Cluster of Systems” and “Ineffective Load Balancing”. This has made it undesirable in CTO and therefore affects the deployment of BCM for CTO. To cover these gaps, a system needs to be designed that may offer simplicity for failover and availability. A conclusion can therefore be made that the BCM method would need to be a DRaaS solution based on a Hot Site. This would make it more familiar with operators and still operate in a safe manner. The study concluded that cloud computing was a fit and viable solution to the main problem of the study.

8.1.1 Impact of ICT on CTOs

The first objective was to determine the impact that ICT Systems have on CTO. From that objective we determined that ICT systems were critical to operations by showing the impact of ICT systems on operations. The results show that throughout the history of container terminal operations, ICT systems became more prolific in the optimisation of operations. Functions that used to require teams of people to perform were eventually taken over by ICT systems and could be managed by one person or none. Better optimisation meant that operations were faster, safer and much better coordinated. Planning functions became more dynamic and expedient. Control of the gate has become seamless with operations, faster to process and is found to be effective in fraud and container loss prevention. The impact of ICT on operations has become so high that working manually has become totally obsolete. When ICT systems become unavailable, operations are put on hold until the ICT systems are brought back up.

The finding strongly suggested that ICT system availability was critical, and that CTO cannot continue without it. This led to significant loss of production hours and revenue.

8.1.2 Critical function in operations

The study defined Critical Business Functions for CTO that needed to be conducted via the assistance of ICT Systems. A main finding of the study was that the use of manual-based BCM methods was poorly inadequate for large CTO. This finding was then used as the starting point for the objective of identifying a framework that would be deemed "Fit" and "Viable" for use in CTO BCM. The Fit and Viability theory was critical to this study as it indicated that a cloud-based solution was the most viable option to consider in the design of the BCM Framework. The study showed that current critical functions are afflicted by an unproductive cluster of systems which resulted from poor HCI, lack of information sharing, lack of seamless integration, ineffective disaster recovery and poor server configuration. This pointed to a general lack of organisational and systems preparedness in cases of disaster events.

8.1.3 Current BCM practices

BCM practices that are currently employed for CTO, were carefully evaluated in accordance with BCM maturity levels and were found to be inadequate. They were found to suffer due to low performance, system failure and labour substitution, and silo operations. All these required that the resilience of the ICT Systems for CTO be improved upon.

8.1.4 Viability of a Cloud-Based ICT BCM Framework

The current architecture was presented and unpacked in order to investigate its shortcomings. It was found to be unproductive, opaque and consisting of a poor load balancing setup. Causes for these problems were found to be through poor HCI, lack of information sharing and seamless integration, ineffective DR and poor server configuration. The conclusion that can be drawn from this is that an ICT based method is one that should be used. However, there is none in existence and will therefore need to be developed.

The study makes a strong case for the use of a cloud computing solution that will ensure the digitalisation of the BCM implementation. It advocates for better and more consistent use of IoT devices, many of which are already in use at the ports. Sensors such as OCR, RFID, fingerprint readers and so forth, are currently deployed by the Camco system, for instance. Their potential when a systematic expansion of their capabilities is undertaken can be greatly realised. This can be further incorporated into the new system to ensure that it is consistent with the latest deployment of new technologies. Notwithstanding the technical requirements of the new model, the need for an ICT based system is non-negotiable as it distinguishes the framework from the manual system. The main issue that formed the basis of this study in the first place was the reluctance of CTO to revert to the manual method BCM implementation.

Cloud-based nature not only provides cost effective BCM, but also allows for flexibility that makes operations at container terminals be sustainable. Having a DRaaS solution based on a Hot Site solves two of the main requirements of BCM; RTO and RPO timeframes. With a Hot Site these are at minimum just a few seconds. With such time frames CTO will never feel the impact of a downtime cause by system problems.

The proposed Cloud BCM conceptual framework for CTO is not system or software-specific (Robinson, Arbez, Birta, Tolk, & Wagner, 2015), although its idea was generated from the Navis N4 implementation at Transnet Port Terminals (TPT) in South Africa. The basic common feature of the framework is a *real-time transaction.*

8.1.5 Limitations of the study

Given the exploratory nature of this study, the conclusions are tentative and future confirmatory research should consider the following: first, the study was interpretive in nature, and thus an extensive study that assesses assimilation of cloud computing in CTO can evolve hypotheses and confirm the applicability of the cloud computing paradigm in business continuity management. Secondly key concepts such as “Intelliport strategy” and “smart BCM” and “CI in ports” have emerged in this study, and therefore, further investigation may clarify their meanings, conceptualisation and applicability in context. This is part of the sense making process that has been identified as critical in BCM and for realising organisational resilience (van der Merwe, Biggs & Preiser, 2019). Thus ‘smart’ BCM is becoming the benchmark organising metaphor that can inform a re-think and re-consideration of overall BCM strategy in complex organisations.

8.2 Implications of the Research Findings

Our main aim in this study was to address the almost total lack of action on what CTO does when ICT Systems become unavailable. We have done so by directly observing and conducting a survey on the daily function of CTO, with special attention to the practices whereby ICT Systems have a high impact on CTO. It was for these systems that we sought to find a solution of providing continuity through a BCM Framework. The main finding of this study was that the BCM framework should be ICT based to eliminate duplication and avoiding impractical implementations. That finding was crucial to our study since normally, ICT unavailability would mean automatically converting to manual methods. The framework developed avoided the pitfalls of the setup for the ICT system. It had to be demonstrable to work by adding or removing some elements of functionality. Findings from this study suggested that a viable framework would have to meet criteria that would help it avoid the pitfalls of the main ICT System being used. The BCM framework developed is ready for switch-over with minimal interaction from operators or system administrators.

The study shows that using the mixed methods design for ICT Systems management is feasible and conclusive. We also demonstrated that following a research design that is ontologically objectivist with a positivist leaning, we were able to combine a logical deduction with empirical observations.

8.3 Impact on practice of CTO and ICT Systems

In accordance with the main aim of this study, the major practical contribution of the present research is that it provides much needed empirical data. The data shows that ICT Systems have a positive impact on CTO and the level of BCM implementation (or lack thereof) in CTO. This study addresses what can be done by the ICT System support function to provide the CTO with a functional BCM alternative to their current ICT System. The system, presented in this study as a framework as described, ensures the continued operational activity of CTO without forcing CTO to revert to manual systems. This is the main essence of this study; to ensure that CTO does not use a manual system in the event of a loss of ICT Systems.

Recounting in depth the activities of CTO using ICT Systems and the opportunity to implement BCM for the CTO environments will allow IT service providers, policy-makers, managers, planners and others to design initiatives, tools and actions based on what is feasible to continue operating when there is an ICT System outage. The finding that for this type of environment, that we cannot use manual methods, serves to provide a deeper understanding to allow other avenues to be followed. It was exactly this finding that led us to conclude that our most practical option was to develop an ICT-based BCM Framework. CTO does not make use of a robust BCM implementation. A manual intervention in a large CTO environment is not a feasible BCM implementation when ICT Systems fail. Theoretically and in preparedness, a manual system may be in place, but in practice, when ICT Systems fail, CTO is stopped until the ICT System is brought back online. The results suggest that an ICT-based BCM implementation is necessary to avoid CTO using a manual BCM method.

When implemented, the BCM framework that this study developed may assist the planning and procedural control for CTO. The ICT service delivery will be positively impacted on by being afforded an alternative system to provide CTO while the main ICT system is being mended. The organisation will be positively impacted by being able to continue providing services to customers. Customers may benefit by not being negatively impacted by having to wait for system problems that they have nothing to do with since all they want is to drop off and collect containers. The positive impact of a working BCM will silently (unbeknownst to those outside of CTO) propagate to the surrounding community by not causing disruptions because of ICT System outages.

8.4 Academic theory of CTO

This study found that there was lack of academic literature regarding CTO and BCM for CTO. Most of the available literature on CTO was found to be dated information which was written during the rise of the usage of ICT Systems in CTO. However, through the Fit and Viability theory, this study found that cloud computing was a viable method to be used in CTO BCM. This makes a major contribution to the field of business continuity in academia. It will contribute to academic literature pertaining to the usage of ICT Systems in CTO. The findings from the study have drawn conclusion on the usage of manual systems as a BCM method as well as the necessary ingredients of a feasible BCM method. With this study we had hoped to add to the body of knowledge on ICT Systems in CTO and subsequently into BCM for CTO. This study can serve as a reference for other academic studies in this field.

8.5 Conclusions

This study aimed at developing a framework for BCM that can be used by container terminal operations when the ICT systems become unavailable. The main essence of the study question was to find out what should be done to provide container terminal operations with a method to continue operating when ICT systems become unavailable. To respond to this request, the following questions were asked to lead the enquiry:

- What is the impact of ICT on operations in the container terminal sector?
- What are the critical processes and functions that a container terminal requires to stay operational?
- What are the current BCM practices that are employed by container terminal operations that respond to the loss of centralised ICT systems?
- What framework for BCM can container terminal operations use in the loss of centralised ICT Systems?

The findings of the study are presented in the following subsections guided by the objectives.

8.6 Recommendations

Our study, being of an objectivist and interpretive nature, raises a number of opportunities for future research, both in terms of theory development and concept validation. More research will in fact be necessary to refine and further elaborate our novel findings. We have generated a number of new and, we believe, useful empirical findings, given the in-depth sampling strategy focused on exploring the function of CTO, very little can be said of the nature of BCM implementations in CTO around the world. This study could thus be extended in search of more statistical, rather than analytical, generalisability, as we have mostly achieved here. Our study offers the opportunity to refine and validate the development of the framework that emerged from our inductive analysis. For example, the need for a framework will need further exploration, refinement and elaboration, in terms of both its component elements and its internal dynamics. One could also ask why there was such a lack of development of BCM strategies for CTO.

This study was limited in its demographical scope in that it was conducted mostly within South Africa, exclusively at Transnet Port Terminals. Although there was outreach to other terminals around the world when using the online questionnaire, qualitatively, the study was exclusively South African. Furthermore, the study completely excluded CTOs which are fully automated, as in, without human operators. Ports including those at Rotterdam have gone fully automated by running equipment which is controlled via remote. Such operations can be very problematic since it can never be possible to allow any form of human intervention whatsoever. Therefore, further research can be done to give research input on how these operations can be run when their ICT Systems fail.

There are a number of gaps in our knowledge around BCM for ICT in CTO environments that follow from our findings, and would benefit from further research, including the BCM framework we have developed here:

i. One of the findings was that the ICT System for the BCM framework should include the use of the 4G networks which are in use as of the writing of this study. We suggest that further exploration of the inclusion (in the model) of the proposed and soon to be implemented 5G networks be conducted. One of the main promises of the 5G networks will be their high speed and the availability of real time interaction between humans and systems. These new advantages will further allow the new system avoid the pitfalls of the current system.

ii. In-depth exploration of how CTO become committed to using BCM for their activities would be very helpful. Further research might seek to confirm, for example, that CTO would indeed cope with using an alternative TOS should their normal day to day TOS become unavailable. Research could explore the difficulties posed by the switching over between systems by operators of equipment.

iii. Research to develop approaches and carry out a full cost–benefit analysis of implementing an alternative TOS would be would be beneficial. Although necessary for BCM, the idea of implementing a secondary TOS may feel off-putting to some and indeed some may even balk at such an implementation. However, this is a challenge that will need to be met head-on if we are to satisfy governance requirements of BCM. Therefore, it would be very useful to see how much cost will be a factor.

iv. A final, relatively narrow but important question that we identified after data collection had finished was of the viewpoint of BCM professionals. This study was based on the participation and viewpoint of CTO (including management structures) and ICT System service providers. It may be helpful to, in a future study, include participants who are in the BCM profession. That would be interesting in seeing how BCM professionals would tackle this type of a problem.

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Annexure A

Crosstabs

How long have you been in the container terminal sector? * What was the worst disruption that you encountered at the terminal and what was the cause?

Crosstab

			What was the worst disruption that you encountered at the terminal and what was the cause?					Total
			Navis system down	Weather delays	Power down	Strike	Equipment failure/Unavailability	
How long have you been in the container terminal sector?	More than 10 years	Count	44	1	0	0	0	45
		% within How long have you been in the container terminal sector?	97.8%	2.2%	0.0%	0.0%	0.0%	100.0%
		% within What was the worst disruption that you encountered at the terminal and what was the cause?	46.8%	20.0%	0.0%	0.0%	0.0%	39.1%
		% of Total	38.3%	0.9%	0.0%	0.0%	0.0%	39.1%

	2 - 5 Years	Count	30	0	1	0	10	41
		% within How long have you been in the container terminal sector?	73.2%	0.0%	2.4%	0.0%	24.4%	100.0%
		% within What was the worst disruption that you encountered at the terminal and what was the cause?	31.9%	0.0%	100.0%	0.0%	90.9%	35.7%
		% of Total	26.1%	0.0%	0.9%	0.0%	8.7%	35.7%
	5 - 10 Years	Count	20	4	0	4	1	29
		% within How long have you been in the container terminal sector?	69.0%	13.8%	0.0%	13.8%	3.4%	100.0%
		% within What was the worst disruption that you encountered at the terminal and what was the cause?	21.3%	80.0%	0.0%	100.0%	9.1%	25.2%
		% of Total	17.4%	3.5%	0.0%	3.5%	0.9%	25.2%
Total		Count	94	5	1	4	11	115
		% within How long have you been in the container terminal sector?	81.7%	4.3%	0.9%	3.5%	9.6%	100.0%

	% within What was the worst disruption that you encountered at the terminal and what was the cause?	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
	% of Total	81.7%	4.3%	0.9%	3.5%	9.6%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	39.090[a]	8	.000
Likelihood Ratio	39.983	8	.000
Linear-by-Linear Association	6.566	1	.010
N of Valid Cases	115		

a. 12 cells (80.0%) have expected count less than 5. The minimum expected count is .25.

Symmetric Measures

		Value	Approximate Significance
Nominal by Nominal	Phi	.583	.000
	Cramer's V	.412	.000
N of Valid Cases		115	

How long have you been in the container terminal sector? * What do you think are the daily causes of disruption to OPS at the terminal?

Crosstab

			What do you think are the daily causes of disruption to OPS at the terminal?					Total
			Weather	System failures	Equipment failures	Startup times	Inefficient planning	
How long have you been in the container terminal sector?	More than 10 years	Count	5	23	0	0	17	45
		% within How long have you been in the container terminal sector?	11.1%	51.1%	0.0%	0.0%	37.8%	100.0%

		% within What do you think are the daily causes of disruption to OPS at the terminal?	55.6%	43.4%	0.0%	0.0%	48.6%	39.1%
		% of Total	4.3%	20.0%	0.0%	0.0%	14.8%	39.1%
	2 - 5 Years	Count	0	24	6	1	10	41
		% within How long have you been in the container terminal sector?	0.0%	58.5%	14.6%	2.4%	24.4%	100.0%
		% within What do you think are the daily causes of disruption to OPS at the terminal?	0.0%	45.3%	37.5%	50.0%	28.6%	35.7%
		% of Total	0.0%	20.9%	5.2%	0.9%	8.7%	35.7%
	5 - 10 Years	Count	4	6	10	1	8	29
		% within How long have you been in the container terminal sector?	13.8%	20.7%	34.5%	3.4%	27.6%	100.0%
		% within What do you think are the daily causes of disruption to OPS at the terminal?	44.4%	11.3%	62.5%	50.0%	22.9%	25.2%
		% of Total	3.5%	5.2%	8.7%	0.9%	7.0%	25.2%
Total		Count	9	53	16	2	35	115

	% within How long have you been in the container terminal sector?	7.8%	46.1%	13.9%	1.7%	30.4%	100.0%
	% within What do you think are the daily causes of disruption to OPS at the terminal?	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
	% of Total	7.8%	46.1%	13.9%	1.7%	30.4%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	28.680[a]	8	.000
Likelihood Ratio	36.818	8	.000
Linear-by-Linear Association	.033	1	.857
N of Valid Cases	115		

a. 7 cells (46.7%) have expected count less than 5. The minimum expected count is .50.

