**UNIVERSITY OF GHANA**

**COLLEGE OF HUMANITIES**

# AFFORDANCES AND CONSTRAINTS OF SEAPORT SMART SERVICE SYSTEMS IN A DEVELOPING COUNTRY: A CASE STUDY FROM GHANA

**FRED AMANKWAH-SARFO**

**A THESIS SUBMITTED TO THE SCHOOL OF GRADUATE STUDIES IN PARTIAL FULFILMENT OF THE AWARD OF DOCTOR OF PHILOSOPHY IN INFORMATION SYSTEMS**

**DEPARTMENT OF OPERATIONS AND MANAGEMENT INFORMATION SYSTEMS**

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**BY**

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# DECLARATION

I do hereby declare that this thesis is my own work produced from research I carried out under supervision. This thesis has not been presented by anyone for any academic award, in this or any other institution.

$6^{th}$ October 2020

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# ABSTRACT

This study seeks to understand affordances and constraints of seaport smart service systems in a developing country context. Smart service systems refer to configurations of smart technologies, people and processes to co-create value for stakeholders. Examples of smart service systems discussed in information systems literature are smart homes, smart cities, smart health, and smart energy. While traditional service systems relied on people and physical processes, smart service systems rely on sensing and autonomous machine capabilities. Thus, based on their awareness and monitoring capabilities, smart service systems sense and respond to dynamic environmental conditions to co-create value for people, other systems, and themselves.

Information Systems (IS) studies on smart service systems are limited in three main ways. First, existing IS research lack theoretical foundation. The focus has rather been on conceptualisations and literature reviews. There is, therefore, the need for in-depth and theory-driven studies to investigate smart service systems' use and effects in an organizational context. Second, extant IS literature on smart service systems has focused more on application areas such as smart health, smart building, smart government, smart grid, smart transportation, smart environment, smart home, and smart lifestyles. The area of seaport smart service system is yet to receive attention in IS research. Third, existing theoretical perspectives in affordance conception conceptualise affordances as action possibilities that emerge from interactions between technologies and goal-oriented actor(s) or user(s) while constraints are hindrances that prevent actors from using the technology to achieve intended goals. However, extant IS studies have concentrated on only the affordance-actualization process. Little or no research focuses on the constraint process of technology affordances theory.

To address the research gap, the research questions that guided this study are: (a) why would a developing country seaport deploy smart service systems for security and container handling? (b) how are the uses of smart service systems for developing country seaport enabled or constrained? (c) what are the consequences of using smart service systems in a developing country seaport? Responding to these questions, this thesis employed the interpretivist research paradigm, the qualitative methodology, the case study method, and the technology affordances and constraints theory to understand the use of smart service systems in seaport in Ghana, a developing country.

Ghana was selected because its main seaport in Tema had recently deployed smart service systems to address challenges of manual security processes and paper-based container handling systems. Accordingly, this study uses a two-case study comprising a smart seaport security service system and a smart container handling system in Ghana's Tema Port. The findings show that deployment of smart service systems for seaport can enable autonomous access control, autonomous data capturing, data analytics and dashboard reporting, online submission of documents, and improved security and container handling services. The findings also show that smart service systems can be constrained by inadequate data storage capacity, internet and power supply instability, smart device breakdowns.

The study contributes to research, theory and practice. With respect to research, this study extends existing knowledge in smart service systems in two ways. First, the study provides an understanding of affordances, constraints and consequences of using seaport smart service systems in a developing country context. Second, this study has extended the literature from a limited focus on conceptualisations and literature reviews to theory-driven empirical studies on seaport smart security service and container handling service systems. For theory, this study contributes to the technology affordances and constraints theory by refining the theory in two ways. First, the study extends the existing types of technology affordances by introducing smart technology affordance as a new type in smart service system context. Second, the study introduces affordance-constraint process as a complement to the existing affordance-actualization process. This study also extends the application of technology affordances and constraints theory from human as the only actors to include smart objects as actors in smart service systems studies in IS.

Based on the research findings, this study offers four implications for practice. First, management can adopt cloud computing to address the constraint of inadequate storage capacity resulting from big data generation. Second, to address the constraint of device breakdowns, management can procure robust smart artefacts as well as establish and enforce risk assessment and maintenance schedule. Third, management can provide standby smart power generators to take over when the national grid goes off. Finally, port authorities can contract multiple internet service providers to address the problem of internet outages.

# DEDICATION

Dedicated to the glory of God

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| | |
|---|---|
| AGS | Automated Gate Systems |
| AID | Automatic Incident Detection |
| APS | Advanced Planning and Scheduling |
| ATC | Automated Transfer Cranes |
| AVI | Automatic Vehicle Identification |
| BoL | Bill of Laden |
| CCTV | Closed Circuit Television |
| CITOS | Computer Integrated Terminal Operations System |
| CPS | Cyber-Physical Systems |
| CSR | Case Study Research |
| CVC | Customs Valuation Code |
| DICs | Destination Inspection Companies |
| DIS | Destination Inspection Scheme |
| DSR | Design Science Research |
| DTOS | Digital Terminal Operating System |
| EDI | Electronic Data Interchange |
| EGS | Electronic Gating Systems |
| ERP | Enterprise Resource Planning |
| eRTG | Electronic Rail-Mounted Gantry |
| GAS | Gate Appointment Systems |
| GCNet | Ghana Community Network |
| GIS | Geographical Information System |
| GJT | Golden Jubilee Terminal |
| GMA | Ghana Maritime Authority |
| GMDSS | Global Maritime Safety and Distress Systems |
| GNSS | Global Navigation Satellite Systems |
| GPHA | Ghana Ports and Harbours Authority |
| GPS | Global Positioning Systems |
| ICD | Inland Cargo Depot |
| ICTs | Information Communication Technologies |
| IMO | International Maritime Organisation |
| IoT | Internet of Things |
| IoV | Internet of Vehicles |
| IS | Information Systems |
| ISPS | International Ship and Port Security Code |
| ITS | Intelligent Transportation System |
| ITS | Intelligent Transportation Systems |
| JMTOS | Jade Master Terminal Operating System |
| LPR | License Plate Recognition |
| LRIT | Long-Range Identification and Tracking |
| MPS | Meridian Port Services |
| NSW | National Single Window |
| OCR | Optical Character Recognition |
| PCS | Port Community System |
| PMIS | Port Management Information System |
| RFID | Radio Frequency Identification |
| RTLS | Real-time location systems |

| | |
|---|---|
| SCHS | Smart Container Handling Systems |
| SO | Smart objects |
| SOP | standard operation procedures |
| SSS | Smart Service System |
| SSSS | Smart Security Service Systems |
| ST | Smart Technologies |
| TACT | Technology affordances and constraints theory |
| TAS | Truck Appointment System |
| TOS | Terminal Operating Systems |
| VTIS | Vessel Traffic Information System |
| WSN | Wireless Sensor Networks |
| WTO | World Trade Organisation |

# CHAPTER ONE

# INTRODUCTION

## 1.1 Background

Increasing advances in information and communication technologies (ICTs) have changed service systems to become smart (Larson, 2016; Watanabe & Mochimaru, 2017). The emergence of smart services can be attributed to the advancement in technology in recent years. (Paukstadt, Strobel & Eicker, 2019; Allmendinger & Lombreglia, 2005). Service systems are made up of technologies, the organizations that employ them, information and actors. All these work for the benefit of each other (Maglio, Vargo, Caswell & Spohrer, 2009). Smart service systems form configurations of smart technologies, physical objects, environment, and people that co-create value (Lim & Maglio, 2018). The configuration shows how smart service system is composed of different elements arranged to carry out the organizational objectives or goals (Fiss, 2011; Misangyi Greckhamer, Furnari, Fiss, Crilly, & Aguilera, 2017; Siggelkow, 2001). Examples of smart service systems discussed in the information systems literature include smart homes, smart cities, smart health, and smart energy (Lim & Maglio, 2018). Smart technologies (ST) refer to information communication technologies that allow sensors, databases, and wireless communication to enable users to interactively engage in various activities (Elwood, 2010; Maglio, 2014; Medina-Borja, 2015).