Symmetric Measures

		Value	Approximate Significance
Nominal by Nominal	Phi	.499	.000
	Cramer's V	.353	.000
N of Valid Cases		115	

How long have you been in the container terminal sector? * Which of the following do you think if unavailable can cause a complete stop of operations?

Crosstab

		Which of the following do you think if unavailable can cause a complete stop of operations?				Total
		Manpower	Electrical	ICT Systems	All of the above	
More than 10 years	Count	4	6	0	35	45

How long have you been in the container terminal sector?		% within How long have you been in the container terminal sector?	8.9%	13.3%	0.0%	77.8%	100.0%
		% within Which of the following do you think if unavailable can cause a complete stop of operations?	44.4%	37.5%	0.0%	42.7%	39.1%
		% of Total	3.5%	5.2%	0.0%	30.4%	39.1%
	2 - 5 Years	Count	4	1	4	32	41
		% within How long have you been in the container terminal sector?	9.8%	2.4%	9.8%	78.0%	100.0%
		% within Which of the following do you think if unavailable can cause a complete stop of operations?	44.4%	6.3%	50.0%	39.0%	35.7%
		% of Total	3.5%	0.9%	3.5%	27.8%	35.7%
	5 - 10 Years	Count	1	9	4	15	29
		% within How long have you been in the container terminal sector?	3.4%	31.0%	13.8%	51.7%	100.0%

	% within Which of the following do you think if unavailable can cause a complete stop of operations?	11.1%	56.3%	50.0%	18.3%	25.2%
	% of Total	0.9%	7.8%	3.5%	13.0%	25.2%
Total	Count	9	16	8	82	115
	% within How long have you been in the container terminal sector?	7.8%	13.9%	7.0%	71.3%	100.0%
	% within Which of the following do you think if unavailable can cause a complete stop of operations?	100.0%	100.0%	100.0%	100.0%	100.0%
	% of Total	7.8%	13.9%	7.0%	71.3%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	18.597[a]	6	.005
Likelihood Ratio	22.008	6	.001

Linear-by-Linear Association	2.112	1	.146
N of Valid Cases	115		

a. 7 cells (58.3%) have expected count less than 5. The minimum expected count is 2.02.

Symmetric Measures

		Value	Approximate Significance
Nominal by Nominal	Phi	.402	.005
	Cramer's V	.284	.005
N of Valid Cases		115	

How long have you been in the container terminal sector? * What is the maximum downtime that OPS can afford

Crosstab

			What is the maximum downtime that OPS can afford					
			10 Min	30 Min	1 Hour	5 Hours	1 Day	Total
How long have you been in the container terminal sector?	More than 10 years	Count	7	11	27	0	0	45
		% within How long have you been in the container terminal sector?	15.6%	24.4%	60.0%	0.0%	0.0%	100.0%
		% within What is the maximum downtime that OPS can afford	38.9%	27.5%	57.4%	0.0%	0.0%	39.1%
		% of Total	6.1%	9.6%	23.5%	0.0%	0.0%	39.1%
	2 - 5 Years	Count	5	19	7	4	6	41
		% within How long have you been in the container terminal sector?	12.2%	46.3%	17.1%	9.8%	14.6%	100.0%
		% within What is the maximum downtime that OPS can afford	27.8%	47.5%	14.9%	100.0%	100.0%	35.7%
		% of Total	4.3%	16.5%	6.1%	3.5%	5.2%	35.7%
	5 - 10 Years	Count	6	10	13	0	0	29
		% within How long have you been in the container terminal sector?	20.7%	34.5%	44.8%	0.0%	0.0%	100.0%

	% within What is the maximum downtime that OPS can afford	33.3%	25.0%	27.7%	0.0%	0.0%	25.2%
	% of Total	5.2%	8.7%	11.3%	0.0%	0.0%	25.2%
Total	Count	18	40	47	4	6	115
	% within How long have you been in the container terminal sector?	15.7%	34.8%	40.9%	3.5%	5.2%	100.0%
	% within What is the maximum downtime that OPS can afford	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
	% of Total	15.7%	34.8%	40.9%	3.5%	5.2%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	31.612[a]	8	.000
Likelihood Ratio	35.280	8	.000
Linear-by-Linear Association	.418	1	.518
N of Valid Cases	115		

a. 7 cells (46.7%) have expected count less than 5. The minimum expected count is 1.01.

Symmetric Measures

		Value	Approximate Significance
Nominal by Nominal	Phi	.524	.000
	Cramer's V	.371	.000
N of Valid Cases		115	

Annexure B

What level management are you? * What was the worst disruption that you encountered at the terminal and what was the cause?

Crosstab

			What was the worst disruption that you encountered at the terminal and what was the cause?					Total
			Navis system down	Weather delays	Power down	Strike	Equipment failure/Unavailability	
What level management are you?	Senior	Count	20	0	0	0	0	20
		% within What level management are you?	100.0%	0.0%	0.0%	0.0%	0.0%	100.0%
		% within What was the worst disruption that you encountered at the terminal and what was the cause?	21.3%	0.0%	0.0%	0.0%	0.0%	17.4%
		% of Total	17.4%	0.0%	0.0%	0.0%	0.0%	17.4%
		Count	25	5	0	4	11	45

	Middle Management	% within What level management are you?	55.6%	11.1%	0.0%	8.9%	24.4%	100.0%
		% within What was the worst disruption that you encountered at the terminal and what was the cause?	26.6%	100.0%	0.0%	100.0%	100.0%	39.1%
		% of Total	21.7%	4.3%	0.0%	3.5%	9.6%	39.1%
	Executive	Count	6	0	0	0	0	6
		% within What level management are you?	100.0%	0.0%	0.0%	0.0%	0.0%	100.0%
		% within What was the worst disruption that you encountered at the terminal and what was the cause?	6.4%	0.0%	0.0%	0.0%	0.0%	5.2%
		% of Total	5.2%	0.0%	0.0%	0.0%	0.0%	5.2%
	Skilled Professional	Count	35	0	1	0	0	36
		% within What level management are you?	97.2%	0.0%	2.8%	0.0%	0.0%	100.0%
		% within What was the worst disruption that you encountered at the terminal and what was the cause?	37.2%	0.0%	100.0%	0.0%	0.0%	31.3%

		% of Total	30.4%	0.0%	0.9%	0.0%	0.0%	31.3%
	Supervisor	Count	8	0	0	0	0	8
		% within What level management are you?	100.0%	0.0%	0.0%	0.0%	0.0%	100.0%
		% within What was the worst disruption that you encountered at the terminal and what was the cause?	8.5%	0.0%	0.0%	0.0%	0.0%	7.0%
		% of Total	7.0%	0.0%	0.0%	0.0%	0.0%	7.0%
Total		Count	94	5	1	4	11	115
		% within What level management are you?	81.7%	4.3%	0.9%	3.5%	9.6%	100.0%
		% within What was the worst disruption that you encountered at the terminal and what was the cause?	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
		% of Total	81.7%	4.3%	0.9%	3.5%	9.6%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	39.523[a]	16	.001
Likelihood Ratio	46.400	16	.000
Linear-by-Linear Association	5.578	1	.018
N of Valid Cases	115		

a. 21 cells (84.0%) have expected count less than 5. The minimum expected count is .05.

Symmetric Measures

		Value	Approximate Significance
Nominal by Nominal	Phi	.586	.001
	Cramer's V	.293	.001
N of Valid Cases		115	

What level management are you? * Which of the following operations processes and functions can be done without the ICT Systems?

Crosstab

			Which of the following operations processes and functions can be done without the ICT Systems?		
			All operations	None of the above	Total
What level management are you?	Senior	Count	9	11	20
		% within What level management are you?	45.0%	55.0%	100.0%
		% within Which of the following operations processes and functions can be done without the ICT Systems?	17.6%	17.2%	17.4%
		% of Total	7.8%	9.6%	17.4%
	Middle Management	Count	23	22	45

		% within What level management are you?	51.1%	48.9%	100.0%
		% within Which of the following operations processes and functions can be done without the ICT Systems?	45.1%	34.4%	39.1%
		% of Total	20.0%	19.1%	39.1%
	Executive	Count	1	5	6
		% within What level management are you?	16.7%	83.3%	100.0%
		% within Which of the following operations processes and functions can be done without the ICT Systems?	2.0%	7.8%	5.2%
		% of Total	0.9%	4.3%	5.2%
	Skilled Professional	Count	10	26	36
		% within What level management are you?	27.8%	72.2%	100.0%
		% within Which of the following operations processes and functions can be done without the ICT Systems?	19.6%	40.6%	31.3%

		% of Total	8.7%	22.6%	31.3%
	Supervisor	Count	8	0	8
		% within What level management are you?	100.0%	0.0%	100.0%
		% within Which of the following operations processes and functions can be done without the ICT Systems?	15.7%	0.0%	7.0%
		% of Total	7.0%	0.0%	7.0%
Total		Count	51	64	115
		% within What level management are you?	44.3%	55.7%	100.0%
		% within Which of the following operations processes and functions can be done without the ICT Systems?	100.0%	100.0%	100.0%
		% of Total	44.3%	55.7%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	16.744[a]	4	.002
Likelihood Ratio	20.117	4	.000
Linear-by-Linear Association	.003	1	.957
N of Valid Cases	115		

a. 4 cells (40.0%) have expected count less than 5. The minimum expected count is 2.66.

Symmetric Measures

		Value	Approximate Significance
Nominal by Nominal	Phi	.382	.002
	Cramer's V	.382	.002
N of Valid Cases		115	

What level management are you? * What do you think are the daily causes of disruption to OPS at the terminal?

Crosstab

			What do you think are the daily causes of disruption to OPS at the terminal?					Total
			Weather	System failures	Equipment failures	Startup times	Inefficient planning	
What level management are you?	Senior	Count	0	5	0	0	15	20
		% within What level management are you?	0.0%	25.0%	0.0%	0.0%	75.0%	100.0%
		% within What do you think are the daily causes of disruption to OPS at the terminal?	0.0%	9.4%	0.0%	0.0%	42.9%	17.4%
		% of Total	0.0%	4.3%	0.0%	0.0%	13.0%	17.4%
	Middle Management	Count	4	27	2	1	11	45
		% within What level management are you?	8.9%	60.0%	4.4%	2.2%	24.4%	100.0%
		% within What do you think are the daily causes of disruption to OPS at the terminal?	44.4%	50.9%	12.5%	50.0%	31.4%	39.1%
		% of Total	3.5%	23.5%	1.7%	0.9%	9.6%	39.1%
	Executive	Count	0	5	0	0	1	6

		% within What level management are you?	0.0%	83.3%	0.0%	0.0%	16.7%	100.0%
		% within What do you think are the daily causes of disruption to OPS at the terminal?	0.0%	9.4%	0.0%	0.0%	2.9%	5.2%
		% of Total	0.0%	4.3%	0.0%	0.0%	0.9%	5.2%
	Skilled Professional	Count	5	16	10	1	4	36
		% within What level management are you?	13.9%	44.4%	27.8%	2.8%	11.1%	100.0%
		% within What do you think are the daily causes of disruption to OPS at the terminal?	55.6%	30.2%	62.5%	50.0%	11.4%	31.3%
		% of Total	4.3%	13.9%	8.7%	0.9%	3.5%	31.3%
	Supervisor	Count	0	0	4	0	4	8
		% within What level management are you?	0.0%	0.0%	50.0%	0.0%	50.0%	100.0%
		% within What do you think are the daily causes of disruption to OPS at the terminal?	0.0%	0.0%	25.0%	0.0%	11.4%	7.0%
		% of Total	0.0%	0.0%	3.5%	0.0%	3.5%	7.0%
Total		Count	9	53	16	2	35	115

	% within What level management are you?	7.8%	46.1%	13.9%	1.7%	30.4%	100.0%
	% within What do you think are the daily causes of disruption to OPS at the terminal?	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
	% of Total	7.8%	46.1%	13.9%	1.7%	30.4%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	52.983[a]	16	.000
Likelihood Ratio	57.511	16	.000
Linear-by-Linear Association	5.725	1	.017
N of Valid Cases	115		

a. 17 cells (68.0%) have expected count less than 5. The minimum expected count is .10.

Symmetric Measures

		Value	Approximate Significance
Nominal by Nominal	Phi	.679	.000
	Cramer's V	.339	.000
N of Valid Cases		115	

What level management are you? * Which of the following do you think if unavailable can cause a complete stop of operations?

Crosstab

		Which of the following do you think if unavailable can cause a complete stop of operations?				Total
		Manpower	Electrical	ICT Systems	All of the above	
Senior	Count	0	0	0	20	20

What level management are you?		% within What level management are you?	0.0%	0.0%	0.0%	100.0%	100.0%
		% within Which of the following do you think if unavailable can cause a complete stop of operations?	0.0%	0.0%	0.0%	24.4%	17.4%
		% of Total	0.0%	0.0%	0.0%	17.4%	17.4%
	Middle Management	Count	5	11	4	25	45
		% within What level management are you?	11.1%	24.4%	8.9%	55.6%	100.0%
		% within Which of the following do you think if unavailable can cause a complete stop of operations?	55.6%	68.8%	50.0%	30.5%	39.1%
		% of Total	4.3%	9.6%	3.5%	21.7%	39.1%
	Executive	Count	0	0	0	6	6
		% within What level management are you?	0.0%	0.0%	0.0%	100.0%	100.0%
		% within Which of the following do you think if unavailable can cause a complete stop of operations?	0.0%	0.0%	0.0%	7.3%	5.2%

		% of Total	0.0%	0.0%	0.0%	5.2%	5.2%
	Skilled Professional	Count	4	5	0	27	36
		% within What level management are you?	11.1%	13.9%	0.0%	75.0%	100.0%
		% within Which of the following do you think if unavailable can cause a complete stop of operations?	44.4%	31.3%	0.0%	32.9%	31.3%
		% of Total	3.5%	4.3%	0.0%	23.5%	31.3%
	Supervisor	Count	0	0	4	4	8
		% within What level management are you?	0.0%	0.0%	50.0%	50.0%	100.0%
		% within Which of the following do you think if unavailable can cause a complete stop of operations?	0.0%	0.0%	50.0%	4.9%	7.0%
		% of Total	0.0%	0.0%	3.5%	3.5%	7.0%
Total		Count	9	16	8	82	115
		% within What level management are you?	7.8%	13.9%	7.0%	71.3%	100.0%

	% within Which of the following do you think if unavailable can cause a complete stop of operations?	100.0%	100.0%	100.0%	100.0%	100.0%
	% of Total	7.8%	13.9%	7.0%	71.3%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	43.103[a]	12	.000
Likelihood Ratio	41.427	12	.000
Linear-by-Linear Association	.364	1	.546
N of Valid Cases	115		

a. 14 cells (70.0%) have expected count less than 5. The minimum expected count is .42.

Symmetric Measures

		Value	Approximate Significance
Nominal by Nominal	Phi	.612	.000
	Cramer's V	.353	.000
N of Valid Cases		115	

Annexure C

What role do you play at the terminal * What was the worst disruption that you encountered at the terminal and what was the cause?

Crosstab

			What was the worst disruption that you encountered at the terminal and what was the cause?					Total
			Navis system down	Weather delays	Power down	Strike	Equipment failure/Unavailability	
What role do you play at the terminal	IT Administrator	Count	44	0	1	0	0	45
		% within What role do you play at the terminal	97.8%	0.0%	2.2%	0.0%	0.0%	100.0%
		% within What was the worst disruption that you encountered at the terminal and what was the cause?	46.8%	0.0%	100.0%	0.0%	0.0%	39.1%
		% of Total	38.3%	0.0%	0.9%	0.0%	0.0%	39.1%
	Commercial	Count	0	4	0	0	0	4

		% within What role do you play at the terminal	0.0%	100.0%	0.0%	0.0%	0.0%	100.0%
		% within What was the worst disruption that you encountered at the terminal and what was the cause?	0.0%	80.0%	0.0%	0.0%	0.0%	3.5%
		% of Total	0.0%	3.5%	0.0%	0.0%	0.0%	3.5%
	Operations Manager	Count	8	0	0	0	1	9
		% within What role do you play at the terminal	88.9%	0.0%	0.0%	0.0%	11.1%	100.0%
		% within What was the worst disruption that you encountered at the terminal and what was the cause?	8.5%	0.0%	0.0%	0.0%	9.1%	7.8%
		% of Total	7.0%	0.0%	0.0%	0.0%	0.9%	7.8%
	IT Manager	Count	23	0	0	0	0	23
		% within What role do you play at the terminal	100.0%	0.0%	0.0%	0.0%	0.0%	100.0%
		% within What was the worst disruption that you encountered at the terminal and what was the cause?	24.5%	0.0%	0.0%	0.0%	0.0%	20.0%

		% of Total	20.0%	0.0%	0.0%	0.0%	0.0%	20.0%
	Yard Planning Manager	Count	9	0	0	0	0	9
		% within What role do you play at the terminal	100.0%	0.0%	0.0%	0.0%	0.0%	100.0%
		% within What was the worst disruption that you encountered at the terminal and what was the cause?	9.6%	0.0%	0.0%	0.0%	0.0%	7.8%
		% of Total	7.8%	0.0%	0.0%	0.0%	0.0%	7.8%
	Key Accounts Represantative	Count	0	1	0	4	0	5
		% within What role do you play at the terminal	0.0%	20.0%	0.0%	80.0%	0.0%	100.0%
		% within What was the worst disruption that you encountered at the terminal and what was the cause?	0.0%	20.0%	0.0%	100.0%	0.0%	4.3%
		% of Total	0.0%	0.9%	0.0%	3.5%	0.0%	4.3%
	Human Resources	Count	1	0	0	0	0	1
		% within What role do you play at the terminal	100.0%	0.0%	0.0%	0.0%	0.0%	100.0%

		% within What was the worst disruption that you encountered at the terminal and what was the cause?	1.1%	0.0%	0.0%	0.0%	0.0%	0.9%
		% of Total	0.9%	0.0%	0.0%	0.0%	0.0%	0.9%
	Operations Checker	Count	4	0	0	0	0	4
		% within What role do you play at the terminal	100.0%	0.0%	0.0%	0.0%	0.0%	100.0%
		% within What was the worst disruption that you encountered at the terminal and what was the cause?	4.3%	0.0%	0.0%	0.0%	0.0%	3.5%
		% of Total	3.5%	0.0%	0.0%	0.0%	0.0%	3.5%
	Risk and Compliance Manager	Count	4	0	0	0	0	4
		% within What role do you play at the terminal	100.0%	0.0%	0.0%	0.0%	0.0%	100.0%
		% within What was the worst disruption that you encountered at the terminal and what was the cause?	4.3%	0.0%	0.0%	0.0%	0.0%	3.5%
		% of Total	3.5%	0.0%	0.0%	0.0%	0.0%	3.5%

	Technical manager	Count	1	0	0	0	10	11
		% within What role do you play at the terminal	9.1%	0.0%	0.0%	0.0%	90.9%	100.0%
		% within What was the worst disruption that you encountered at the terminal and what was the cause?	1.1%	0.0%	0.0%	0.0%	90.9%	9.6%
		% of Total	0.9%	0.0%	0.0%	0.0%	8.7%	9.6%
Total		Count	94	5	1	4	11	115
		% within What role do you play at the terminal	81.7%	4.3%	0.9%	3.5%	9.6%	100.0%
		% within What was the worst disruption that you encountered at the terminal and what was the cause?	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
		% of Total	81.7%	4.3%	0.9%	3.5%	9.6%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	283.963[a]	36	.000
Likelihood Ratio	129.681	36	.000
Linear-by-Linear Association	43.643	1	.000
N of Valid Cases	115		

a. 45 cells (90.0%) have expected count less than 5. The minimum expected count is .01.

Symmetric Measures

		Value	Approximate Significance
Nominal by Nominal	Phi	1.571	.000
	Cramer's V	.786	.000
N of Valid Cases		115	

What role do you play at the terminal * Which of the following operations processes and functions can be done without the ICT Systems?

Crosstab

			Which of the following operations processes and functions can be done without the ICT Systems?		
			All operations	None of the above	Total
What role do you play at the terminal	IT Administrator	Count	22	23	45
		% within What role do you play at the terminal	48.9%	51.1%	100.0%
		% within Which of the following operations processes and functions can be done without the ICT Systems?	43.1%	35.9%	39.1%
		% of Total	19.1%	20.0%	39.1%
	Commercial	Count	0	4	4
		% within What role do you play at the terminal	0.0%	100.0%	100.0%

		% within Which of the following operations processes and functions can be done without the ICT Systems?	0.0%	6.3%	3.5%
		% of Total	0.0%	3.5%	3.5%
	Operations Manager	Count	4	5	9
		% within What role do you play at the terminal	44.4%	55.6%	100.0%
		% within Which of the following operations processes and functions can be done without the ICT Systems?	7.8%	7.8%	7.8%
		% of Total	3.5%	4.3%	7.8%
	IT Manager	Count	10	13	23
		% within What role do you play at the terminal	43.5%	56.5%	100.0%
		% within Which of the following operations processes and functions can be done without the ICT Systems?	19.6%	20.3%	20.0%
		% of Total	8.7%	11.3%	20.0%

	Yard Planning Manager	Count	1	8	9
		% within What role do you play at the terminal	11.1%	88.9%	100.0%
		% within Which of the following operations processes and functions can be done without the ICT Systems?	2.0%	12.5%	7.8%
		% of Total	0.9%	7.0%	7.8%
	Key Accounts Represantative	Count	0	5	5
		% within What role do you play at the terminal	0.0%	100.0%	100.0%
		% within Which of the following operations processes and functions can be done without the ICT Systems?	0.0%	7.8%	4.3%
		% of Total	0.0%	4.3%	4.3%
	Human Resources	Count	0	1	1
		% within What role do you play at the terminal	0.0%	100.0%	100.0%

		% within Which of the following operations processes and functions can be done without the ICT Systems?	0.0%	1.6%	0.9%
		% of Total	0.0%	0.9%	0.9%
	Operations Checker	Count	0	4	4
		% within What role do you play at the terminal	0.0%	100.0%	100.0%
		% within Which of the following operations processes and functions can be done without the ICT Systems?	0.0%	6.3%	3.5%
		% of Total	0.0%	3.5%	3.5%
	Risk and Compliance Manager	Count	4	0	4
		% within What role do you play at the terminal	100.0%	0.0%	100.0%
		% within Which of the following operations processes and functions can be done without the ICT Systems?	7.8%	0.0%	3.5%
		% of Total	3.5%	0.0%	3.5%

	Technical manager	Count	10	1	11
		% within What role do you play at the terminal	90.9%	9.1%	100.0%
		% within Which of the following operations processes and functions can be done without the ICT Systems?	19.6%	1.6%	9.6%
		% of Total	8.7%	0.9%	9.6%
Total		Count	51	64	115
		% within What role do you play at the terminal	44.3%	55.7%	100.0%
		% within Which of the following operations processes and functions can be done without the ICT Systems?	100.0%	100.0%	100.0%
		% of Total	44.3%	55.7%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	30.250[a]	9	.000
Likelihood Ratio	38.751	9	.000
Linear-by-Linear Association	2.171	1	.141
N of Valid Cases	115		

a. 13 cells (65.0%) have expected count less than 5. The minimum expected count is .44.

Symmetric Measures

		Value	Approximate Significance
Nominal by Nominal	Phi	.513	.000
	Cramer's V	.513	.000
N of Valid Cases		115	

What role do you play at the terminal * What do you think are the daily causes of disruption to OPS at the terminal?

Crosstab

			What do you think are the daily causes of disruption to OPS at the terminal?					Total
			Weather	System failures	Equipment failures	Startup times	Inefficient planning	
What role do you play at the terminal	IT Administrator	Count	1	15	14	1	14	45
		% within What role do you play at the terminal	2.2%	33.3%	31.1%	2.2%	31.1%	100.0%
		% within What do you think are the daily causes of disruption to OPS at the terminal?	11.1%	28.3%	87.5%	50.0%	40.0%	39.1%
		% of Total	0.9%	13.0%	12.2%	0.9%	12.2%	39.1%
	Commercial	Count	4	0	0	0	0	4
		% within What role do you play at the terminal	100.0%	0.0%	0.0%	0.0%	0.0%	100.0%

		% within What do you think are the daily causes of disruption to OPS at the terminal?	44.4%	0.0%	0.0%	0.0%	0.0%	3.5%
		% of Total	3.5%	0.0%	0.0%	0.0%	0.0%	3.5%
	Operations Manager	Count	0	3	1	0	5	9
		% within What role do you play at the terminal	0.0%	33.3%	11.1%	0.0%	55.6%	100.0%
		% within What do you think are the daily causes of disruption to OPS at the terminal?	0.0%	5.7%	6.3%	0.0%	14.3%	7.8%
		% of Total	0.0%	2.6%	0.9%	0.0%	4.3%	7.8%
	IT Manager	Count	0	16	1	0	6	23
		% within What role do you play at the terminal	0.0%	69.6%	4.3%	0.0%	26.1%	100.0%
		% within What do you think are the daily causes of disruption to OPS at the terminal?	0.0%	30.2%	6.3%	0.0%	17.1%	20.0%
		% of Total	0.0%	13.9%	0.9%	0.0%	5.2%	20.0%
	Yard Planning Manager	Count	4	4	0	0	1	9
		% within What role do you play at the terminal	44.4%	44.4%	0.0%	0.0%	11.1%	100.0%

		% within What do you think are the daily causes of disruption to OPS at the terminal?	44.4%	7.5%	0.0%	0.0%	2.9%	7.8%
		% of Total	3.5%	3.5%	0.0%	0.0%	0.9%	7.8%
	Key Accounts Represantative	Count	0	1	0	0	4	5
		% within What role do you play at the terminal	0.0%	20.0%	0.0%	0.0%	80.0%	100.0%
		% within What do you think are the daily causes of disruption to OPS at the terminal?	0.0%	1.9%	0.0%	0.0%	11.4%	4.3%
		% of Total	0.0%	0.9%	0.0%	0.0%	3.5%	4.3%
	Human Resources	Count	0	0	0	1	0	1
		% within What role do you play at the terminal	0.0%	0.0%	0.0%	100.0%	0.0%	100.0%
		% within What do you think are the daily causes of disruption to OPS at the terminal?	0.0%	0.0%	0.0%	50.0%	0.0%	0.9%
		% of Total	0.0%	0.0%	0.0%	0.9%	0.0%	0.9%
	Operations Checker	Count	0	4	0	0	0	4
		% within What role do you play at the terminal	0.0%	100.0%	0.0%	0.0%	0.0%	100.0%

		% within What do you think are the daily causes of disruption to OPS at the terminal?	0.0%	7.5%	0.0%	0.0%	0.0%	3.5%
		% of Total	0.0%	3.5%	0.0%	0.0%	0.0%	3.5%
	Risk and Compliance Manager	Count	0	4	0	0	0	4
		% within What role do you play at the terminal	0.0%	100.0%	0.0%	0.0%	0.0%	100.0%
		% within What do you think are the daily causes of disruption to OPS at the terminal?	0.0%	7.5%	0.0%	0.0%	0.0%	3.5%
		% of Total	0.0%	3.5%	0.0%	0.0%	0.0%	3.5%
	Technical manager	Count	0	6	0	0	5	11
		% within What role do you play at the terminal	0.0%	54.5%	0.0%	0.0%	45.5%	100.0%
		% within What do you think are the daily causes of disruption to OPS at the terminal?	0.0%	11.3%	0.0%	0.0%	14.3%	9.6%
		% of Total	0.0%	5.2%	0.0%	0.0%	4.3%	9.6%
Total		Count	9	53	16	2	35	115
		% within What role do you play at the terminal	7.8%	46.1%	13.9%	1.7%	30.4%	100.0%

	% within What do you think are the daily causes of disruption to OPS at the terminal?	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
	% of Total	7.8%	46.1%	13.9%	1.7%	30.4%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	163.154[a]	36	.000
Likelihood Ratio	88.588	36	.000
Linear-by-Linear Association	.070	1	.792
N of Valid Cases	115		

a. 44 cells (88.0%) have expected count less than 5. The minimum expected count is .02.

Symmetric Measures

		Value	Approximate Significance
Nominal by Nominal	Phi	1.191	.000
	Cramer's V	.596	.000
N of Valid Cases		115	

What role do you play at the terminal * Which of the following do you think if unavailable can cause a complete stop of operations?

Crosstab

			Which of the following do you think if unavailable can cause a complete stop of operations?				
			Manpower	Electrical	ICT Systems	All of the above	Total
What role do you play at the terminal	IT Administrator	Count	4	5	4	32	45
		% within What role do you play at the terminal	8.9%	11.1%	8.9%	71.1%	100.0%

		% within Which of the following do you think if unavailable can cause a complete stop of operations?	44.4%	31.3%	50.0%	39.0%	39.1%
		% of Total	3.5%	4.3%	3.5%	27.8%	39.1%
	Commercial	Count	0	4	0	0	4
		% within What role do you play at the terminal	0.0%	100.0%	0.0%	0.0%	100.0%
		% within Which of the following do you think if unavailable can cause a complete stop of operations?	0.0%	25.0%	0.0%	0.0%	3.5%
		% of Total	0.0%	3.5%	0.0%	0.0%	3.5%
	Operations Manager	Count	0	2	0	7	9
		% within What role do you play at the terminal	0.0%	22.2%	0.0%	77.8%	100.0%
		% within Which of the following do you think if unavailable can cause a complete stop of operations?	0.0%	12.5%	0.0%	8.5%	7.8%
		% of Total	0.0%	1.7%	0.0%	6.1%	7.8%

	IT Manager	Count	0	1	0	22	23
		% within What role do you play at the terminal	0.0%	4.3%	0.0%	95.7%	100.0%
		% within Which of the following do you think if unavailable can cause a complete stop of operations?	0.0%	6.3%	0.0%	26.8%	20.0%
		% of Total	0.0%	0.9%	0.0%	19.1%	20.0%
	Yard Planning Manager	Count	4	4	0	1	9
		% within What role do you play at the terminal	44.4%	44.4%	0.0%	11.1%	100.0%
		% within Which of the following do you think if unavailable can cause a complete stop of operations?	44.4%	25.0%	0.0%	1.2%	7.8%
		% of Total	3.5%	3.5%	0.0%	0.9%	7.8%
	Key Accounts Represantative	Count	0	0	0	5	5
		% within What role do you play at the terminal	0.0%	0.0%	0.0%	100.0%	100.0%

		% within Which of the following do you think if unavailable can cause a complete stop of operations?	0.0%	0.0%	0.0%	6.1%	4.3%
		% of Total	0.0%	0.0%	0.0%	4.3%	4.3%
	Human Resources	Count	1	0	0	0	1
		% within What role do you play at the terminal	100.0%	0.0%	0.0%	0.0%	100.0%
		% within Which of the following do you think if unavailable can cause a complete stop of operations?	11.1%	0.0%	0.0%	0.0%	0.9%
		% of Total	0.9%	0.0%	0.0%	0.0%	0.9%
	Operations Checker	Count	0	0	0	4	4
		% within What role do you play at the terminal	0.0%	0.0%	0.0%	100.0%	100.0%
		% within Which of the following do you think if unavailable can cause a complete stop of operations?	0.0%	0.0%	0.0%	4.9%	3.5%
		% of Total	0.0%	0.0%	0.0%	3.5%	3.5%

	Risk and Compliance Manager	Count	0	0	4	0	4
		% within What role do you play at the terminal	0.0%	0.0%	100.0%	0.0%	100.0%
		% within Which of the following do you think if unavailable can cause a complete stop of operations?	0.0%	0.0%	50.0%	0.0%	3.5%
		% of Total	0.0%	0.0%	3.5%	0.0%	3.5%
	Technical manager	Count	0	0	0	11	11
		% within What role do you play at the terminal	0.0%	0.0%	0.0%	100.0%	100.0%
		% within Which of the following do you think if unavailable can cause a complete stop of operations?	0.0%	0.0%	0.0%	13.4%	9.6%
		% of Total	0.0%	0.0%	0.0%	9.6%	9.6%
Total		Count	9	16	8	82	115
		% within What role do you play at the terminal	7.8%	13.9%	7.0%	71.3%	100.0%

	% within Which of the following do you think if unavailable can cause a complete stop of operations?	100.0%	100.0%	100.0%	100.0%	100.0%
	% of Total	7.8%	13.9%	7.0%	71.3%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	133.942[a]	27	.000
Likelihood Ratio	89.440	27	.000
Linear-by-Linear Association	1.388	1	.239
N of Valid Cases	115		

a. 34 cells (85.0%) have expected count less than 5. The minimum expected count is .07.