The concepts of smart technologies are predominantly based on the power of the internet to provide smart services (Marimon, Llach, Alonso-Almeida & Mas-Machuca, 2019). For instance, when ordinary home appliances such as electricity, refrigerators, and washing machines are embedded with smart technologies and the internet, they become smart home appliances (Beverungen, Müller, Matzner, Mendling & vom Brocke, 2017). Moreover, smart technologies have received much attention in IS research where they have been applied to areas such as retail store usage (Lee, 2012b), health and home systems (Patsadu, Nukoolkit, & Watanapa, 2012), governance (Himmelreich, 2013), energy (Rogerson & Sims, 2012) and education (McCardle, 2002). Little attention has been given to studies that focus on seaports security and container handling.

The use of traditional paper-based also processes is dominant in developing country's seaport operations. Consequently, stakeholders, according to Tijan (2018), who are involved in seaport processes still grapple with paper document and the input of data manually. Documents required for seaport transactions for imports and export processes used manual processes and paper-records. These processes were costly, time-consuming, labour-intensive and error-prone (Heilig, Schwarze & Voss, 2017).

In recent times, smart technologies are being used for critical roles in seaport operations competitiveness because information is one of the paramount resources of any seaport (Tijan et al., 2012). They are used in port operations to enhance safety, productivity, visibility, and efficiency in port procedures (Heilig et al., 2017). By their nature, seaports are complex ecosystems with varied stakeholders who have diverse interests but collaborate for efficient and effective processes (Capdevila & Zarlenga, 2015). It is, therefore, important for lessons to be drawn from the application of smart technologies to the seaport domain in order to advance knowledge in research, theory and also in practice.

In Ghana, Tema Port is the hub for international trade and economic growth (Ghana National Chamber of Commerce & Industry, 2017). Over the years, an increase in trade volumes has resulted in congestions, lack of yard space and storage areas, and cumbersome administrative processes resulting in delays and high costs. Most significantly, seaports are constructing new berths and container terminals, upgrading equipment and reforms aimed at improving the efficiency of operations. This is intended to facilitate trade and to improve revenue mobilization. However, for efficiency in port operations, Tema Port has deployed smart technology to meet international standards, reduce the cost of doing business at the port, and increase revenue generation (Ghanaian Times Reporter, 2020). Moreover, these smart service systems afford and constrain stakeholders from achieving their objectives and consequences. This study aims at understanding the affordances and constraints of seaport smart service system.

## 1.2 Research Problem

Prior IS studies have investigated smart service systems (Lim & Maglio, 2019; Massink, Harrison & Latella, 2010). However, these studies have stagnated in different application areas (Beverungen, Müller, Matzner, Mendling & vom Brocke, 2017) including agriculture (Cu Lamacchia & Nguyen, 2017; Sari Garcia, Mendia, Piedra, Zaruma, Orellana, 2017; Perera Zaslavsky, Christen & Georgakopoulos, 2014), transportation (Lim, Kim, Kim, Heo, Kim & Maglio, 2018) and healthcare (Kim, Kwon, Kim, Kang, Kim, Kim, Jun, Lee, & Lee, 2014a; Chung and Park, 2016; Lim and Maglio, 2018), commerce (Lee, 2012), governance (Himmelreich, 2013), energy (Rogerson & Sims, 2012; Cai & Li, 2014), smart cities smart health and smart buildings (Winkler, Beltran, Esfahani, Maglio & Cerpa, 2016).

For instance, in agriculture, IS studies on smart service systems has focused on smart irrigation systems for smart farming (Sari et al., 2017). Here, through the application of smart technologies such as the Internet of Things, farmers obtain a better understanding of plant growth using efficient farming models, land conditions, and climate variability for optimization and improved yield (Cu et al., 2017). In the healthcare sector, smart location systems have been used to support people with disabilities (Wessel, Davidson, Barquet, Rothe, Peters & Megges, 2019). In transportation and vehicle operations, research has discussed in the context of intelligent transportation systems (ITS) and how these can benefit smart cities (Adart, Mouncif & Naïmi, 2017; Dimitrakopoulos & Demestichas, 2010). The term Internet of Vehicles (IoV) has been referenced in some studies (Ismagilova Hughes, Dwivedi & Raman, 2019). These concepts play crucial roles within Intelligent Transport Systems by providing applications to improve road safety and traffic efficiency (Chen et al., 2015).

Generally, IS research on smart service systems has largely been conceptual (Geirbo, 2017; Lim & Maglio, 2018, 2019) and literature reviews (Lim & Maglio, 2018). For example, IS studies have investigated the development of a conceptual model for smart tourism systems to enable destination competitiveness and management ( Koo, Shin, Gretzel, Hunterd & Chunge, 2016). Thus, limited empirical, theory-driven research in information systems exists on organisational use and effects of seaport smart service systems. In terms of literature reviews, IS research covering smart cities has been published (Ismagilova et al., 2019; Anthopoulos, 2015; Bibri & Krogstie, 2017; Chatterjee, Khas, Kar, & Khas, 2015; Chauhan, Agarwal & Kar, 2016; Cocchia, 2014). These reviews highlight the key accomplishments of smart service systems as well as articulate the challenges and opportunities.

In seaports, IS research has focused largely on port community systems (Carlan, Sys & Vanelslander, 2015). Seaport smart security and container handling systems have received less attention in IS studies. This study seeks to address these limitations in IS literature by researching smart container handling and smart security systems in a seaport.

In summary, the limitations in existing IS literature on smart service systems are that:

- Notwithstanding the increase in research on smart service systems, extant IS literature has focused on conceptual frameworks (Geirbo, 2017; Lim & Maglio, 2018, 2019) and literature reviews of papers largely from other disciplines (Heilig & Voß, 2017). Therefore, new studies must focus beyond conceptual frameworks and literature reviews to cover in-depth empirical and theory-driven research in the Information Systems discipline.

- Extant IS literature has focused more on research domains such as smart health, smart building, smart environment, smart transportation, smart, smart home, smart government, and smart grid (Caragliu et al., 2011; Pramanik et al., 2017). IS research on seaport smart container handling and seaport smart security systems needs much attention. This is because of the role of seaports to the development of a nation cannot be overemphasized. Dwarakish & Salim (2015) argue that notwithstanding their support of economic activities in the hinterland since ports act as a crucial connection between sea and land transport, supplier of jobs, exchange of goods and also hosting a majority of industries. Hence, any research which seeks to ascertain ways of using information technologies, like smart service systems, to enhance the efficiency of port activities in a developing country is timely and also a critical source of knowledge (Dwarakish & Salim, 2015).

- Theory driven IS studies on smart service systems are limited. A research gap therefore exists on in-depth and theory-driven studies that investigate smart service systems' use and effects in an organisational context. This study addresses this limitation by conducting an in-depth and theory-driven study using technology affordances and constraints theory (TACT) (Majchrzak & Markus, 2012) in a seaport environment. Also, in IS, TACT show affordance-actualisation process and neglects affordance-constraint process. There is a need to extend TACT by introducing the affordance-constraint process framework as a complementary lens to the existing affordance-actualisation process framework, which dominates affordance-based studies in information systems.

To address these limitations, this study uses two embedded case studies comprising smart service systems for security and for container handling in Ghana's Tema Port. These cases were purposefully selected to provide an in-depth understanding of the affordances and constraints of smart service systems in a developing country context.

In addressing the research gaps, this thesis adds to the body of knowledge in smart service systems using an interpretive case study methodology (Crowe et al., 2011; Klein & Myers, 1999b; Walsham & Barrett, 2004) and technology affordances and constraints theory (Markus & Silver, 2008b; Thapa & Sein, 2018) as a lens to understand seaport smart service systems in Ghana. Tema Port was selected for this study because the seaport recently implemented smart service systems. However, the project was faced with resistance from some of the stakeholders.

Also, this innovation is yet to receive comprehensive academic research from an IS perspective. The current study is needed in order to provide practical and in-depth understanding of the deployment and use of seaport smart service system within orgnisational context to appreciate their affordances and constraints. The subsequent section describes how access to the field sites was gained.

## 1.3 Research Context

The case study concerns Tema Port in Ghana, a developing country that lies along the Gulf of Guinea and the Atlantic Ocean. Ghana has two commercial seaports, at Tema and Takoradi. Due to Ghana's boundary with the sea, some landlocked countries utilise the Tema Port as a transit point. Tema Port handles about 80% of the Ghana's import and export freight. The port is about 18 miles from Accra.

### 1.3.1 Smart Service Systems

Smart service systems are the context of this research**.** Smart service systems enable interconnection between providers and users, data sensing and context awareness (Lim & Maglio, 2019, p .361). Efficient and effective accomplishment of tasks by customers are what smart service systems provide. Such systems portray five essential features, known as the 5Cs, which are (a) Connection between things and people, (b) Collection of data for context awareness, (c) Computation in the cloud, (d) Communications by wireless, and (e) Co-creation of value (Lim & Maglio, 2019, p. 361).

A system that uses smart technology resources of connected networks, wireless communication, context-aware computing, and sensing to control things can also be termed as smart service system (Lim & Maglio, 2018). Among the examples of smart service systems include smart, smart cities, smart systems, smart infrastructures, or even the smart world (Liu et al., 2019). In IS research attention has focused on the application of smart technologies (Neuhofer et al., 2015) in a number of areas (Lee, 2012a), including health and home systems (Patsadu et al., 2012), retail store usage (Lee, 2012b), urban governance (Himmelreich, 2013), education (McCardle, 2002) and energy monitoring in hotels (Rogerson & Sims, 2012). In these contexts, smart technologies have been portrayed as instrumental tools with specific functionalities that add value. In several ways, intelligent systems have been conceptualized as self-directed systems that anticipate user needs and encompass comprehensive and specific knowledge adaptable to user input (Gretzel, 2011). Effective understanding of service and service systems often requires combining multiple methods to consider how interactions of people, technology, organisations, and information create value under various conditions.

### 1.3.2 Technology Affordances and Constraints Theory

Technology affordances and constraints theory (TACT) (Majchrzak & Markus, 2012) in information systems studies is an extension of Gibson (1986)'s studies in ecological psychology. The theory provides a lens to study technology as environmental objects with respect to the capabilities perceived by humans (Markus & Silver, 2008b). TACT overcomes the limitations of technology studied as immutable objects independent of the environmental influence, and provides perspectives related to different users, as it dynamically interacts with the context (Majchrzak & Markus, 2012). While affordances are valuable in understanding the action potentials of the technology that the users perceive, it is also essential to observe the constraints that result in limiting technology use (Pal et al., 2018).

TACT has been used in IS research on mobile payment technology as a methodological framework (Pal et al., 2018), challenges of digital innovation (Chan & Sadreddin, 2019), artificial intelligence (Keller et al., 2019), IT and healthcare (Klecun et al., 2016), adaptive use of enterprise systems (Wang & Nandhakumar, 2016), technology, materiality and individual (Bemgal, 2018) and collaborative police emergency response (Verhulst, 2017) among many others.

The premise of the theory is the idea of affordance and constraints. The idea of affordance views IT as socio-technical artefact and perceives affordances as relations between the artefact and the individuals who use them. The relational concept of affordances helps to resolve issues with social and technical determinism discussed in the IS literature (Leonardi, 2011; Markus & Silver, 2008). For example since it avoid deterministic view of IT and its impacts, cannot be the sole reason for change (Markus & Silver, 2008). As such, both IT capabilities and the choices people make when using those capabilities can help better explain the ultimate effects of IT on social structures (Leonardi, 2013). This perspective conforms to non-deterministic view of IT, as noted in previous studies (DeSanctis & Poole, 1994).

IS literature has conceptualized affordances at the levels of individual, group, and organisation (Leonardi, 2013; Majchrzak & Markus, 2012). In that context, they have been characterized as what an individual, group, or organisation with a specific goal can do with technology. Again, as indicated by the IS literature, higher-level affordances can be collectively created by lower-level affordances (Leonardi, 2013). For example, (Leonardi, 2013) introduced the concept of shared and collective affordances as action possibilities that are created by group members which in turn allows a group to accomplish something that it could not otherwise achieve (Savoli & Barki, 2016).

### 1.4 Research Purpose

Understanding the affordances and constraints of seaport smart service systems in a developing country is the purpose of this study. The overall goal is to study the affordances of Ghana's paperless port system. Ghana was selected because its main seaport in Tema had recently deployed smart service systems to address challenges of manual security processes and paper-based container handling systems.

## 1.5 Research Questions

To achieve the purpose, the study will address three key questions as follows:

a. Why would a developing country seaport deploy smart service systems for security and container handling?

b. How are the uses of smart service systems for developing country seaport enabled or constrained?

c. What are the consequences of using smart service systems in a developing country seaport?

To answer these questions, this study employed interpretivist research paradigm, qualitative methodology, case study method, and technology affordances and constraints theory to investigate the deployment and use of seaport smart service systems in Ghana, a developing country.

## 1.6 Chapter Outline

In order to study affordances and constraints of seaport smart service systems in a developing country, it is significant to study seaport smart service systems in particular and smart service systems in general. As the case study is from Tema Port in Ghana, literature on the nature of seaports community systems in the developing country context will be studied.

Chapter One serves as the introduction of this study and captures issues like background, statement of problem, research context and purpose, as well as research objectives.

Chapter Two delves into the literature review of service systems. The chapter covers seaport smart service generally by focusing on the types of smart service systems applications that exist in the maritime industry.

Chapter Three focuses on the theoretical foundation underpinning the research. In particular, the chapter examines the Technology Affordances and Constraints Theory by discussing its concepts and principles. The chapter, moreover, reflects on areas in which these theories have been applied and the justification for adopting the Technology Affordances and Constraints Theory as the analytical lens. The limitation of technology affordances and constraints theory in the context of the study is also provided.

Chapter Four discusses the methodology. The discussion centres on the philosophical assumptions and methodology in terms of research method as well as the data collection and analysis techniques that are employed in this study. This chapter further discusses the reasons for the choice of the interpretive paradigm, qualitative case study method. It also explains the case study selection, fieldwork, data collection and analysis.

Chapter Five presents the case description. To position empirical research in a developing country context seaport smart service context the chapter describes the context of study, Tema Port and the findings of case study in to address the research questions

Chapter Six focuses on the case analysis based on the affordances and constraints theory presented in Chapter three. The chapter begins with within case analysis for the two cases in Chapter 5 followed by their cross-case analyses. The first section presents an analysis of smart security service system, followed by its affordance and constraints processes. The second section presents analysis of smart container handling system followed by its affordance and constraints processes. The third section presents the cross-case analysis of two seaport smart service systems. The chapter concludes with a summary.