Symmetric Measures

		Value	Approximate Significance
Nominal by Nominal	Phi	1.079	.000
	Cramer's V	.623	.000
N of Valid Cases		115	

What role do you play at the terminal * What is the maximum downtime that OPS can afford

Crosstab

			What is the maximum downtime that OPS can afford					
			10 Min	30 Min	1 Hour	5 Hours	1 Day	Total
What role do you play at the terminal	IT Administrator	Count	5	15	24	0	1	45
		% within What role do you play at the terminal	11.1%	33.3%	53.3%	0.0%	2.2%	100.0%
		% within What is the maximum downtime that OPS can afford	27.8%	37.5%	51.1%	0.0%	16.7%	39.1%
		% of Total	4.3%	13.0%	20.9%	0.0%	0.9%	39.1%
	Commercial	Count	4	0	0	0	0	4

		% within What role do you play at the terminal	100.0%	0.0%	0.0%	0.0%	0.0%	100.0%
		% within What is the maximum downtime that OPS can afford	22.2%	0.0%	0.0%	0.0%	0.0%	3.5%
		% of Total	3.5%	0.0%	0.0%	0.0%	0.0%	3.5%
	Operations Manager	Count	8	0	1	0	0	9
		% within What role do you play at the terminal	88.9%	0.0%	11.1%	0.0%	0.0%	100.0%
		% within What is the maximum downtime that OPS can afford	44.4%	0.0%	2.1%	0.0%	0.0%	7.8%
		% of Total	7.0%	0.0%	0.9%	0.0%	0.0%	7.8%
	IT Manager	Count	0	7	16	0	0	23
		% within What role do you play at the terminal	0.0%	30.4%	69.6%	0.0%	0.0%	100.0%
		% within What is the maximum downtime that OPS can afford	0.0%	17.5%	34.0%	0.0%	0.0%	20.0%
		% of Total	0.0%	6.1%	13.9%	0.0%	0.0%	20.0%
	Yard Planning Manager	Count	0	4	5	0	0	9
		% within What role do you play at the terminal	0.0%	44.4%	55.6%	0.0%	0.0%	100.0%

		% within What is the maximum downtime that OPS can afford	0.0%	10.0%	10.6%	0.0%	0.0%	7.8%
		% of Total	0.0%	3.5%	4.3%	0.0%	0.0%	7.8%
	Key Accounts Represantative	Count	1	4	0	0	0	5
		% within What role do you play at the terminal	20.0%	80.0%	0.0%	0.0%	0.0%	100.0%
		% within What is the maximum downtime that OPS can afford	5.6%	10.0%	0.0%	0.0%	0.0%	4.3%
		% of Total	0.9%	3.5%	0.0%	0.0%	0.0%	4.3%
	Human Resources	Count	0	0	1	0	0	1
		% within What role do you play at the terminal	0.0%	0.0%	100.0%	0.0%	0.0%	100.0%
		% within What is the maximum downtime that OPS can afford	0.0%	0.0%	2.1%	0.0%	0.0%	0.9%
		% of Total	0.0%	0.0%	0.9%	0.0%	0.0%	0.9%
	Operations Checker	Count	0	0	0	4	0	4
		% within What role do you play at the terminal	0.0%	0.0%	0.0%	100.0%	0.0%	100.0%
		% within What is the maximum downtime that OPS can afford	0.0%	0.0%	0.0%	100.0%	0.0%	3.5%

		% of Total	0.0%	0.0%	0.0%	3.5%	0.0%	3.5%
	Risk and Compliance Manager	Count	0	4	0	0	0	4
		% within What role do you play at the terminal	0.0%	100.0%	0.0%	0.0%	0.0%	100.0%
		% within What is the maximum downtime that OPS can afford	0.0%	10.0%	0.0%	0.0%	0.0%	3.5%
		% of Total	0.0%	3.5%	0.0%	0.0%	0.0%	3.5%
	Technical manager	Count	0	6	0	0	5	11
		% within What role do you play at the terminal	0.0%	54.5%	0.0%	0.0%	45.5%	100.0%
		% within What is the maximum downtime that OPS can afford	0.0%	15.0%	0.0%	0.0%	83.3%	9.6%
		% of Total	0.0%	5.2%	0.0%	0.0%	4.3%	9.6%
Total		Count	18	40	47	4	6	115
		% within What role do you play at the terminal	15.7%	34.8%	40.9%	3.5%	5.2%	100.0%
		% within What is the maximum downtime that OPS can afford	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
		% of Total	15.7%	34.8%	40.9%	3.5%	5.2%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	243.590[a]	36	.000
Likelihood Ratio	137.874	36	.000
Linear-by-Linear Association	8.411	1	.004
N of Valid Cases	115		

a. 45 cells (90.0%) have expected count less than 5. The minimum expected count is .03.

Symmetric Measures

		Value	Approximate Significance
Nominal by Nominal	Phi	1.455	.000
	Cramer's V	.728	.000
N of Valid Cases		115	

What role do you play at the terminal * Currently, what does Operations do when ICT Systems go down?

Crosstab

			Currently, what does Operations do when ICT Systems go down?		
			Stop operations	Go manual	Total
What role do you play at the terminal	IT Administrator	Count	40	5	45
		% within What role do you play at the terminal	88.9%	11.1%	100.0%
		% within Currently, what does Operations do when ICT Systems go down?	43.5%	21.7%	39.1%
		% of Total	34.8%	4.3%	39.1%
	Commercial	Count	4	0	4
		% within What role do you play at the terminal	100.0%	0.0%	100.0%
		% within Currently, what does Operations do when ICT Systems go down?	4.3%	0.0%	3.5%
		% of Total	3.5%	0.0%	3.5%
	Operations Manager	Count	4	5	9

		% within What role do you play at the terminal	44.4%	55.6%	100.0%
		% within Currently, what does Operations do when ICT Systems go down?	4.3%	21.7%	7.8%
		% of Total	3.5%	4.3%	7.8%
	IT Manager	Count	12	11	23
		% within What role do you play at the terminal	52.2%	47.8%	100.0%
		% within Currently, what does Operations do when ICT Systems go down?	13.0%	47.8%	20.0%
		% of Total	10.4%	9.6%	20.0%
	Yard Planning Manager	Count	9	0	9
		% within What role do you play at the terminal	100.0%	0.0%	100.0%
		% within Currently, what does Operations do when ICT Systems go down?	9.8%	0.0%	7.8%
		% of Total	7.8%	0.0%	7.8%
	Key Accounts Represantative	Count	4	1	5

		% within What role do you play at the terminal	80.0%	20.0%	100.0%
		% within Currently, what does Operations do when ICT Systems go down?	4.3%	4.3%	4.3%
		% of Total	3.5%	0.9%	4.3%
	Human Resources	Count	0	1	1
		% within What role do you play at the terminal	0.0%	100.0%	100.0%
		% within Currently, what does Operations do when ICT Systems go down?	0.0%	4.3%	0.9%
		% of Total	0.0%	0.9%	0.9%
	Operations Checker	Count	4	0	4
		% within What role do you play at the terminal	100.0%	0.0%	100.0%
		% within Currently, what does Operations do when ICT Systems go down?	4.3%	0.0%	3.5%
		% of Total	3.5%	0.0%	3.5%
	Risk and Compliance Manager	Count	4	0	4

		% within What role do you play at the terminal	100.0%	0.0%	100.0%
		% within Currently, what does Operations do when ICT Systems go down?	4.3%	0.0%	3.5%
		% of Total	3.5%	0.0%	3.5%
	Technical manager	Count	11	0	11
		% within What role do you play at the terminal	100.0%	0.0%	100.0%
		% within Currently, what does Operations do when ICT Systems go down?	12.0%	0.0%	9.6%
		% of Total	9.6%	0.0%	9.6%
Total		Count	92	23	115
		% within What role do you play at the terminal	80.0%	20.0%	100.0%
		% within Currently, what does Operations do when ICT Systems go down?	100.0%	100.0%	100.0%
		% of Total	80.0%	20.0%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	32.464[a]	9	.000
Likelihood Ratio	34.487	9	.000
Linear-by-Linear Association	.743	1	.389
N of Valid Cases	115		

a. 14 cells (70.0%) have expected count less than 5. The minimum expected count is .20.

Symmetric Measures

		Value	Approximate Significance
Nominal by Nominal	Phi	.531	.000
	Cramer's V	.531	.000
N of Valid Cases		115	

What role do you play at the terminal * What is the impact that ICT downtime has on the business?

Crosstab

			What is the impact that ICT downtime has on the business?			
			Very negative	Negative	Not sure	Total
What role do you play at the terminal	IT Administrator	Count	25	19	1	45
		% within What role do you play at the terminal	55.6%	42.2%	2.2%	100.0%
		% within What is the impact that ICT downtime has on the business?	34.2%	61.3%	9.1%	39.1%
		% of Total	21.7%	16.5%	0.9%	39.1%
	Commercial	Count	4	0	0	4

		% within What role do you play at the terminal	100.0%	0.0%	0.0%	100.0%
		% within What is the impact that ICT downtime has on the business?	5.5%	0.0%	0.0%	3.5%
		% of Total	3.5%	0.0%	0.0%	3.5%
	Operations Manager	Count	8	1	0	9
		% within What role do you play at the terminal	88.9%	11.1%	0.0%	100.0%
		% within What is the impact that ICT downtime has on the business?	11.0%	3.2%	0.0%	7.8%
		% of Total	7.0%	0.9%	0.0%	7.8%
	IT Manager	Count	12	6	5	23
		% within What role do you play at the terminal	52.2%	26.1%	21.7%	100.0%
		% within What is the impact that ICT downtime has on the business?	16.4%	19.4%	45.5%	20.0%
		% of Total	10.4%	5.2%	4.3%	20.0%
	Yard Planning Manager	Count	5	4	0	9

		% within What role do you play at the terminal	55.6%	44.4%	0.0%	100.0%
		% within What is the impact that ICT downtime has on the business?	6.8%	12.9%	0.0%	7.8%
		% of Total	4.3%	3.5%	0.0%	7.8%
	Key Accounts Represantative	Count	4	1	0	5
		% within What role do you play at the terminal	80.0%	20.0%	0.0%	100.0%
		% within What is the impact that ICT downtime has on the business?	5.5%	3.2%	0.0%	4.3%
		% of Total	3.5%	0.9%	0.0%	4.3%
	Human Resources	Count	1	0	0	1
		% within What role do you play at the terminal	100.0%	0.0%	0.0%	100.0%
		% within What is the impact that ICT downtime has on the business?	1.4%	0.0%	0.0%	0.9%
		% of Total	0.9%	0.0%	0.0%	0.9%
	Operations Checker	Count	4	0	0	4

		% within What role do you play at the terminal	100.0%	0.0%	0.0%	100.0%
		% within What is the impact that ICT downtime has on the business?	5.5%	0.0%	0.0%	3.5%
		% of Total	3.5%	0.0%	0.0%	3.5%
	Risk and Compliance Manager	Count	4	0	0	4
		% within What role do you play at the terminal	100.0%	0.0%	0.0%	100.0%
		% within What is the impact that ICT downtime has on the business?	5.5%	0.0%	0.0%	3.5%
		% of Total	3.5%	0.0%	0.0%	3.5%
	Technical manager	Count	6	0	5	11
		% within What role do you play at the terminal	54.5%	0.0%	45.5%	100.0%
		% within What is the impact that ICT downtime has on the business?	8.2%	0.0%	45.5%	9.6%
		% of Total	5.2%	0.0%	4.3%	9.6%
Total		Count	73	31	11	115

	% within What role do you play at the terminal	63.5%	27.0%	9.6%	100.0%
	% within What is the impact that ICT downtime has on the business?	100.0%	100.0%	100.0%	100.0%
	% of Total	63.5%	27.0%	9.6%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	41.669[a]	18	.001
Likelihood Ratio	43.693	18	.001
Linear-by-Linear Association	.363	1	.547
N of Valid Cases	115		

a. 23 cells (76.7%) have expected count less than 5. The minimum expected count is .10.

Symmetric Measures

		Value	Approximate Significance
Nominal by Nominal	Phi	.602	.001
	Cramer's V	.426	.001
N of Valid Cases		115	

What role do you play at the terminal * What effect does ICT downtime have on the image of the terminal?

Crosstab

		What effect does ICT downtime have on the image of the terminal?			
		Very negative	Negative	Not sure	Total
What role do you play at the terminal IT Administrator	Count	25	19	1	45
	% within What role do you play at the terminal	55.6%	42.2%	2.2%	100.0%
	% within What effect does ICT downtime have on the image of the terminal?	31.3%	63.3%	20.0%	39.1%

		% of Total	21.7%	16.5%	0.9%	39.1%
	Commercial	Count	4	0	0	4
		% within What role do you play at the terminal	100.0%	0.0%	0.0%	100.0%
		% within What effect does ICT downtime have on the image of the terminal?	5.0%	0.0%	0.0%	3.5%
		% of Total	3.5%	0.0%	0.0%	3.5%
	Operations Manager	Count	7	2	0	9
		% within What role do you play at the terminal	77.8%	22.2%	0.0%	100.0%
		% within What effect does ICT downtime have on the image of the terminal?	8.8%	6.7%	0.0%	7.8%
		% of Total	6.1%	1.7%	0.0%	7.8%
	IT Manager	Count	17	6	0	23
		% within What role do you play at the terminal	73.9%	26.1%	0.0%	100.0%
		% within What effect does ICT downtime have on the image of the terminal?	21.3%	20.0%	0.0%	20.0%

		% of Total	14.8%	5.2%	0.0%	20.0%
	Yard Planning Manager	Count	9	0	0	9
		% within What role do you play at the terminal	100.0%	0.0%	0.0%	100.0%
		% within What effect does ICT downtime have on the image of the terminal?	11.3%	0.0%	0.0%	7.8%
		% of Total	7.8%	0.0%	0.0%	7.8%
	Key Accounts Represantative	Count	4	1	0	5
		% within What role do you play at the terminal	80.0%	20.0%	0.0%	100.0%
		% within What effect does ICT downtime have on the image of the terminal?	5.0%	3.3%	0.0%	4.3%
		% of Total	3.5%	0.9%	0.0%	4.3%
	Human Resources	Count	0	1	0	1
		% within What role do you play at the terminal	0.0%	100.0%	0.0%	100.0%
		% within What effect does ICT downtime have on the image of the terminal?	0.0%	3.3%	0.0%	0.9%

		% of Total	0.0%	0.9%	0.0%	0.9%
	Operations Checker	Count	4	0	0	4
		% within What role do you play at the terminal	100.0%	0.0%	0.0%	100.0%
		% within What effect does ICT downtime have on the image of the terminal?	5.0%	0.0%	0.0%	3.5%
		% of Total	3.5%	0.0%	0.0%	3.5%
	Risk and Compliance Manager	Count	0	0	4	4
		% within What role do you play at the terminal	0.0%	0.0%	100.0%	100.0%
		% within What effect does ICT downtime have on the image of the terminal?	0.0%	0.0%	80.0%	3.5%
		% of Total	0.0%	0.0%	3.5%	3.5%
	Technical manager	Count	10	1	0	11
		% within What role do you play at the terminal	90.9%	9.1%	0.0%	100.0%
		% within What effect does ICT downtime have on the image of the terminal?	12.5%	3.3%	0.0%	9.6%

	% of Total	8.7%	0.9%	0.0%	9.6%
Total	Count	80	30	5	115
	% within What role do you play at the terminal	69.6%	26.1%	4.3%	100.0%
	% within What effect does ICT downtime have on the image of the terminal?	100.0%	100.0%	100.0%	100.0%
	% of Total	69.6%	26.1%	4.3%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	108.875[a]	18	.000
Likelihood Ratio	52.634	18	.000
Linear-by-Linear Association	.009	1	.923
N of Valid Cases	115		

a. 23 cells (76.7%) have expected count less than 5. The minimum expected count is .04.