Chapter Seven addresses the research questions stated in this introductory chapter through discussion and interpreting the study's findings in relation to the research questions and the literature review in Chapter Two. The chapter ends with reflections on the use of the Technology Affordances and Constraints Theory for this study.

Chapter Eight outlines the summary and the conclusion of the study. The chapter addresses the purpose of study and research questions. This chapter also discusses technology affordances and constraints theory, providing a rich insight on seaport smart service systems in a developing country. The study purpose and research questions. This chapter also presents the contribution to research, theory and practice. The chapter finally presents the study's limitations and offers overall conclusions and directions for further research.

# CHAPTER TWO

# SMART SERVICE SYSTEMS AND SEAPORTS

## 2.1 Introduction

The previous chapter presented the background, the research problem, the research context and research questions this study seeks to answer. The current chapter presents the IS literature review on smart service systems and seaports. The chapter begins by reviewing IS literature on smart technologies and smart objects. This is followed by a review of features, benefits and challenges of smart service systems. The next section examines smart technologies followed by Smart Service Systems in Seaports. The chapter concludes with a summary.

## 2.2 Smart Technologies

Smart technologies (ST) refer to information communication technologies that allow sensors, databases, and wireless communication to enable users to interactively engage in various activities (Elwood, 2010; Medina-Borja, 2015b). This interactivity is made possible by sensors, actuators and mobile technologies to support real-time exchange of information among actors (Heilig et al., 2017).

The emergence of smart technologies has led to unprecedented opportunities for application and focus of attention (Neuhofer et al., 2015) and research interest (Lee, 2012a), in health systems (Patsadu et al., 2012), commerce (Lee, 2012b), governance (Himmelreich, 2013), education (McCardle, 2002), electricity grid (Parikh et al., 2010) and energy monitoring in hotels (Rogerson & Sims, 2012). In the above instances, smart technologies have been shown to be instruments that have specific functionalities and add value in many ways. As an example, the use of Quick Response (QR) has supported consumers in retail settings (Lee, 2012b), while the combination of Radio-Frequency Identification (RFID), sensors, tags, cloud computing and semantics is used in the establishment of a smart city (Komninos, 2013). The concept of smart technologies has received traction in tourism (Zach et al., 2010) and many other disciplines.

Recent IS studies show smart technologies impact on improvement in public sector organisations through performance monitoring (Ning & Khuntia, 2019). Research findings show that, smart household devices, smart cars and smart assistive technologies are touted as transformational for business, society and individual human experience. Smart technologies enable stimulation of innovation or disrupt interconnections among practice elements (Wessel et al., 2019).

These features then allow smart technologies to configure and reconfigure services over time (Beverungen et al., 2017; Lim et al., 2018) so that services become more personal and tailor-made (Medina-Borja, 2015a). Smart technologies enable systems to configure or reconfigure elements as they learn from and adjust to change and become "smarter" (Spohrer et al., 2017; Demirkan, 2015). The advent of smart technologies, therefore, means that systems can evolve towards becoming "smarter" as they learn and respond to their environment (Spohrer et al., 2017). According to Barile and Polese (2010), system goals are achieved through the dynamic configuration of the elements of smart technologies customers' and employees' interaction with smart technologies can show whether human practices and smart technology are compatible (consonance) and operate in harmony (resonance).

Smart technologies are usually seen as supplementing or elevating human activities, for instance, by integrating resources so that value propositions can be obtained (Beverungen et al., 2017; 2019). Some research has revealed that service systems see "smartness" as a desirable state and so they gravitate towards them (Beverungen et al., 2019;Lim & Maglio, 2018).

## 2.3 Smart Service Systems

Smart service systems (SSS) refer to human-technology configurations that depend on smart technologies to co-create value for stakeholders (Demirkan et al., 2008; Mikalef, 2014). Examples of such systems discussed in the information systems literature are smart homes, smart cities, smart health, and smart energy (Lim & Maglio, 2018). While traditional service systems relied on people and physical processes (Vargo & Lusch, 2008b), smart service systems rely on sensing and autonomous machine capabilities (Beverungen et al., 2017). Thus, based on their awareness and monitoring capabilities, smart service systems sense and respond to dynamic environmental conditions to co-create value for people, other systems and themselves (Beverungen et al., 2019; Wessel et al., 2019). Smart service systems are a new generation of service systems that are particularly interesting due to their scalable, adaptable and reactive traits (Polese et al., 2016). Service systems in the retail, transportation, entertainment, hospitality healthcare, and other sectors are configurations of information, people, technologies, and organisations that work together for the benefit of one another (Spohrer et al., 2007; Maglio et al., 2009). As technology is increasingly being used in services, service systems have become smarter (Larson, 2016; Watanabe & Mochimaru, 2017).

A number of sectors have employed smart service systems. These include homes (Alam et al., 2018), transportation (Pelletier et al., 2011), healthcare (Maglio & Lim, 2016), among others. Industrialists, government and academics are focusing on the concept of smart service systems as the concepts of smart technology and smart service system interconnect (Larson, 2016; Maglio et al., 2015). The term "smart" connotes innovative technologies, especially those that are embedded with artificial intelligence (Papagiannidis & Marikyan, 2019). The key elements of "smart services" are 1) machine intelligence, 2) connectedness and 3) value co-creation by client and provider of a service (Gavrilova & Kokoulina, 2015). Thus, smart services are based on the idea of co-creation of value and rely on machine intelligence in connected systems (Gavrilova & Kokoulina, 2015).

Service systems comprise varying parts applying competences with and for one another (Maglio et al., 2009; Vargo & Lusch, 2004), incorporating resources, knowledge and technologies from across the system to increase overall value (Vargo & Lusch, 2008a). In IT outsourcing arrangements, an organisation can operate and deploy IT infrastructure and application for another organisation (Maglio et al., 2015). Since the value that emerges from the interactions among different stakeholders like service providers, customers and others required coordinated activities the service system can be described as a complex one (Badinelli, 2010).

A service system can be transformed into a smart service system by means of introducing connected things and automation into service systems. According to Lim et al., (2016), smart service systems are service systems that have connected things (objects) and automated parts. These two features allow for the transfer of data and information as people and organisations interact. The goal of this kind of interaction is to improve decision-making and operations. Therefore, due to their awareness and monitoring capabilities, smart service systems sense and respond to dynamic environmental conditions to co-create value for people, other systems and themselves (Beverungen et al., 2019; Wessel et al., 2019).

Smart services systems are capable of self-diagnostic, self-detection, and self-corrective functions through the combination of actuation, technologies for sensing, coordination, control, communication and more (Maglio, 2014). A smart service system consists of four components: (1) connected things, (2) automation, (3) people and organisations, and (4) data and information interactions (Lim et al., 2016). This concept of smart service system is described as an extension of the service system containing self-management capabilities (Barile & Polese, 2010; Medina-Borja, 2015). "Smart service systems are service systems in which value co-creation between customers, providers, and other stakeholders are automated or facilitated based on a connected network, data collection (sensing), context-aware computation, and wireless communication" (Chiehyeon & Maglio, 2019).

### 2.3.1 Features and Smart Services Systems

The core features of smart services systems have been conceptualized as 5Cs (Lim & Maglio, 2018, 2019). The 5Cs of smart service systems are connection, collection, computation, and communications for co-creation: (a) connection between things and people, (b) data collection for context awareness, (c) computation, (d) wireless communication, and (e) value co-creation. First, smart service systems support digital connection through IoTs and people. Second, smart service systems use sensing technologies and humans to gather context-awareness data. Third, computation involves the use of algorithms and AI capabilities to process data for human or machine interpretation. Fourth, wireless communication supports remote and mobile data transmission. Finally, value co-creation involves the use of data and information to create mutual benefits for stakeholders.

Smart technologies have been applied in different industries such as smart manufacturing, smart homes, smart cities, smart electricity grid, smart ports. These applications deploy a 'smart' infrastructure, comprising Cyber-Physical Systems (CPSs) and the Internet of Things (IoT) for communication (Jakobs, 2017). The Internet of Things refers to the phenomenon where things (i.e., objects) connected to the internet can be accessed via many technologies (Atzori et al., 2012). Internet of Things (IoT), is a network of items including sensors and embedded systems which are connected to the internet and enable physical objects to gather and exchange data (Gubbi et al., 2013).

### 2.3.2 Functions of Smart Services Systems

The key functions of smart service systems are monitoring, controlling, optimisation and autonomous actions (Paukstadt et al., 2019; Porter & Heppelmann, 2015). In smart service systems, monitoring involves data sensing and environmental awareness of conditions and states of objects, people and spaces, including alerts and notifications for changes (Porter & Heppelmann, 2015). Controlling involves remote manipulation of objects (Beverungen et al., 2017). The optimisation uses information from monitoring and control activities to make appropriate decisions in a particular context (Paukstadt et al., 2019). Autonomous capabilities involve the application of AI for self-operation without human intervention (Paukstadt et al., 2019; Porter & Heppelmann, 2015).

Functions of smart service systems enable analysis and evaluation of big data (Klötzer & Pflaum, 2015) to support intelligent decisions and planning (Sadiku et al., 2017). Smart systems are associated with intelligence (Allmendinger & Lombreglia, 2005; Boukhris & Fritzsche, 2019), a capability previously attributed to humans only (Allmendinger & Lombreglia, 2005). However, with the advancement in machine intelligence, sensors, actuators and network connectivity, ordinary objects such as electricity meters, cars and phones have become smart (Lim & Maglio, 2019).

### 2.3.3 Benefits of Smart Services Systems

Service systems comprise technologies, information and people that work together to co-create value for users (Larson, 2016). Benefits of smart service systems include the ability to bring on board the perspective of a provider and customer, on value creation, with respect to a smart product (Beverungen et al., 2019). Furthermore, assigning names like smart objects, smart devices, and cyber-physical systems, embedding software and hardware systems into physical goods that can connect digitally to other products and information systems has become a trend in many industries. There are a number of uses of sensors in a smart product. Sensors are used to exchange data with actors, obtain contextual data, make autonomous decision, store and process data locally and act physically by means of actuators (Technikwissenschaften, 2011).

Smart products are common in many industries. These exactly means often remains unclear (Gretzel et al., 2015). For instance, cars are not only transporting machines but they are also intelligent data-processing units that obtain information on their physical surroundings (e.g., the position and trajectory of other vehicles as well as road conditions). They also linked to other intelligent gadgets and smart infrastructure (e.g., toll-collection systems, traffic information systems). Furthermore, they can act or respond in near real-time and this is based on various data streams analysis (e.g. braking after detecting a dangerous situation). One benefit is sensor monitoring of objects, events and environments (Baheti & Gill, 2011). Another benefit is automated integration of physical and digital components for data capturing and analysis to support decision making (Klotzer et al., 2017). In addition, smart service systems enable remote and real-time connectivity for machine-to-machine and machine-to-human interactions (Shim et. al., 2019).

Furthermore, smart service systems enable actors and objects to capture, retrieve and to analyse aggregated field data on changing situations and environments (Müller, et al., 2019). They also enable remote control of objects without the need for physical presence (Müller, et al., 2019). Despite the above literature, the area of smart services in seaports in developing country context is yet to receive research attention; hence, the need for this study. It has been argued by IS scholars that "the introduction of smart products transforms service systems framed as a configuration of people, technologies, and other resources that interact with other service systems to create mutual value into smart service systems" (Maglio et al., 2009, p. 395).

### 2.3.4 Challenges of Smart Services Systems

Notwithstanding these benefits, some challenges with smart service systems have been discussed (Zhao & White, 2017; Mois, Sanislav, & Folea, 2016) in IS literature. These challenges include difficulties for system integration (Zhou et al., 2015) and security threats (Mahmoud, Hamdan, & Baroudi, 2019). Another challenge stems from mismatches between how technology functions and how human beings behave (Larson, 2016). For example, in education, the "$100 laptop computer" was marketed as an innovation that would fix education in developing countries, however, lack of coordinated training of teachers and lack of local computer repair infrastructure made this initiative failed.

Another challenge identified is the need for frequent charging of battery as a problem that contributed to the non-use of a smart device (Wessel et al., 2019). Other problems include concern about its possible breakdown. Generally, information systems research on smart service systems have largely been conceptual and literature reviews based (Lim & Maglio, 2018, 2019). In 2017, Heilig and Voß (2017) conducted a literature review on information systems in seaports, including the use of smart systems. Another challenge of smart service systems is lack of standardization and high costs often constrain adoption of electronic data interchange (EDIs) by all port community members, especially small organisations (Garstone, 1995). Despite the above literature, the area of seaport smart services in a developing country context is yet to receive research attention; hence, the need for this study.

### 2.4 Seaport Systems

Seaport systems enable increase efficiency levels, greater transparency and traceability of logistics chains and improve seaport activities (Acciaro et al., 2020). Modern seaports use different types of information systems which have been divided into ten different types: national single window, port community systems, vessel traffic services, TOSs, gate appointment systems, automated gate systems, automated yard systems, port road and traffic control information systems, intelligent transportation systems, and port hinterland intermodal information systems for improving the efficiency of the whole supply chain (Heilig & Voß, 2017).

The increase in international trade through seaports has culminated in high cargo volumes, requiring quicker and more efficient seaport cargo handling procedures (Jovic et al., 2019). The seaport is a multidimensional system combined between economical function, infrastructure system, geographical space and trade (Hlali & Hammami, 2017). The utilisation of advanced technology is common in almost every application of a port (Keceli & Choi, 2008). The term 'port information system' is used for every kind of IT – hardware or software – that is used in port operations. Since the ports consist of various activities with different characteristics, a well-designed Port Management Information System (PMIS) is used to supply information, goals, timing and frequencies to enable decision-making for efficient port management. Such a system can be extremely diversified according to the functions of the system and the tasks that are carried out within the port. The intelligent use of IT is a critical area for port planners to improve port operations since the construction of new terminals would require a long period of time and huge financial investments (Bagchi & Paik, 2001).

A study on the importance of IT for port terminal operations compared two container terminals, one with electronic devices, such as microwave technology, Radio Frequency (RF) tagging and voice recognition, and one without such devices. Among the various seaport systems are Terminal Operating Systems (TOS). TOSs are computer systems use for organising the container terminal itself (Jeffery, 1999). In their research, Keceli and Choi (2008) described the functions of TOS. These functions include managing the flow of containers through the terminal by relocating the containers in the right places. This is done in the most efficient manner, during the planning, loading/unloading schedule and yard transfer operation.