Symmetric Measures

		Value	Approximate Significance
Nominal by Nominal	Phi	.973	.000
	Cramer's V	.688	.000
N of Valid Cases		115	

What role do you play at the terminal * What is the consequence of ICT downtime on customers?

Crosstab

			What is the consequence of ICT downtime on customers?		
			Very negative	Negative	Total
What role do you play at the terminal	IT Administrator	Count	30	15	45
		% within What role do you play at the terminal	66.7%	33.3%	100.0%
		% within What is the consequence of ICT downtime on customers?	38.5%	40.5%	39.1%

		% of Total	26.1%	13.0%	39.1%
	Commercial	Count	0	4	4
		% within What role do you play at the terminal	0.0%	100.0%	100.0%
		% within What is the consequence of ICT downtime on customers?	0.0%	10.8%	3.5%
		% of Total	0.0%	3.5%	3.5%
	Operations Manager	Count	9	0	9
		% within What role do you play at the terminal	100.0%	0.0%	100.0%
		% within What is the consequence of ICT downtime on customers?	11.5%	0.0%	7.8%
		% of Total	7.8%	0.0%	7.8%
	IT Manager	Count	18	5	23
		% within What role do you play at the terminal	78.3%	21.7%	100.0%
		% within What is the consequence of ICT downtime on customers?	23.1%	13.5%	20.0%

		% of Total	15.7%	4.3%	20.0%
	Yard Planning Manager	Count	5	4	9
		% within What role do you play at the terminal	55.6%	44.4%	100.0%
		% within What is the consequence of ICT downtime on customers?	6.4%	10.8%	7.8%
		% of Total	4.3%	3.5%	7.8%
	Key Accounts Represantative	Count	1	4	5
		% within What role do you play at the terminal	20.0%	80.0%	100.0%
		% within What is the consequence of ICT downtime on customers?	1.3%	10.8%	4.3%
		% of Total	0.9%	3.5%	4.3%
	Human Resources	Count	1	0	1
		% within What role do you play at the terminal	100.0%	0.0%	100.0%
		% within What is the consequence of ICT downtime on customers?	1.3%	0.0%	0.9%

		% of Total	0.9%	0.0%	0.9%
	Operations Checker	Count	4	0	4
		% within What role do you play at the terminal	100.0%	0.0%	100.0%
		% within What is the consequence of ICT downtime on customers?	5.1%	0.0%	3.5%
		% of Total	3.5%	0.0%	3.5%
	Risk and Compliance Manager	Count	4	0	4
		% within What role do you play at the terminal	100.0%	0.0%	100.0%
		% within What is the consequence of ICT downtime on customers?	5.1%	0.0%	3.5%
		% of Total	3.5%	0.0%	3.5%
	Technical manager	Count	6	5	11
		% within What role do you play at the terminal	54.5%	45.5%	100.0%
		% within What is the consequence of ICT downtime on customers?	7.7%	13.5%	9.6%

	% of Total	5.2%	4.3%	9.6%
Total	Count	78	37	115
	% within What role do you play at the terminal	67.8%	32.2%	100.0%
	% within What is the consequence of ICT downtime on customers?	100.0%	100.0%	100.0%
	% of Total	67.8%	32.2%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	24.897[a]	9	.003
Likelihood Ratio	30.581	9	.000
Linear-by-Linear Association	.004	1	.951
N of Valid Cases	115		

a. 13 cells (65.0%) have expected count less than 5. The minimum expected count is .32.

Symmetric Measures

		Value	Approximate Significance
Nominal by Nominal	Phi	.465	.003
	Cramer's V	.465	.003
N of Valid Cases		115	

Annexure D

BCM Survey

The aim of this survey is to collect information on how container terminals in general operate. The survey will gauge the preparedness of terminals with regards to ICT problems and elicit the views of container terminal management about the need for business continuity management. The ICT systems downtime or unavailability here refers to complete shutdown of ICT systems, such as for example, all computers and ICT equipment not switching on.

1. From which country do you operate?

Click below and type the answer.

....

....

....

....

....

2. From which city do you operate?

Click below and type the answer.

....

....

....

....

....

3. What role do you play at the terminal?

Click below and elaborate on your position or title and and how many employees you oversee.

....

....

....

....

....

4. What level management are you?

Mark only one oval.

- ◯ Executive
- ◯ Senior
- ◯ Middle Management
- ◯ Supervisor
- ◯ Skilled Professional

. How long have you been in the container terminal sector?

Mark only one oval.

- More than 10 years
- 5 - 10 Years
- 2 - 5 Years
- Less than 2 years

6. How much does your job interact with Operations?

Mark only one oval.

- I am in Operations
- All the time
- Some of the time
- Very little
- Not at all

7. What was the worst disruption that you encountered at the terminal and what was the cause?

Type your answer below and describe anything non-environmental that caused operations to come to a standstill until it was resolved.

....

....

....

....

....

8. Which of these are the Critical Business Functions and processes of operations at a container terminal?

Here you can choose more than one answer. Check all that apply.

- [ ] a. Loading and off-loading a vessel
- [ ] b. Loading and off-loading trucks
- [ ] c. Tracking containers within the yard
- [ ] d. Loading and off-loading trains
- [ ] e. Maintain an accurate container inventory of all vessels, Vehicles and trains that enter or leave the terminal
- [ ] f. Monitoring of hazardous, refrigerated and special instruction containers

9. Do the functions and processes selected above require ICT Systems in order to take place?

Mark only one oval.

- Yes
- No

10. Which of the following operations processes and functions can be done without the ICT Systems?

Here you can choose more than one answer. Check all that apply.

- ☐ a. Loading and off-loading a vessel
- ☐ b. Loading and off-loading trucks
- ☐ c. Tracking containers within the yard
- ☐ d. Loading and off-loading trains
- ☐ e. Maintain an accurate container inventory of all vessels, Vehicles and trains that enter or leave the terminal
- ☐ f. Monitoring of hazardous, refrigerated and special instruction containers
- ☐ g. None of the above

11. What do you think are the daily causes of disruption to OPS at the terminal? Please exclude environmental factors.

Type your explanation below.

....

....

....

....

....

12. On average, how long does the main cause of daily disruption take to resolve?

Mark only one oval.

- ◯ Half hour
- ◯ Hour
- ◯ 2 Hours
- ◯ More than 2 hours
- ◯ Other: ....

13. Which of the following do you think if unavailable can cause a complete stop of operations?

Check all that apply.

- ☐ Manpower
- ☐ Electrical
- ☐ Technical (Equipment)
- ☐ ICT Systems
- ☐ None of the above
- ☐ Other: ______________________________

14. How important is the Terminal Operating System (Navis, Tideworks, etc.) to Operations?

Please rate on a scale of 1 to 5 on what you think of availability of the following:

Mark only one oval.

	1	2	3	4	5	
Can work without it	⬭	⬭	⬭	⬭	⬭	Cannot work without it

15. How important is File Sharing to Operations?

Mark only one oval.

	1	2	3	4	5	
Can work without it	⬭	⬭	⬭	⬭	⬭	Cannot work without it

16. How important are Printing Services to Operations?

Mark only one oval.

	1	2	3	4	5	
Can work without them	⬭	⬭	⬭	⬭	⬭	Cannot work without them

17. How important is E-mail to Operations?

Mark only one oval.

	1	2	3	4	5	
Can work without it	⬭	⬭	⬭	⬭	⬭	Cannot work without it

18. How important are Telephones to Operations?

Mark only one oval.

	1	2	3	4	5	
Can work without them	⬭	⬭	⬭	⬭	⬭	Cannot work without them

19. How important is the Narrow Band Equipment (VMTs, HHTs, etc.) to Operations?

Mark only one oval.

	1	2	3	4	5	
Can work without them	⬭	⬭	⬭	⬭	⬭	Cannot work without them

20. How important is the Gate Operating System (Gamco, etc.) to Operations?

Mark only one oval.

	1	2	3	4	5	
Can work without it	⬭	⬭	⬭	⬭	⬭	Cannot work without it

21. If pushed - given no other choice - would you be able to run operations manually (without IT)?

Mark only one oval.

- ⬭ Yes
- ⬭ No

22. What BCM practices are you aware of?

Check all that apply.

- ☐ Business Continuity Planning
- ☐ Contingency Planning
- ☐ Continuity of Operations Planning
- ☐ Crisis Planning
- ☐ Scenario Planning
- ☐ None of these
- ☐ Other: ____________________

23. What is the maturity level of BCM for OPS for all events?

Mark only one oval.

- ⬭ g. Processes are unpredictable, poorly controlled and reactive.
- ⬭ h. Processes are planned, documented, performed, monitored and controlled at the PROJECT level, still reactive.
- ⬭ i. Processes are well characterised and understood. Processes, standards, procedures and tools are defined at the ORGANISATIONAL level. Proactive.
- ⬭ j. Processes are controlled using statistical and other quantitative techniques.
- ⬭ k. Process performance is continually improved through incremental and innovative technological improvements.

24. Do you have BCM specifically for IT?

Mark only one oval.

- ⬭ Yes
- ⬭ No

25. If Yes, what is the maturity level of operations BCM in case of ICT Systems loss?

Mark only one oval.

- ◯ a. Processes are unpredictable, poorly controlled and reactive.
- ◯ b. Processes are planned, documented, performed, monitored and controlled at the PROJECT level, still reactive.
- ◯ c. Processes are well characterised and understood. Processes, standards, procedures and tools are defined at the ORGANISATIONAL level. Proactive.
- ◯ d. Processes are controlled using statistical and other quantitative techniques.
- ◯ e. Process performance is continually improved through incremental and innovative technological improvements.

26. If No, then why not?

Mark only one oval.

- ◯ It was never needed
- ◯ I'm not aware of it
- ◯ It would never work anyway
- ◯ I don't know why, but feel it is needed
- ◯ Other: ....

27. What is the maximum downtime that OPS can afford?

Mark only one oval.

- ◯ 10 Minutes
- ◯ 30 Minutes
- ◯ 1 Hour
- ◯ 5 Hours
- ◯ 1 Day

28. What is your perceived level of uptime for ICT in your terminal?

Mark only one oval.

- ◯ ICT is Always UP
- ◯ ICT is up Most of the time
- ◯ Intermittent
- ◯ ICT is Never Up

29. Currently, what does Operations do when ICT Systems go down?

Please elaborate on the actions taken to mitigate this event.

....

....

....

....

....

30. What is the impact that ICT downtime has on the business?

Please elaborate in financial or any relevant terms regarding the terminal.

....

....

....

....

....

31. What effect does ICT downtime have on the image of the terminal?

Elaborate based on media reports, customer feedback, executive management of the company, government or regulators.

....

....

....

....

....

32. What is the consequence of ICT downtime on customers?

Elaborate on the type of impact and severity of the consequences of ICT downtime on customers.

....

....

....

....

....

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Annexure E

Starting qualitative questions for guidance.

1. Did you ever work here before the ICT system was introduced?
    a. How did you run operations?
    b. How is now different from last time?
2. Compared to how you were able to work without ICT systems, can you do that nowadays without the ICT systems?
3. Do you have a manual system for operations in case there is no ICT system in place?
4. Do you have a method of providing minimal ICT availability when experiencing problems with the central ICT database?
5. Have you ever explored other ways of providing ICT continuity?

Annexure F

All current quotations (176). Quotation-Filter: All

____

HU: Container Terminals BCM

File: [C:\Users\Felix\Documents\Scientific Software\ATLASti\TextBank\Container Terminals BCM.hpr7]

Edited by: Super

Date/Time: 2016-03-20 15:43:19

____

P 1: Participant Transcript.docx - 1:2 [little to no graphics, you know..] (24:24) (Super)

Codes: [Architecture]

No memos

Little to no graphics, you know, a graphical user interface, where the planner could see exactly what they were planning and things like that

P 1: Participant Transcript.docx - 1:3 [And also it was text based so ..] (20:20) (Super)

Codes: [Architecture]

No memos

And also it was text based so it had a bit of a dated look.

P 1: Participant Transcript.docx - 1:4 [one of the attractions of navi..] (26:26) (Super)

Codes: [Impact of ICT on operations: Ease of use]

No memos

one of the attractions of navis or one of the process of navis was the graphics that were available. You could see your plan, you could see your vessel structure and things

P 1: Participant Transcript.docx - 1:5 [the manual thing is eh, there ..] (34:34) (Super)

Codes: [Impact of ICT on operations: Manual system]

No memos

the manual thing is eh, there was no such thing as preadvise on cosmos. You had to bring your documents, and your documents was captured by a-check officials. Each cubicle was... well now we have cubicles that's automated but that time each cubicle had an official there soo you brought your documents, and handed your documents over and your information was captured

P 1: Participant Transcript.docx - 1:6 [Nowadays, oh, not nowadays but..] (36:36) (Super)

Codes: [Impact of ICT on operations: Ease of use]

No memos

Nowadays, oh, not nowadays but in Navis, the container is preadvised and only, and once it becomes active it's definitely gonna be here we're gonna start planning for that container. We couldn't do that with navis, I mean, uhh, with cosmos

P 1: Participant Transcript.docx - 1:7 [BCM will be possible in a very..] (114:114) (Super)

Codes: [Proposed model for ICT continuity]

No memos

BCM will be possible in a very limited state like for example; We'd be able to accept, accept export boxes

P 1: Participant Transcript.docx - 1:8 [export containers because we d..] (116:116) (Super)

Codes: [Proposed model for ICT continuity]

No memos

export containers because we don't have to verify who the inbound carrier is

P 1: Participant Transcript.docx - 1:9 [So we could accept the boxes f..] (118:118) (Super)

Codes: [Proposed model for ICT continuity]

No memos

So we could accept the boxes for export, ehh, mark it off or keep the information on what time the container came in on an excel worksheet, and then we can update the system after the fact. But, we need to have very strict controls in place in terms of tracking the positions of these containers. Whether it will be just marking a single block, let them all go in there and then verifying the container position, after the, after the fact, but we need to have strict controls in terms of where these export containers go in our yard. When it comes to the vessel side of things, its, it's a converse, we can't deal with export boxes on the vessel side because we need to keep track of exactly where on the vessel we put these containers

P 1: Participant Transcript.docx - 1:10 [But also in terms of planning,..] (122:122) (Super)

Codes: [Proposed model for ICT continuity]

No memos

But also in terms of planning, erm, this is something that will require a bit of investment. If they had a third party software that we could do vessel planning on, which is available

P 1: Participant Transcript.docx - 1:11 [Independent of any terminal op..] (124:124) (Super)

Codes: [Proposed model for ICT continuity]

No memos

Independent of any terminal operating system, of any TOS. We can get a vessel planning, vessel planning software. We could actually plan vessels and get EDI's approved so that when we get back online, yeah, we don't go back to part of planning the vessel and then trying to get approval you know, work can be ready to continue once the system is restored

P 1: Participant Transcript.docx - 1:12 [with cosmos, each terminal had..] (16:16) (Super)

Codes: [Architecture]

No memos

with cosmos, each terminal had their own installation of cosmos. So the information was not shared across all the terminals

P 1: Participant Transcript.docx - 1:13 [Like you had, uhh, a program t..] (28:28) (Super)

Codes: [Architecture]

No memos

Like you had, uhh, a program that was used for yard planning. Then you had to convert this information send it over into the cosmos. Then you had uhh, vessel planning program, it was totally a separate program

P 1: Participant Transcript.docx - 1:14 [The system also had to upload ..] (30:30) (Super)

Codes: [Architecture]

No memos

The system also had to upload its information into the cosmos database. So, ehh, there wasn't a seamlessness between the different planning, planning

P 1: Participant Transcript.docx - 1:15 [some advantages: in using cosm..] (32:32) (Super)

Codes: [Architecture]

No memos

some advantages: in using cosmos, erm, because it was so robust, didn't take space and things like that, you could integrate it every easily with other programs so you could do this they had these autostow programs, auto plan programs, where you plan an entire vessel and then just, import that information into the AS400

P 1: Participant Transcript.docx - 1:16 [Cosmos did not have a autogate..] (38:38) (Super)