The emergence of smart technologies has enabled automation of smart devices in smart cars, smartwatch, smart cards, smart cameras, smart fridges, smart homes and smart factories. Generally, all things and objects are being turned into their smart substitutions. These substitutions that are evident in seaports are making several scholars to research in the marine world, specifically in developed countries (Kamolov & Park, 2018). Seaport systems support global supply chains by integrating a multiplicity of systems, networks and stakeholders so as to synchronize seaport operations (Baron & Mathieu, 2013). Therefore, seaports are a cluster of organisations which perform various activities in value-creating logistics chains.

These organisations are required to corporate to achieve their goals (Islam et al., 2013). The processes involved in digital transformation and information management (Heilig et al., 2017b) help lower costs of seaport operations and transactions to make up for the inadequate infrastructure and congestion at ports. Heilig (2017b) has asserted that researchers have established that the combination of IT and IS have promoted automation and restructuring port processes, including container terminals.

### 2.4.1 Traditional Seaport System

Traditionally, seaports operations were conducted using paper-based documentation which caused inefficiencies in business and administrative processes and increased costs (Tijan, 2012). In the traditional seaport operations, the lack of automatic data exchange between existing systems created inefficiencies. This is because processes were slowed down due to the administrative load for the entry of data related to the announcement and regis tration of the arrival of ships into the port (Tijan, 2018). Traditional processes were also inefficient in commercial part of port activities (cargo-related data) because of similar reasons. Stakeholders involved in seaport processes are still burdened with the manual inputting of data into paper documents, documents that contain almost the same information as already electronically submitted data.

The processing of huge volume of paper documents was labour-intensive and mundane. It affected staff productivity and morale. Moreover, coordination and communication among stakeholders such as controlling agencies, the customs and other authorities were difficult because their computer systems were not connected. These organisations maintained their own data, resulting in unnecessary data redundancy (Teo et al., 1997).

Port users deliver cargo-related documents and forms for port service requests through paper-based methods, such as sending a fax or handing in the documents directly (Keceli et al., 2008). The traditional systems were used in performing the tasks of identification, confirmation and security such as approving and checking the input/output of trucks and containers, physical check of containers and providing loading/unloading location to the external trucks (Choi & Park, 2006). Moreover, one of the significant changes in first generation seaport systems was the reduction of paper-based documents in inter-organisational processes (Heilig, Schwarze, et al., 2017b). However, port operations were depended highly on the printed versions of these documents for handling terminal and administrative procedures such as container pickup/delivery services. This often resulted in inefficiencies and process errors due to outdated or incomplete or even false information. Inter-organisational platforms such as Port Community Systems (PCSs) brought a reduction in the use paper-based processing, however, these depended on the port community's willingness to participate adequately (Heilig et al., 2017b).

In the traditional seaport systems, the checking of the status of every container seal was during import and export processes involved manual procedures. Manual checking of the seal status and reporting resulted in high expenditures on personnel, higher costs and loss of time (Heilig & Voß, 2017). RFID electronic seals have been developed to and introduced in ports to reduce manual procedures significantly. The RFIDs automatically store mandatory data and protocol information on seal numbers, seal status, sealing and opening times (Dontharaju et al., 2008).

### 2.4.2 Seaport Operations

Seaport is considered to be an important part of the supply chain (Heaver, 2002; Bichou & Gray, 2005; Tongzon & Heng, 2005). Seaport operations can be categorized into seaside operations, terminal operations and landside operations (Heilig & Voß, 2017). Seaport operations experience process and coordination problems due to a lack of information exchange and decision support (Heilig & Voss, 2016). These operations involve efficient planning and coordination of activities involving multiple seaport actors (Goccia et al., 2003). The main seaside operations are loading and unloading of containers, berth allocation, quay crane assignment and quay crane scheduling (Salhi et al., 2019).

Seaside operations involve time monitoring and space optimisation for vessels and container locations. These are the major functions of a Terminal Operation System (TOS) (Hervás-Peralta et al., 2019). Terminal Operating Systems (TOS) are responsible for operations within the terminal, in addition to the importance of maintaining the efficiency of loading and unloading operations (Acciaro & McKinnon, 2015).

Landside operations include yard planning, yard crane assignment, container storage planning and many others. Increasing container numbers as a result of larger vessel sizes (Giuliano & O'Brien, 2007; Zhao & Goodchild, 2010). Seaside operations include activities such as berthing of the ship in terminal operations, gates operations. Berthing operations, security operations, container handling, logistics and intermodal transport operations. Seaport operations can be categorized into the seaside operations, the yard operations and the landside operations (Vis & De Koster, 2003).

### 2.4.3 Smart Technologies for Seaports

Smart technologies are used to support all activities of port terminal operations, warehousing, logistics, yard and port transportation with connected wireless network or special network seaports and shipping industry (Li et al., 2018). Smart technologies in seaport operations have received research attention in Information Systems studies (Heilig & Voß, 2017). Smart technologies refer to innovative technologies, especially those that are embedded with artificial intelligence (Papagiannidis & Marikyan, 2019) as new services to replace traditional practices

(Jovic et al., 2019) by automating the manual processes (Kamolov & Park, 2019). As global shipping cargo volumes increases, seaport cargo handling procedures need to be performed efficiently (Jovic et al., 2019).

IS literature has classified the main smart technologies used in seaports (Heilig & Voß, 2017). The authors reviewed ICT applications in ports and identify a range of technologies that are widespread in ports, namely Global Navigation Satellite Systems (GNSS), Electronic Data Interchange (EDI), Radio-Frequency Identification (RFID), Optical Character Recognition (OCR) systems, Wireless Sensor Networks (WSN), Real-Time Location Systems (RTLS), and mobile devices.

One of the main smart technologies installed in seaport is the global positioning systems (GPS) which is global navigation satellite systems (GNSS) (Steenken et al., 2004). The GPS detect and track movable objects like trucks, containers, ships and equipment (Reynolds et al., 1990). GPS has become the major navigation tool in and outside the port area for cargo vessels (Heilig & Voß, 2017). As an important aspect for seaports, GPS improve visibility and efficiency of planning and coordinate activities involving multiple actors for seaport operations, real-time data capturing on the position and status of objects (Giuliano & O'Brien, 2007; Heilig & Voß, 2014).

Another important seaport smart systems are the Electronic Data Interchange (EDI) systems that were developed in the 1960s and 1970s to bring about new means of information flow and the first digital transformation in the maritime shipping industry (Heilig et al., 2017b). However, a long standardization process had to take place before port communities could fully utilize new opportunities for EDI. Major ports have adopted electronic data interchange (EDI) technologies to enable paperless communication between those stakeholders based on international EDI standards like UN/EDIFACT.

The EDI introduction required stakeholders within the community to make investments in the appropriate ICT infrastructure and setups, to be able to participate in information sharing, and accordingly change their business processes. The adoption of EDI had a significant impact on the efficiency of port processes by significantly improving information flow between port actors, enhance collaboration, and reduce the use of paper-based documents (Neo, 1994). Seaports actors invest in IT resources and adjust their business processes to meet standards for EDI application (Leonard et al., 2017).

The development and application of the Internet of Things, mobile broadband networks, next-generation and cloud computing and. informatization has a tendency of higher smarter stage (Kamolov & Park, 2018). Smart technologies are used for collecting, storing, processing, presenting and distributing relevant data and information to seaport participants (Attia, 2016). The term 'smartness' emerges from the application of ICT-enabled capabilities into traditional applications (Jakobs, 2017) like smart grid, smart manufacturing, smart homes, smart cities, and smart seaports.

In general, smart technologies are outcomes of merging different technologies. These applications will deploy a 'smart' infrastructure, comprising Cyber-Physical Systems (CPSs) and deploying the Internet of Things (IoT) for communication. Smart Technologies such as Internet of Things, big data analytics are easing the operations as key factors of competitive advantage activities of seaports (Cimino et al., 2017). The use of smart systems such as sensors and actuators to control part of the port infrastructure is acknowledged for many years (Cimino et al., 2017). In a study by Fernández et al. (2016) presented a smart port as a platform that offers a collection of sensors' data and application of internet and web-based service. Smart technologies in seaports are technologies that enable port services to be automated by connecting all devices online. A network of smart sensors and actuators, wireless devices, and data centres make up the key examples of smart technology in seaports. Smart technology allows port authorities to provide essential services in a faster and more efficient manner (Yang et al., 2018). Smart service systems are service systems where connected objects and automation allows for intensive exchanges of information between individuals and organizations to enhance decision making and services (Lim et al., 2016).

One of the main seaport smart technologies is RFID. RFID is an automatic identification and data capturing device that enable automatic wireless identification by using a tag from a small chip to an RFID reader (Hakam & Solvang, 2012). RFID has variously referred to as object monitoring, location-aware, real-time tracking, connected-RFID, sensor-based location, wireless communication systems are synonymously used to describe these systems in most related literature (Bardaki et al., 2013). RFID enables us to read added information via wireless communication media for the identification of various objects such as people, cars, cargoes, and cattle. It makes various kinds of manual jobs to be automated (Joshi et al., 2014). An automated gate system based on RFID is a system automated by applying RFID technology for identification of truck and container numbers. The system is to automatically identify the external trucks and containers passing through the terminal gate (Choi & Park, 2006).

Such identification and tracking technologies, wireless networks and smart sensor offer a number of new monitoring alternatives for objects in a particular domain, anywhere and anytime (Bardaki et al., 2013). IS studies have identified RFID use in monitoring of freights moving through a distribution centre (Yang et al., 2011), monitoring the location of building tools (Woo et al., 2011), antitheft vehicles (Maurya et al., 2012), and elderly and home caretakers (Yan et al., 2010) are examples in the literature (Bardaki et al., 2013). Improving data handling processes has become central (Porter et al., 2004) making them as automatic as possible by avoiding human intervention, thus eliminating human errors (Hakam & Solvang, 2012). The real advantage of RFID technology is its noncontact, non-line-of-sight reading, multiple reads at long ranges and high speeds (ca. 100 milliseconds), making it reliable in bad weather conditions for instance. It gives thus real-time monitoring and increases security and visibility of the supply chain (Hakam & Solvang, 2012). RFID technology requires a network of interrogators or readers and RFID tags. These tags can be either passive, read-only, or active that can actually send messages, thus requiring a battery.

Depending on their source of electric power, RFID tags can either be active or passive. Active RFID tags contain on-board battery power supply and passive RFID tags gain their electric power from an external reader (Finkenzeller, 2010). Active RFID tags share at high operating frequencies and enable longer distances communication. However, the costs for passive tags are relatively lower in comparison to the active tags.

As an integrated system, RFIDs in humanitarian distribution centres track moving cargo and climate conditions for food and medications (Yang et al., 2011). RFIDs can monitor the location of resources in a construction project (Woo et al., 2011). In addition, Maurya et al., (2012) developed a vehicle location monitoring system that uses GPS and GSM, and anti-theft system. Similarly, Yan et al., (2010) implemented a wireless sensor network for continuous monitoring of the elderly and their caregivers. These systems have similar features for monitoring their environment and tracking objects. In particular, they use automatic detection, RFIDs, and navigation systems to track objects (Bardaki et al., 2013). RFID technologies have been discussed intensively in research and practice logistics and supply chain management (Tajima, 2007). Even though the container transportation industry is still in the infant stages with regards to RFID applications, a number of scenarios to enhance port operation efficiency have been identified to include automatic coordination and cargo handling of procedures (Shi et al., 2011). Additionally, RFIDs enable automatic compliance of security regulations, reduce the costs of adhering to regulatory conditions of major international security requirements including the International Ship and Port Facility Security Code; ISPS Code (Barletta & Bichou, 2013).

**2.5 Smart Service Systems in Seaports**

Extant IS studies have examined different smart technologies and smart service systems for seaports (e.g. Heilig & Voß, 2017; Heilig, Voß, & Lalla-ruiz, 2017; Heilig, Schwarze, & Voß, 2017). A review research paper show classification of smart technologies in seaports as Global Positioning Systems (GPS), Optical Character Recognition (OCR) systems, Electronic Data Interchange (EDI), Radio-Frequency Identification (RFID), Real-Time Location Systems (RTLS), mobile devices, Global Navigation Satellite Systems (GNSS), Wireless Sensor Networks (WSN) and communication technologies (Heilig & Voß, 2017).

Seaports use GPS detecting and tracking the locations of vessels, containers, intermodal trucks and other movable objects within the port (Reynolds et al., 1990) and guide automated vehicles and cranes (Heilig et al., 2017a; Heilig & Voß, 2017). GPS is also an important component for vessel navigation in and outside the port area, real-time data gathering in port operations, check the status and position of objects, improve visibility, coordinate the various stakeholders and planning activities (Giuliano & O'Brien, 2007; Heilig & Voß, 2014). The installation of the first optical character recognition (OCR) systems was used in seaports to enable automatic recognition of alphanumeric and hand-written characters or images (Heilig & Voß, 2017). Research on OCRs has been done on the historical development from both academic and industrial perspective (Mori et al., 1992). IS studies have proposed methods for improving the automatic recognition of container numbers (Goccia et al., 2003).

Research has also established several application areas of OCR in modern ports. Among these are the identification of loading units and intermodal shipping containers where installed OCR systems at terminal gates enable partial automation of administrative and check-in procedures for guided access to through the entry and exit gates (Böse, 2011). Moreover, automated OCR-based facilitate fast lane procedures and improve the security and effectiveness of port processes (Elovic, 2003). In intermodal transportation, OCR systems are attached to yard and ship-to-shore (STS) gantry cranes to allow real-time exchange of container identification data to improve efficiency of procedures and reduce errors and prevent the unloading or loading of the wrong container from the vessel to intermodal trucks (Heilig & Voß, 2017).

Electronic Data Interchange (EDI) is a smart service system used by stakeholders in seaports to migrate from paper-based to paperless processes (Wrigley et al., 1994). The exchange of electronic documents such as bill of lading, packing list and invoice between port actors are enabled by EDI technologies (Heilig et al., 2017a; Shi et al., 2011) working with other smart technologies to gather data and generate electronic documents for online transactions. A number of seaports use EDI technologies to enable a paperless transactions and communication between stakeholders based on international standards such as the UN/EDIFACT (Lee-Partridge et al.,2000; Neo, 1994; Notteboom & Winkelmans, 2001). These technologies help to conduct collaborative and control processes, monitoring and coordination tasks (Lairet &

Rowe, 2016). The main purpose of EDIs is to support ports to improve coordination, collaboration and communication (Hill & Scudder, 2002). However, the challenge of EDIs is the lack of universal standardization and high costs constrain the use of EDIs by small organisations in the port (Garstone, 1995).

Another smart technology used by seaport is Radio-frequency identification (RFID). RFIDs use an automatic identification (Auto-ID) technologies that allow identification of tagged objects to communicate through radio waves without requiring cables (Finkenzeller, 2010). IS literature show that RFIDs are used to automate collection and verification of data on trucks, drivers and companies as part of gate access controls (Shi et al., 2011), checking the status of container seals as well as digitalization of toll collection. For these reasons, some ports the Port of Seattle, for example, require that before a truck is allowed to enter the port, it must be fixed with RFID tag (Heilig & Voß, 2017).  Reviewed literature also shows how RFID work together with other smart technologies to automate data capturing, verification and communication. These smart technologies are Real-Time Location Systems (RTLS), mobile devices, wireless sensor networks, communication devices. These smart technologies seaports enable automation and coordination between vehicles and cranes as well as capture and transmit data for operations and analysis (Heilig & Voß, 2017). Despite these advantages, there are a number of challenges associated with the use of RFIDs. These challenges include high costs of tags, and cybersecurity threats and incompatible standards (Rieback et al., 2006).