Codes: [Impact of ICT on operations: Old computer system]

No memos

Cosmos did not have a autogate

P 1: Participant Transcript.docx - 1:17 [There was one person in a cubi..] (40:40) (Super)

Codes: [Impact of ICT on operations: Manual system]

No memos

There was one person in a cubicle, who captured your documents

P 1: Participant Transcript.docx - 1:18 [There was one person with a HH..] (42:42) (Super)

Codes: [Impact of ICT on operations: Manual system]

No memos

There was one person with a HHT. Who captured the physical information for example, hazards, the state of the container.. ehh so, it was, we needed more staff and it was very manual. It was very labour intensive

P 1: Participant Transcript.docx - 1:19 [even capturing the ISO's and s..] (48:48) (Super)

Codes: [Impact of ICT on operations: Manual system]

No memos

even capturing the ISO's and stuff was also subject you did errors because you will be capturing with the HHT. Somebody, looking at these things and capturing, dealing with 3000 containers a day, there will be errors now and then

P 1: Participant Transcript.docx - 1:20 [In those five or six odd years..] (66:66)   (Super)

Codes: [Impact of ICT on operations: Old computer system]

No memos

In those five or six odd years we only had one, shutdown and that is due to a power failure

P 1: Participant Transcript.docx - 1:21 [we've never had to, you know, ..] (66:66)   (Super)

Codes: [Impact of ICT on operations: Old computer system]

No memos

we've never had to, you know, worry about database integrity, or any of those things. There was no downtime due to the systems

P 1: Participant Transcript.docx - 1:22 [in terms of business continuit..] (68:68)   (Super)

Codes: [Architecture]

No memos

in terms of business continuity from the server side, we had something called mimix. Which I know is a third party software but it worked with the AS400s, where every transaction was saved to a separate server. It had a different IP address, different physical location. In the event of something going wrong it automatically cut over to a redundant server

P 1: Participant Transcript.docx - 1:23 [these guys were maybe updating..] (70:70)   (Super)

Codes: [Architecture]

No memos

these guys were maybe updating their modules and then they'd just cut over, change the IP address for the server and you'd, ehh working on clients that you wouldn't even know

P 1: Participant Transcript.docx - 1:24 [Whatever instruction or transa..] (84:84)   (Super)

Codes: [Architecture]

No memos

Whatever instruction or transaction was being done in production environment; it wrote it over directly into the redundant server

P 1: Participant Transcript.docx - 1:25 [I'm not sure if it's because w..] (92:92)   (Super)

Codes: [Architecture]

No memos

I'm not sure if it's because we are on the centralised national database. Ehh, maybe it's the ehh, the way we save our database. I know we've changed, we've got SQL and our distributed cache environment

P 1: Participant Transcript.docx - 1:26 [Navis, owned by zebra technolo..] (94:94)   (Super)

Codes: [Architecture]

No memos

Navis, owned by zebra technologies did not have, did not ever do a project on a national level. They were always independent, erm, terminal operators, working within a harbour. They just operate one berth, or one warehouse or they try to link a warehouse to a berth

P 1: Participant Transcript.docx - 1:27 [but, the types of, types of se..] (98:98) (Super)

Codes: [Architecture]

No memos

but, the types of, types of servers uses a distributed cache environment that wasn't really working for us. There was no failover, the load balancer

P 1: Participant Transcript.docx - 1:28 [I don't think we use the right..] (100:100) (Super)

Codes: [Architecture]

No memos

I don't think we use the right type of load balancer because the load balancer was, was... every new client that logged on to Navis the load balance was just going in, it's a sequential load balancing

P 1: Participant Transcript.docx - 1:29 [power as one example, our serv..] (106:106) (Super)

Codes: [Architecture]

No memos

power as one example, our servers are located in Durban station, but we've got our fibers and LAN cables, you know in different distribution hubs from Neotel side at different sites. Ehh, the hub, the distribution hub is always at DCT is based at Island View

P 1: Participant Transcript.docx - 1:30 [Now, it didn't take into effec..] (102:102) (Super)

Codes: [System Problems]

No memos

Now, it didn't take into effect that what if more users logged off on a different node. So you were still... even though you had so many different nodes available, the, the balancer across it was not, you know not adequate so you have too many people trying to access data off one cache

P 1: Participant Transcript.docx - 1:31 [When Island View had a problem..] (106:106) (Super)

Codes: [System Problems]

No memos

When Island View had a problem, ehh, everything at DCT had to stop

P 1: Participant Transcript.docx - 1:32 [When Navis is down, everything..] (110:110) (Super)

Codes: [System Problems]

No memos

When Navis is down, everything comes to a standstill

P 1: Participant Transcript.docx - 1:33 [yes, you do get software that ..] (130:130) (Super)

Codes: [Proposed model for ICT continuity]

No memos

yes, you do get software that just does, that you can only use for vessel planning

P 1: Participant Transcript.docx - 1:34 [From a safety point of view, t..] (144:144) (Super)

Codes: [Impact of ICT on operations: Safety]

No memos

From a safety point of view, this is something that Navis actually helps with is, when a container is busy, ehh, when a straddle is busy in a block, or in a stack, you can configure Navis to say don't dispatch any moves to or from that stack. So you don't want to have the possibility of two straddles ending up into the same stack and preventing and accident, so it's a safety point of view

P 1: Participant Transcript.docx - 1:35 [Also, ehh, we use pooling whic..] (148:148) (Super)

Codes: [Impact of ICT on operations: Safety]

No memos

Also, ehh, we use pooling which we use to separate the straddles so that they all working in different areas. And so again it's still safety

P 1: Participant Transcript.docx - 1:36 [Navis, it does spread out your..] (154:154) (Super)

Codes: [Impact of ICT on operations: Ease of use]

No memos

Navis, it does spread out your load in terms your straddle allocation. Now without working on those pools and equipments the ECs will be able to call any straddle so you won't be able to balance your productivity among different vessels

P 1: Participant Transcript.docx - 1:37 [We have got different types of..] (156:156) (Super)

Codes: [Critical Business Functions in operations]

No memos

We have got different types of operations going on. So we've got stack check, where we are checking for lost containers or verifying positions in the row

P 1: Participant Transcript.docx - 1:38 [We've got cargo controllers wh..] (158:158) (Super)

Codes: [Critical Business Functions in operations]

No memos

We've got cargo controllers who are recording reefer, ehm, settings, you know, all the reefer containers in the reefer yard. At the same time you got your, contain.. your straddles, picking up and dropping off containers or moving containers within the yard.

P 1: Participant Transcript.docx - 1:39 [on Navis, you can set your wor..] (160:160) (Super)

Codes: [Impact of ICT on operations: Ease of use]

No memos

on Navis, you can set your work queues to different ehh, modes. You can set it where there's “man working”, so it won't let any vehicles go to that stack because it knows there's people in there

P 1: Participant Transcript.docx - 1:40 [From a safety point of view yo..] (164:164) (Super)

Codes: [Impact of ICT on operations: Safety]

No memos

From a safety point of view you can't have straddles mixing up where people or the NRE vehicles are driving within the stacks. Because of the different heights of the operators and they won't see anything coming around the block

P 1: Participant Transcript.docx - 1:41 [So we still use the 21 channel..] (168:168) (Super)

Codes: [Impact of ICT on operations: Safety]

No memos

So we still use the 21 channels but, Navis is the, is what coordinates. Your, your Navis is your tool that you use to coordinate that the straddles don't end up. You know there isn't too much of a concentration of straddles in one area, were mixing up people, NRE vehicles and straddles in the same area

P 1: Participant Transcript.docx - 1:42 [We've got and EC for each bert..] (168:168) (Super)

Codes: [Critical Business Functions in operations]

No memos

We've got and EC for each berth, which is eight ECs. We've got EC for rail, we've got an EC for, the ITZ, and we've got ECs for the housekeeping. And they all controls different bits of information on different radio channels. So they aren't talking to each other. They're also based at different physical locations

P 1: Participant Transcript.docx - 1:43 [So, it's impractical for them ..] (170:170) (Super)

Codes: [Impact of ICT on operations: Unsafe use of radio]

No memos

So, it's impractical for them to, you know, all be on the same channel, 'cause you need to speak to the operators

P 1: Participant Transcript.docx - 1:44 [Navis is what actually, sets t..] (172:172) (Super)

Codes: [Impact of ICT on operations: Ease of use]

No memos

Navis is what actually, sets the dispatch. We setup the dispatch rules in Navis, it's not up to the ECs. Without that tool, you would have to rely on the ECs trying to talk each other. So, you're trying, switching between channels, at the same time talking to your operators. You know, go to a certain container position. A certain position in the yard. So, that communication process without Navis would be very difficult

P 1: Participant Transcript.docx - 1:45 [obviously between the drivers ..] (174:174) (Super)

Codes: [Impact of ICT on operations: Unsafe use of radio]

No memos

obviously between the drivers themselves I mean they've got to sequence themselves when they get who is going first into the.. which container is needed first into the, on the you know, they working on the row, which containers is supposed to go onto that row first in the vessel first so... they need to speak to each other as well

P 1: Participant Transcript.docx - 1:46 [the better way to go for us is..] (176:176) (Super)

Codes: [Proposed model for ICT continuity]

No memos

the better way to go for us is to host in the cloud because then you're not relying on South Africa’s infrastructure

P 1: Participant Transcript.docx - 1:47 [Not relying, you know solely o..] (178:178) (Super)

Codes: [Proposed model for ICT continuity]

No memos

Not relying, you know solely on your ISP for national, national connectivity.

P 1: Participant Transcript.docx - 1:48 [Because you're connecting to a..] (180:180) (Super)

Codes: [Proposed model for ICT continuity]

No memos

Because you're connecting to a database that’s hosted on the cloud, each site would be dependent on their own ISP and you can have more than one ISP

P 1: Participant Transcript.docx - 1:49 [And you can go wireless as wel..] (182:182) (Super)

Codes: [Proposed model for ICT continuity]

No memos

And you can go wireless as well as wired connections. You know, so I think that the robustness of having, or the availability will be much more, will be much higher, if we had uhh, a cloud based solution.

P 1: Participant Transcript.docx - 1:50 [We've got different systems in..] (190:190) (Super)

Codes: [Architecture]

No memos

We've got different systems in place for that so, we've got our main database, which is hosted at Durban main station

P 2: Transript 2.docx - 2:1 [for running servers and infras..] (4:4) (Super)

Codes: [Architecture]

No memos

for running servers and infrastructure. If you centralise it. It’s also… on application layer it allows us, as Transnet to have a, uhh, full view of movement of containers in and out of the system, via a single source.

P 2: Transript 2.docx - 2:2 [So, instead of having multiple..] (6:6) (Super)

Codes: [Architecture]

No memos

So, instead of having multiple databases all over, and having to integrate between those that way so, you have a single database, that is uhh, that, that’s hosts, through our terminal for us to have that, that holistic view without having multiple sources.

P 2: Transript 2.docx - 2:3 [it's got application benefits,..] (8:8) (Super)

Codes: [Architecture]

No memos

it's got application benefits, as well as infrastructure benefits,

P 2: Transript 2.docx - 2:4 [application benefits is that y..] (10:10) (Super)

Codes: [Architecture]

No memos

application benefits is that you don't have multiple databases and sources of information

P 2: Transript 2.docx - 2:5 [all your areas, or regions, yo..] (12:12) (Super)

Codes: [Architecture]

No memos

all your areas, or regions, you have a single source, that's has uhh, uhh, complex view, holistic view of that, of those transactions, or the entries into the system.

P 2: Transript 2.docx - 2:6 [I mean on the maintenance comp..] (14:14) (Super)

Codes: [Architecture]

No memos

I mean on the maintenance component it has its benefits, so there's a lot of benefits in each areas, Uhhmm, there's also cons to it, right? So as much as there's pros, there's cons. So the pros is you have, the uh, your maintenance is easier,

P 2: Transript 2.docx - 2:7 [So in the event that we lose t..] (34:34) (Super)

Codes: [Architecture]

No memos

So in the event that we lose the primary source, uhhh, we would need to failover to that secondary environment. So the disruption and the cutover if it's not, uhh, high availability environment, it will be hour disruption to the end users.

P 3: Participant interview transcript.docx - 3:1 [the VMT over and above, it red..] (3:3) (Super)

Codes: [Impact of ICT on operations: Safety]

No memos

the VMT over and above, it reducing the time that the operators of the machine is preoccupied with all other things. One it allows him to focus more. That's one. And secondly, it assists us, assists us with data, in the occurrence of the incident

P 3: Participant interview transcript.docx - 3:2 [that we can actually extract v..] (3:3) (Super)

Codes: [Impact of ICT on operations: Safety]

No memos

that we can actually extract very important data that can tell you how the machine was being operated and, and what container the person was for instance, handling

P 3: Participant interview transcript.docx - 3:3 [on the IMDG side which is the ..] (5:5) (Super)

Codes: [Impact of ICT on operations: Safety]

No memos

on the IMDG side which is the harzadous goods containers as well, it alerts the driver, to the fact that he is now going to be handling the IMDG. Because he sees that on the display of the VMT. So he knows what are the precautions. Again, among other things, which could be that if you're handling these flammable substance you shouldn't be smoking or using the cellphone so it assists

P 3: Participant interview transcript.docx - 3:4 [the, benefit of radios, is, is..] (9:9) (Super)

Codes: [Impact of ICT on operations: Safety]

No memos

the, benefit of radios, is, is there for everyone to see. In that they communicate, they communicate among themselves and we can pick up what the conversation is. We can even understand when the people that are talking indicating that there is a problem somewhere. But also very important there is a radio link between operations and the SHERQ department. So they can radio SHERQ immediately when incident happen.

P 3: Participant interview transcript.docx - 3:5 [Which then shortens the respon..] (11:11) (Super)

Codes: [Impact of ICT on operations: Safety]

No memos

Which then shortens the response time of the SHERQ.

P 3: Participant interview transcript.docx - 3:6 [the SHERQ, and paramedics resp..] (11:11) (Super)

Codes: [Impact of ICT on operations: Safety]

No memos

the SHERQ, and paramedics respond and they need help instead of now relying on the cellphone. They can also radio for help and the, the communication becomes quicker and easier.

P 3: Participant interview transcript.docx - 3:7 [hauler, was driven into the se..] (13:13) (Super)

Codes: [Impact of ICT on operations: Unsafe use of radio]

No memos

hauler, was driven into the sea. And because people were discussing non operational things over the radio, the message did not get

P 3: Participant interview transcript.docx - 3:8 [somebody who had picked up tha..] (15:15) (Super)

Codes: [Impact of ICT on operations: Unsafe use of radio]

No memos

somebody who had picked up that something serious had happened, he had to use a cellphone to check the valididty of the information by phoning one of the persons he has heard on the radio to verify

P 3: Participant interview transcript.docx - 3:9 [things like, people who discus..] (19:19) (Super)

Codes: [Impact of ICT on operations: Unsafe use of radio]

No memos

things like, people who discuss soccer, over the radio and other people who call each other on the radio and to talk about things that are not.. the result is that all these, these, these problems with getting the communication.

P 3: Participant interview transcript.docx - 3:10 [talking on the radio and at th..] (21:21) (Super)

Codes: [Impact of ICT on operations: Unsafe use of radio]

No memos

talking on the radio and at the same time they are busy on their cellphones. Which them makes them not to concentrate on, on operation of the machine safely

P 3: Participant interview transcript.docx - 3:11 [CCTV has assisted us with our ..] (23:23) (Super)

Codes: [Impact of ICT on operations: Safety]

No memos

CCTV has assisted us with our investigations. Cause it gives us a very very reliable picture of what actually happened over and above what witnesses may claim to have seen.

P 3: Participant interview transcript.docx - 3:12 [we have cut some other videos ..] (25:25) (Super)

Codes: [Impact of ICT on operations: Safety]

No memos

we have cut some other videos that show, to use, as part of training

P 3: Participant interview transcript.docx - 3:13 [As part of training to show ei..] (27:27) (Super)

Codes: [Impact of ICT on operations: Safety]

No memos

As part of training to show either things that should not be done. Which are picked up by CCTV. Or good things, that should be encouraged to continue

P 3: Participant interview transcript.docx - 3:14 [It is quite very critical that..] (31:31) (Super)

Codes: [Impact of ICT on operations: Safety]

No memos

It is quite very critical that the planners who use the system, try to make sure that there is very little criss crossing of the equipment when they fetch containers in the various areas

P 3: Participant interview transcript.docx - 3:15 [that criss crossing ehh, has l..] (33:33) (Super)

Codes: [Impact of ICT on operations: Safety]

No memos

that criss crossing ehh, has led to straddles colliding with each other. Ehhh, using, ehh, not using Navis to plan which straddles go to the stack, has led to instances where two straddles go into the stack and they collide there.

P 3: Participant interview transcript.docx - 3:16 [Navis, we are told, we have co..] (35:35) (Super)

Codes: [Impact of ICT on operations: Safety]

No memos

Navis, we are told, we have come to know about, how much we are going to do work on a vessel. So we kind of create a very good way of even, plan, for fatigue. So that then we know how much work we are going to do. So that then we can plan breaks for people who work,

P 4: Participant interview Transcript.docx - 4:10 [From a landside point of view,..] (39:39) (Super)

Codes: [Current BCM Practices]

No memos

From a landside point of view, I think the trucks that come in, we can actually run, cutting out the Camco, we can actually run it manually, we can actually run the trucks in manually,

P 4: Participant interview Transcript.docx - 4:11 [The volumes! Based on the volu..] (41:41) (Super)

Codes: [Current BCM Practices]

No memos

The volumes! Based on the volumes.

P 4: Participant interview Transcript.docx - 4:12 [Number of containers you have ..] (43:43) (Super)

Codes: [Current BCM Practices]

No memos

Number of containers you have and number of containers they have. It's very different. That's why we actually had our conversation earlier on

P 4: Participant interview Transcript.docx - 4:13 [How can we split the terminal...] (43:43) (Super)

Codes: [Current BCM Practices]

No memos

How can we split the terminal. How can we maybe... if there is an issue of manpower that we need more, get more manpower. We can actually make it work.

P 4: Participant interview Transcript.docx - 4:14 [You have to get more cargo coo..] (47:47) (Super)

Codes: [Current BCM Practices]

No memos

You have to get more cargo coordinators. You need to get more cargo coordinators, ehh, plan more manual, ehh, stack sheets.

P 4: Participant interview Transcript.docx - 4:15 [also, when the system comes ba..] (47:47) (Super)

Codes: [Current BCM Practices]

No memos

also, when the system comes back up, probably need to get people to put input to the data so that it doesn't mess up, the planning configuration

P 4: Participant interview Transcript.docx - 4:16 [Can be done at DCT, we just ne..] (51:51) (Super)

Codes: [Current BCM Practices]

No memos

Can be done at DCT, we just need to analyse DCT

P 4: Participant interview Transcript.docx - 4:17 [Break DCT down. Erm, when you ..] (51:51) (Super)

Codes: [Proposed model for ICT continuity]

No memos

Break DCT down. Erm, when you say something is big it's a matter of have you broken it down?

P 4: Participant interview Transcript.docx - 4:19 [When we have got a continuity ..] (55:55) (Super)

Codes: [Current BCM Practices]

No memos

When we have got a continuity issue, performance will get affected.

P 4: Participant interview Transcript.docx - 4:20 [So in, in critical zones, you ..] (53:53) (Super)

Codes: [Current BCM Practices]

No memos

So in, in critical zones, you need people that will assist and make sure that it flows. However, always remember when you have a continuity issue, you will not operate, at the optimum that you usually operate when there is no continuity issue.

P 4: Participant interview Transcript.docx - 4:21 [So the issue of running busine..] (60:60) (Super)

Codes: [Proposed model for ICT continuity]

No memos

So the issue of running business continuity manually, is actually an issue that's actually gonna die.

P 4: Participant interview Transcript.docx - 4:23 [was around business continuity..] (62:62) (Super)

Codes: [Proposed model for ICT continuity]

No memos

was around business continuity plans running continuity plans manually. It's gonna die. They're now introducing apps. That at a click of button, all the relevant signatures and the roles and responsibility, gets done

P 4: Participant interview Transcript.docx - 4:24 [There's companies that are int..] (62:62) (Super)

Codes: [Proposed model for ICT continuity]

No memos

here's companies that are introducing these IT solutions into business continuity.

P 4: Participant interview Transcript.docx - 4:25 [So, the issue of still not mov..] (64:64) (Super)

Codes: [Proposed model for ICT continuity]

No memos

So, the issue of still not moving with the times and saying you're running manually, It's not gonna be sustainable. You're gonna have to look at IT solutions around, business continuity problems. That's where we're going

P 4: Participant interview Transcript.docx - 4:26 [It's around looking at the iss..] (66:66) (Super)

Codes: [Proposed model for ICT continuity]

No memos

It's around looking at the issue of the business strategy right now, called Intelliports. Intelliports is around the IT working for the business.

P 4: Participant interview Transcript.docx - 4:27 [When you have a business conti..] (70:70) (Super)

Codes: [Proposed model for ICT continuity]

No memos

When you have a business continuity issue, you should have, technology that should be reactive, to that process.

P 4: Participant interview Transcript.docx - 4:28 [So, if Navis is a problem, whe..] (76:76) (Super)

Codes: [Proposed model for ICT continuity]

No memos

So, if Navis is a problem, when it goes out, can we actually use another operation, operating system or not?

P 4: Participant interview Transcript.docx - 4:29 [Analysis, how much will it cos..] (80:80) (Super)

Codes: [Proposed model for ICT continuity]

No memos

Analysis, how much will it cost for me to rent this or for me not to have this? So those are the things you, you need analysis

P 4: Participant interview Transcript.docx - 4:30 [It's the maturity level.] (82:82) (Super)

Codes: [Proposed model for ICT continuity]

No memos

It's the maturity level.

P 4: Participant interview Transcript.docx - 4:31 [One port in Ngqura versus this..] (84:84) (Super)

Codes: [Proposed model for ICT continuity]

No memos

One port in Ngqura versus this port. That's why I can't treat this as the same. The maturity level is different.

P 4: Participant interview Transcript.docx - 4:32 [gone are the days, that you ca..] (84:84) (Super)

Codes: [Critical Business Functions in operations: Old method]

No memos

gone are the days, that you can't, you can afford not to be resilient.

P 4: Participant interview Transcript.docx - 4:33 [Stopping is, is not an option ..] (88:88) (Super)

Codes: [Critical Business Functions in operations: Old method]

No memos

Stopping is, is not an option now. You can't just stop. You need to make other plans

P 5: Supervisor Transcript.docx - 5:1 [So what they'll do is they'll ..] (20:20) (Super)

Codes: [Critical Business Functions in operations]

No memos

So what they'll do is they'll provide us with a list. And say, these are the containers that are coming in, these are the containers that are going out, these are transhipment, these are late arrivals, this is this and that

P 5: Participant Transcript.docx - 5:2 [we used to have different depa..] (20:20) (Super)

Codes: [Critical Business Functions in operations]

No memos

we used to have different departments. So we used to be called,… one department used to be ICL list, one used to be the main section, one was this import capturing section, one was export capturing section and stuff like that

P 5: Participant Transcript.docx - 5:3 [Now if you had like, nine hund..] (21:21) (Super)

Codes: [Critical Business Functions in operations]

No memos

Now if you had like, nine hundred, discharging, the whole nine hundred would have to be captured manually into the system. Exports, same, they go like that, right?

P 5: Participant Transcript.docx - 5:4 [The line would actually submit..] (23:23) (Super)

Codes: [Critical Business Functions in operations]

No memos

The line would actually submit, a CTO

P 5: Participant Transcript.docx - 5:5 [to put it for the first move o..] (25:25) (Super)

Codes: [Critical Business Functions in operations]

No memos

to put it for the first move on the system, they will submit us with a list with the first move on the system, and that's called the ICL list, from that ICL list they'll give us nine hundred (I'm using nine hundred as an example). They'll tell us, this is the containers that are coming into the terminal. We take the ICL list, and then they're captured manually into the system. So that's the first move that's on the system. Right? So there's no COPRA no BAPLIE, nothing. So then they would then capture it. Then what would happen is, they would, have to submit a CTO. The line will submit a CTO, with the vessel that's coming in, container number, who's the transporter

P 5: Participant Transcript.docx - 5:6 [all paperwork must be filled, ..] (27:27) (Super)

Codes: [Impact of ICT on operations: Manual system]

No memos

all paperwork must be filled, documentation must be signed, the line stamp must be there. All those things you got to check.

P 5: Participant Transcript.docx - 5:7 [import/export, would hand me t..] (27:27) (Super)

Codes: [Impact of ICT on operations: Manual system]

No memos

import/export, would hand me the tickets that are to be captured, so then with, for example, imports, they would capture it

P 5: Participant Transcript.docx - 5:8 [CTOs were all manual, they wer..] (27:27) (Super)

Codes: [Impact of ICT on operations: Manual system]

No memos

CTOs were all manual, they were handled all manually

P 5: Participant Transcript.docx - 5:9 [STAMP those documents, uh, the..] (27:27) (Super)

Codes: [Impact of ICT on operations: Manual system]

No memos

STAMP those documents, uh, the first three copies of it, and then the first two, would go to filing, and then we hand them the? Third and rest of it, back to them, CTS and the like. So they did the filing. So we… would take the first two, right? And we would file the first one. And then the second one we used to put it into the box for the.. each transporter. Each line. So we used to have a box for each line. The line would come on a daily basis and fetch their copies. Just in case the first one was missing with the agent or something. So, that was captured manually. In terms of that, that was in terms of the first process where the CTOs were done and the moves were done

P 5: Participant Transcript.docx - 5:10 [the trucking company would com..] (29:29) (Super)

Codes: [Impact of ICT on operations: Manual system]

No memos

the trucking company would come, with the C, same CTO, the copy of the CTO. And they would come to the uhh, that was previously used to be the A-check, and everything was done manually.

P 5: Participant Transcript.docx - 5:11 [Now when we MOVED over to Navi..] (31:31) (Super)

Codes: [Impact of ICT on operations: Ease of use]

No memos

Now when we MOVED over to Navis, right, we moved over to Navis and there's.. NO paperwork at all.

P 5: Participant Transcript.docx - 5:12 [introducing Navis for the firs..] (31:31) (Super)

Codes: [Impact of ICT on operations: Ease of use]

No memos

introducing Navis for the first time, which departments we have to take out, which departments we keep, and stuff like that

P 5: Participant Transcript.docx - 5:13 [you got to know how many peopl..] (31:31) (Super)

Codes: [Impact of ICT on operations: Ease of use]

No memos

you got to know how many people to put in there, in terms of the pre-gate and the trouble desk, to see that you're not overloaded, or underutilised,, or, overutilised

P 5: Participant Transcript.docx - 5:14 [that's when it came and then w..] (31:31) (Super)

Codes: [Impact of ICT on operations: Ease of use]

No memos

that's when it came and then with Navis now is total paperless. Paperless, because everything is done by the, instead of the ICL list, is done by the BAPLIE. So the vessel planner, receives the BAPLIE, via email and he loads the BAPLIE, so that's the first move that's taken off the ICL list

P 5: Participant Transcript.docx - 5:15 [OK, now that would be pre-gate..] (31:31) (Super)

Codes: [Critical Business Functions in operations]

No memos

OK, now that would be pre-gate, this would trouble desk

P 5: Participant Transcript.docx - 5:16 [move in terms of the CTO, wher..] (31:31) (Super)

Codes: [Critical Business Functions in operations]

No memos

move in terms of the CTO, where they used to submit the import and export, that's where the COPRA comes in and DOC centre loads the COPRA, after, uhh vessel planners load the BAPLIE.

P 5: Participant Transcript.docx - 5:17 [process an email baplie will t..] (37:37) (Super)

Codes: [Impact of ICT on operations: Ease of use]

No memos

process an email baplie will take the, ummhh, if, if there's no complications it uhh, it's like just put it on the system, choosing this correct line, hitting the end button, and its done on the system. So it's about five minutes

P 5: Participant Transcript.docx - 5:18 [yeah, less than five minutes.] (39:39) (Super)

Codes: [Impact of ICT on operations: Ease of use]

No memos

yeah, less than five minutes.

P 5: Participant Transcript.docx - 5:19 [that used to take ages. Becaus..] (41:41) (Super)

Codes: [Critical Business Functions in operations: Old method]

No memos

that used to take ages. Because you used to cop…. the, the uhhh, we used to capture each container

P 5: Participant Transcript.docx - 5:20 [we used to capture each contai..] (43:43) (Super)

Codes: [Critical Business Functions in operations: Old method]

No memos

we used to capture each container.

P 5: Participant Transcript.docx - 5:21 [So it used to be a whole lot o..] (47:47) (Super)

Codes: [Impact of ICT on operations: Manual system]

No memos

So it used to be a whole lot of people that used be ICL deparment

P 5: Participant Transcript.docx - 5:22 [And they worked per shift.] (49:49) (Super)

Codes: [Impact of ICT on operations: Manual system]

No memos

And they worked per shift.

P 5: Participant Transcript.docx - 5:23 [and you had to do that at that..] (51:51) (Super)

Codes: [Impact of ICT on operations: Manual system]

No memos

and you had to do that at that time.

P 5: Participant Transcript.docx - 5:24 [we used to handle more because..] (65:65) (Super)

Codes: [Impact of ICT on operations: Manual system]

No memos

we used to handle more because of the lar… number of people we had in the department to make sure the process ran smoothly.

P 5: Participant Transcript.docx - 5:25 [It's being handled very effici..] (67:67) (Super)

Codes: [Impact of ICT on operations: Ease of use]

No memos

It's being handled very efficiently, because the thing is now, all the container needs to do is, the the the, line needs to preadvise it and theh, the unit needs to just come to pregate

P 5: Participant Transcript.docx - 5:26 [Navis is like the touch of a b..] (77:77) (Super)

Codes: [Impact of ICT on operations: Ease of use]

No memos

Navis is like the touch of a button, it's done.

P 5: Participant Transcript.docx - 5:27 [why it was done OK, is because..] (79:79) (Super)

Codes: [Impact of ICT on operations: Manual system]

No memos

why it was done OK, is because we had additional people. Before, we had 24 people in the capturing section. So now, with this same 24 people, so now, with this still 24 people, you don't have 24 people. Nothing at all.

P 5: Participant Transcript.docx - 5:28 [One person] (81:81) (Super)

Codes: [Impact of ICT on operations: Ease of use]

No memos

One person

P 5: Participant Transcript.docx - 5:29 [by cutting down on the resourc..] (85:85) (Super)

Codes: [Impact of ICT on operations: Ease of use]

No memos

by cutting down on the resources, which is, we should, I mean we shouldn't even be thinking of

P 5: Participant Transcript.docx - 5:30 [we cutting down on resources] (87:87) (Super)

Codes: [Impact of ICT on operations: Ease of use]

No memos

we cutting down on resources

P 5: Participant Transcript.docx - 5:31 [Mistakes were very easy to mak..] (91:91) (Super)

Codes: [Impact of ICT on operations: Ease of use]

No memos

Mistakes were very easy to make because the thing is, uhh, there was lot of fraud that could take place

P 5: Participant Transcript.docx - 5:32 [it's not easy to make mistakes..] (99:99) (Super)

Codes: [Impact of ICT on operations: Ease of use]

No memos

it's not easy to make mistakes because it can be looked into.

P 5: Participant Transcript.docx - 5:33 [It's got a trail of things tha..] (101:101) (Super)

Codes: [Impact of ICT on operations: Ease of use]

No memos

It's got a trail of things that can be looked into.

P 5: Participant Transcript.docx - 5:34 [but here, you can't make delib..] (105:105) (Super)

Codes: [Impact of ICT on operations: Ease of use]

No memos

but here, you can't make deliberate mistakes, because you can be held accountable because of Navis. And the trail that it has is very very efficient.

P 5: Participant Transcript.docx - 5:35 [So it was easy to make mistake..] (97:97) (Super)

Codes: [Impact of ICT on operations: Manual system]

No memos

So it was easy to make mistakes also on capturing the wrong; container number. It was very easy to make mistakes.

P 5: Participant Transcript.docx - 5:36 [here's certain deliberate mist..] (103:103) (Super)

Codes: [Impact of ICT on operations: Manual system]

No memos

here's certain deliberate mistakes that you can make over there, that you would not get caught out

P 5: Participant Transcript.docx - 5:37 [the move was like, ehh, I thin..] (109:109) (Super)

Codes: [Impact of ICT on operations: Ease of use]

No memos

the move was like, ehh, I think, manually created, or whatever. But now with Navis, it's ehh, it gives them a thing on the screen

P 5: Participant Transcript.docx - 5:38 [And they just have to press on..] (111:111) (Super)

Codes: [Impact of ICT on operations: Ease of use]

No memos

And they just have to press one button, you know

P 5: Participant Transcript.docx - 5:39 [So which means you gotta get s..] (143:143) (Super)

Codes: [Impact of ICT on operations: Manual system]

No memos

So which means you gotta get somebody to pregate, then you got to have somebody to en, ehhh, ingate, then you got to go through it via the ITZ now. Then it goes into the yard. When it comes back to the outgate you got to gate it out manually

P 5: Participant Transcript.docx - 5:40 [So manually, it's a long proce..] (145:145) (Super)

Codes: [Impact of ICT on operations: Manual system]

No memos

So manually, it's a long process.

P 5: Participant Transcript.docx - 5:41 [So manually, you got to, you k..] (160:160) (Super)

Codes: [Impact of ICT on operations: Manual system]

No memos

So manually, you got to, you know, look at each ticket that you got to do this that and the other. So, manual process is a long process. I mean, we fully automated and I think it's a most amazing thing.

P 5: Participant Transcript.docx - 5:42 [in terms of the process, in te..] (162:162) (Super)

Codes: [Impact of ICT on operations: Ease of use]

No memos

in terms of the process, in terms of the frustration from the clients and drivers. It's, it's, it's just that you know, such a lot of things have been sorted out.

P 6: Participant transcript.docx - 6:1 [it would come up on your scree..] (7:7) (Super)

Codes: [Critical Business Functions in operations]

No memos

it would come up on your screen and tell you directly where to go. Won't tell you where to pick err, Basically it will tell you the crane number

P 6: Participant transcript.docx - 6:2 [We used to go on any crane we ..] (24:24) (Super)

Codes: [Critical Business Functions in operations]

No memos

We used to go on any crane we wanted, they eventually changed it. And then, not long after that, I'd say a year after, cosmos came in. and then we started doing that, and we just convinced the guys to go into ehh, doing, working all cranes. If we discharging. So wherever you see most of the boxes, you've got to take them

P 6: Participant transcript.docx - 6:3 [See, in the old system it was ..] (24:24) (Super)

Codes: [Critical Business Functions in operations: Old method]

No memos

See, in the old system it was easy as well. So you just go there, if you did that, you just punch in the number and you're gone. Take from that, take from that stack and you're gone

P 6: Participant transcript.docx - 6:4 [when we never had computers we..] (32:32) (Super)

Codes: [Critical Business Functions in operations: Old method]

No memos

when we never had computers we used to use radio comms. To tell the manual moves

P 6: Participant transcript.docx - 6:5 [the radio man called, you, 'ri..] (34:34) (Super)

Codes: [Critical Business Functions in operations: Old method]

No memos

the radio man called, you, 'right' he wanted you to go to ff5, erm, row so and so. Say row 22, erm, position, 2b, 3c, or CA

P 6: Participant transcript.docx - 6:6 [will tell you which position i..] (36:36) (Super)

Codes: [Critical Business Functions in operations: Old method]

No memos

will tell you which position inn the row

P 6: Participant transcript.docx - 6:7 [No, you, you, YOU as a driver ..] (42:42) (Super)

Codes: [Critical Business Functions in operations: Old method]

No memos

No, you, you, YOU as a driver will pick up the box

P 6: Participant transcript.docx - 6:8 [tell the CC which is the conta..] (44:44) (Super)

Codes: [Critical Business Functions in operations: Old method]

No memos

tell the CC which is the container number

P 6: Participant transcript.docx - 6:9 [They will tell you where the c..] (46:46) (Super)

Codes: [Critical Business Functions in operations: Old method]

No memos

They will tell you where the container goes.

P 6: Participant transcript.docx - 6:10 [it's still being done.] (50:50) (Super)

Codes: [Proposed model for ICT continuity]

No memos

it’s still being done.

P 6: Participant transcript.docx - 6:11 [now and again you get them doi..] (54:54) (Super)

Codes: [Proposed model for ICT continuity]

No memos

now and again you get them doing it. Ahh, what can I say… At 108 at one time, the system went down

P 6: Participant transcript.docx - 6:12 [All that happened was... CC had ..] (58:58) (Super)

Codes: [Proposed model for ICT continuity]

No memos

All that happened was… CC had to write it down. The box number, OK, we sent it to that row, that block. When I was, … when the line,… the system came back on, they give it to the EC to punch it in. It will come into anyone’s computer. Won’t specifically go to the machine that did the move. The guys will just push enter, enter, enter, till it’s all up to date on the system

P 6: Participant transcript.docx - 6:13 [Not very smooth. ‘cause everyo..] (72:72) (Super)

Codes: [Impact of ICT on operations: Unsafe use of radio]

No memos

Not very smooth. ‘cause everyone was talking over each other

P 6: Participant transcript.docx - 6:14 [eventually we had to say guys.....] (74:74) (Super)

Codes: [Impact of ICT on operations: Unsafe use of radio]

No memos

eventually we had to say guys… Whoever talks on the radio first, let them finish getting their moves and then go.

P 6: Participant transcript.docx - 6:15 [It’s dangerous. My opinion is,..] (78:78) (Super)

Codes: [Impact of ICT on operations: Unsafe use of radio]

No memos

It’s dangerous. My opinion is, it’s too dangerous.

P 6: Participant transcript.docx - 6:16 [That guy is still communicatin..] (84:84) (Super)

Codes: [Impact of ICT on operations: Unsafe use of radio]

No memos

That guy is still communicating on the radio. Now other guys communicate on the radio, we all got boxes now.

P 6: Participant transcript.docx - 6:17 [You might get some guy calling..] (88:88) (Super)

Codes: [Impact of ICT on operations: Unsafe use of radio]

No memos

You might get some guy calling you to say; “Watch out, I’m coming through this side”, you can’t hear him.

P 6: Participant transcript.docx - 6:18 [Because remember, when you wor..] (90:90) (Super)

Codes: [Impact of ICT on operations: Unsafe use of radio]

No memos

Because remember, when you working, in, in, ah, you got to physical work in operations understanding what I'm saying, where I'm getting here. When you coming into… underneath the crane. When you tell a guy, "watch out, we coming in, behind you, machine so and so" and you don't hear him, and you just start pulling out, you gonna smack him

P 6: Participant transcript.docx - 6:19 ['cause, its one; ALWAYS COMMUN..] (92:92) (Super)

Codes: [Impact of ICT on operations: Safety]

No memos

'cause, its one; ALWAYS COMMUNICATE!

P 6: Participant transcript.docx - 6:20 [Your communication is your mai..] (94:94) (Super)

Codes: [Impact of ICT on operations: Safety]

No memos

Your communication is your main safety point, over there at the moment.

P 6: Participant transcript.docx - 6:21 [And your observations. Because..] (96:96) (Super)

Codes: [Impact of ICT on operations: Safety]

No memos

And your observations. Because if you can't hear another person on the radio, calling you and telling you "This is what I'm doing. Watch out this is where I'm coming from." Because the guys they… If you hear them on the radio, if you hear them talking to each other, where they coming from, how they going, where they going.

P 6: Participant transcript.docx - 6:22 [Your concentration. Is also af..] (102:102) (Super)

Codes: [Critical Business Functions in operations: Old method]

No memos

Your concentration. Is also affected by thinking now… 'cause remember, I'm giving you a move now, ff5

P 6: Participant transcript.docx - 6:23 [Now you must keep it there] (106:106) (Super)

Codes: [Critical Business Functions in operations: Old method]

No memos

Now you must keep it there

P 6: Participant transcript.docx - 6:24 [So you thinking of a position ..] (108:108) (Super)

Codes: [Critical Business Functions in operations: Old method]

No memos

So you thinking of a position now,

P 6: Participant transcript.docx - 6:25 [And you're driving.] (110:110) (Super)

Codes: [Critical Business Functions in operations: Old method]

No memos

And you're driving.

P 6: Participant transcript.docx - 6:26 [But your mind is on the positi..] (112:112) (Super)

Codes: [Critical Business Functions in operations: Old method]

No memos

But your mind is on the position the whole time

P 6: Participant transcript.docx - 6:27 [So it takes your concentration..] (114:114) (Super)

Codes: [Critical Business Functions in operations: Old method]

No memos

So it takes your concentration off, when you supposed to be concentrating on driving, and the other machines

P 6: Participant transcript.docx - 6:28 [Communication you have to have..] (123:123) (Super)

Codes: [Critical Business Functions in operations]

No memos

Communication you have to have. Otherwise you end up blocking into each other

P 6: Participant transcript.docx - 6:29 [the uh, VMT is about communica..] (124:124) (Super)

Codes: [Impact of ICT on operations: Ease of use]

No memos

the uh, VMT is about communication, to tell you what to do. To tell you where to find or take the box

P 6: Participant transcript.docx - 6:30 [So each step you take into you..] (136:136) (Super)

Codes: [Critical Business Functions in operations]

No memos

So each step you take into your mind, whereas, you're not really concentrating on the actual where it must go

P 6: Participant transcript.docx - 6:31 [Cause you know where the block..] (136:136) (Super)

Codes: [Impact of ICT on operations: Ease of use]

No memos

Cause you know where the block is, you're driving. You're looking, observing for other machines

P 6: Participant transcript.docx - 6:32 [which cuts down your job, righ..] (138:138) (Super)

Codes: [Impact of ICT on operations: Ease of use]

No memos

which cuts down your job, right? Makes it safer?

P 6: Participant transcript.docx - 6:33 [And it cuts down all your dela..] (141:141) (Super)

Codes: [Impact of ICT on operations: Ease of use]

No memos

And it cuts down all your delays

P 6: Participant transcript.docx - 6:34 [cause a lot of the time a guys..] (143:143) (Super)

Codes: [Critical Business Functions in operations: Old method]

No memos

cause a lot of the time a guys will forget halfway there, call the controller back, "Where must my box go?"

P 6: Participant transcript.docx - 6:35 [Now she must back and look and..] (145:145) (Super)

Codes: [Critical Business Functions in operations: Old method]

No memos

Now she must back and look and say, "Eish, that machine number I gave that box to…" but, she's already done another ten boxes.

P 6: Participant transcript.docx - 6:36 [in the old days, where manual ..] (149:149) (Super)

Codes: [Critical Business Functions in operations: Old method]

No memos

in the old days, where manual moves was easy

P 6: Participant transcript.docx - 6:37 [yes, manual move was easy] (149:149) (Super)

Codes: [Critical Business Functions in operations: Old method]

No memos

yes, manual move was easy

P 6: Participant transcript.docx - 6:38 [Right now our staff compliment..] (151:151) (Super)

Codes: [Critical Business Functions in operations: Old method]

No memos

Right now our staff compliment is too big.

P 6: Participant transcript.docx - 6:39 [To run a manual operations] (153:153) (Super)

Codes: [Critical Business Functions in operations: Old method]

No memos

To run a manual operations

P 6: Participant transcript.docx - 6:40 [Now especially with safety bei..] (156:156) (Super)

Codes: [Impact of ICT on operations: Safety]

No memos

Now especially with safety being such a priority now

Annexure G

Transnet Limited
Registration Number
1990/000900/30

Transnet Port Terminals
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(Previously Stanger Street)
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TRANSNET

Transnet Port Terminals

MEMORANDUM

www.transnet.net

To:	Karl Socikwa, Chief Executive, Transnet Port Terminals
From:	Brenda Magqwaka, General Manager: KZN, Containers
Date:	13 October 2015
Subject:	PERMISSION FOR MR F KUTAME, ICT MANAGER: DCT, TRANSNET PORT TERMINALS TO CONDUCT RESEARCH AT TRANSNET PORT TERMINALS AS PART OF HIS PHD THESIS.

PURPOSE:

1. The aim of this submission is to request permission for Felix Kutame to conduct research at Transnet Port Terminals as part of his PhD qualification.

BACKGROUND:

2. I'm currently studying my PhD through the University of Venda. I have so far completed two years of my study and am now in my final year. At this stage, as part of my research, I will be conducting a survey.
3. The topic of my research is "Business continuity model for container terminal operations in the event of unavailability of ICT systems."
4. My topic has been approved by the University's School of Management higher degree committee. I have been assigned a promoter from the university named Professor Armstrong Kadyamatimba.

DISCUSSION:

5. It can be noted that container terminals use ICT systems for automation to direct their primary operations.
6. What is also notable is that when the ICT systems go down, operations are stopped and have to wait for the system to be brought up again; this leaves the ICT system as being a serious bottleneck.
7. The main aim of this thesis is to develop a method whereby operations can be continued should the ICT system be rendered unavailable.

1

8. To achieve this aim, the study will consist of a survey to assess the level of business continuity maturity models in container terminals with reference to ICT systems.
9. Based on the data collection method of this study, a sample size of 100 respondents will be surveyed across different container terminals by means of a questionnaire that will be sent electronically. I will also be conducting on the job observation of the utilization of ICT systems by operations.
10. Throughout the research process including data collection and analysis process, ethics and confidentiality will be considered and maintained at all times.

FINANCIAL IMPLICATIONS:

11. This study is self-funded.
12. There will be no further financial implications for TPT in terms of this study.

RECOMMENDATION:

13. It is recommended that this request for conducting research as part of my PhD thesis at Transnet Port Terminals be approved.

Requested By:

Felix Kutame
ICT Manager, DCT

Date: 14/10/2015

Recommended By:

Joe Madlala
Terminal Manager, DCT

Date: 14/10/2015

Recommended By:

Brenda Magqwaka
GM: KZN, Containers

Date: 21/10/2015

Recommended By:

Deirdre Ackerman
GM: EIMS, TPT

Date: 22/10/2015

Approved By:

Karl Socikwa
Chief Executive, TPT

Date: 5.11.15

Annexure H

RESEARCH AND INNOVATION
OFFICE OF THE DIRECTOR

NAME OF RESEARCHER/INVESTIGATOR:
Mr NF Kutame

Student No:
11638193

PROJECT TITLE: **Development of a business continuity model for container terminal operations in the event of a loss of centralised ICT systems.**

PROJECT NO: SMS/16/BMA/04/1406

SUPERVISORS/ CO-RESEARCHERS/ CO-INVESTIGATORS

NAME	INSTITUTION & DEPARTMENT	ROLE
Prof A Kadyamatimba	University of Venda	Supervisor
Prof MP Khwashaba	University of Venda	Co-Supervisor
Mr NF Kutame	University of Venda	Investigator - Student

ISSUED BY:
UNIVERSITY OF VENDA, RESEARCH ETHICS COMMITTEE

Date Considered: September 2016
Decision by Ethical Clearance Committee Granted
Signature of Chairperson of the Committee: ....
Name of the Chairperson of the Committee: Prof. G.E. Ekosse

UNIVERSITY OF VENDA
DIRECTOR
RESEARCH AND INNOVATION
2016 -09- 2 1
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University of Venda
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"A quality driven financially sustainable, rural-based Comprehensive University"

Annexure I

23 Elfin Glen Road, Nahoon Valley Heights, East London, 5200

Professional EDITORS Group

To whom it may concern:

This document certifies that the research proposal whose title appears below has been reviewed for proper English language, grammar, punctuation, spelling, and overall style by Rose Masha, a member of the Professional Editors' Group whose qualifications are listed in the footer of this certificate.

Title:

Business continuity model for container terminal operations in the event of unavailability of ICT systems

Author:

FELIX NYADZANI KUTAME

Date Reviewed:

10 October 2015

Signed:

Rose Khanyisile Masha

082 770 8892

Bachelor of Library and Information Science, Hons (English Language Teaching), HDE,
MA (Hypermedia in Lang. Learning), PhD (Ed).