A review of smart technologies and service systems literature from other disciplines discusses various constraints (Heilig & Voß, 2017). Among these constraints is cybersecurity threat due to security vulnerability of Global National Satellite System (GNSS) on which marine transportation depends (Williams et al., 2008). Another is a lack of common standards for

EDIs. Despite the availability of international standards for documents in the maritime industry, getting the numerous stakeholders of ports to all adopt the same document standards remains an issue, especially with small organisations that interact with ports (Garstone, 1995; Heilig & Voß, 2017).

IS literature review indicate that seaport smart service systems are national single window, port community system, vessel traffic services, terminal operating systems, gate appointment systems, automated gate systems, automated yard system, road and traffic control information systems, intelligent transport systems and port hinterland intermodal information systems (Heilig & Voß, 2017). Smart service systems research has received academic attention in the information systems literature in the developed world (Acciaro et al., 2020). For example, there have been researched works on enablers in the context of container terminals and maritime ports in general (Heilig & Voß, 2017). However, the area of port security systems and container handling is yet to receive empirical IS research attention, hence the need for this research.

IS studies on smart service systems have focused on conceptual frameworks (Geirbo, 2017; Lim & Maglio, 2018; 2019) and literature reviews of papers largely from other disciplines (Heilig & Voß, 2017) without theoretical foundations. A research gap, therefore, exists for in-depth and theory-driven studies to investigate smart service systems use and effects in an organisational context. Also, there is lack of empirical research on smart service systems as extant IS literature has focused more on application areas such as smart health, smart building, smart government, smart grid, smart transportation, smart environment, smart home, and smart lifestyle (Caragliu et al., 2011; Pramanik et al., 2017). Seaport smart container handling and smart security systems as a significant study are yet to receive IS research attention.

### 2.6 Chapter Summary

This chapter started by reviewing IS literature on smart technologies and smart objects. It also examined the literature on features, benefits and challenges of smart service systems. The chapter also discussed traditional seaport system in IS research indicating a lack of research attention on seaport smart security and smart container handling systems which the thesis intended to fill. Finally, smart technologies in seaports were also examined. In all, the chapter provides the basis for defining the gaps that this study seeks to address. First, IS studies in smart service system are mainly of conceptual frameworks and literature review of papers from other disciplines. Secondly, there is lack of theoretical foundation. Third and finally, IS research has studied application areas such as smart cities, smart health, smart agriculture and smart home; seaport smart security and smart container handling systems are yet to receive attention. The next chapter presents the theoretical foundation for the thesis.

# CHAPTER THREE

# THEORETICAL FOUNDATIONS

## 3.1 Introduction

The previous chapter presented a review of IS literature on smart service systems and seaports. The current chapter presents technology affordances and constraints theory (TACT) as the foundation for this study. The chapter is structured as follows. Starting the chapter, the next section examines the technology affordances and constraints theory (TACT) in IS studies and the limitations. The section indicates how the limitation will be addressed in this study using TACT. The following section presents the concepts and principles of TACT. The next two sections discuss the application of TACT and its limitations in IS research. The final section discusses the application of the TACT in this thesis and how it addresses the limitations.

## 3.1 Technology Affordances and Constraints Theory

Technology affordances and constraints theory (TACT) (Majchrzak & Markus, 2012) is an Information Systems theory derived from  Gibson's (1979) original affordance theory. The original theory focused on what an environment offers to actors such as a chair affords sitting. In relation to information systems, TACT focuses on action possibilities as related concepts that emerge from interactions between ICTs and individual user or groups. Thus, TACT seeks to explain technology-user interactions (Nambisan et al., 2017) and possible action that can emerge and or actualized (A. Majchrzak & Markus, 2012). Thus, TACT was developed to overcome the failure of Gibson's affordance to account for technology. Technology affordance and constraints theory gives equal attention to the social and the material (Leonardi, 2011, 2013; Vaast et al., 2017), relying on the symbiotic relationship between the materiality of technology and the potential actions individuals could perceive and take (Université & Sébastien, 2020).

Affordances have recently received much attention from IS scholars (Vom Brocke et al., 2013; Burton-Jones & Volkoff, 2017; Leonardi, 2013; Tim et. al., 2018). An important reason is that an affordance is a property of the relationship between an object and an actor. Hence, it offers researchers a perspective from which to study both technical and social aspects (Majchrzak & Markus, 2012; Volkoff & Strong, 2013), whereas existing IT implementation studies tend to overemphasize the social aspects and treat the technical specifics as irrelevant (Strong et al., 2014; Zammuto et al., 2007).

TACT can be used to understand the relationship between technologies, users and organisations (Wang et al., 2018; Majchrzak & Markus, 2013). Therefore, the theory has received considerable attention in IS studies (Benbunan-fich, 2019). The origin of the term can be traced to Gibson (1986), who used the verb afford to refer to what the environment offers to an organism – to what it provides or furnishes, for good or ill and the noun affordance to capture the complementarity of a subject (a human being or an animal) and its environment (Benbunan-fich, 2019). Thus, affordances describe what is offered, provided, or furnished to someone or something by an object (Strong et al., 2014, p. 55).

Therefore, affordances always arise from the relation between the actor and the object. Gibson's original definition and examples associate affordances with physical properties of the environment but recognise that affordances are not just abstract physical properties; they are unique to the subject because subjects anticipate the affordances in their environment and act accordingly. TACT scholars agree on the relational concept of technology affordances and constraints. This relational concept is distinct from features of the technology (Leonardi, 2011; Markus & Silver, 2008; Robey et al., 2013). TACT facilitates understanding of technology use in organisations (Majchrzak & Markus, 2012).

When humans experience constraints from technology, they may change it. Whereas a feeling of affordance triggers human to change their routines (Leonardi, 2011b). In Information Systems (IS) literature, (Nambisan et al., 2017), TACT is the action possibilities that emerge from such interactions in organisational environments (Majchrzak & Markus, 2012). In IS research, technology affordances and constraints theory has been used to examine human interactions with technology (Leonardi, 2011; Pozzi et al., 2014; Seidel et al., 2013; Volkoff & Strong, 2013). The technology affordances and constraints theory, for example, has been employed to find out the relationship between materials and the social. This was done through an analysis of how properties or features of technology relate to the subjective goals and perception of individuals (Leonardi, 2011). Affordances can be understood in relation to the perceptions of individuals. Therefore, there is a possibility of affordances to determine by the experience, culture, knowledge or ability of individuals (Davern et al., 2012; Treem & Leonardi, 2013).

Affordances do not guarantee results. This is because they refer to action potentials rather than actual actions or outcomes (Du et al., 2019). To transform potentials into results, actors must take goal-oriented actions to use the technology to achieve an outcome, a process known as "affordance actualisation" (Burton-Jones & Volkoff, 2017; Strong et al., 2014). An affordance is therefore not exclusively properties of people or artefacts but emerge from the relationships between users and the physical properties of artefacts with which they interact (Wang et al., 2018). The affordance concept, with its relational understanding of human-technology interaction, acknowledges the relationship between information technology (IT) and human users and that their interplay leads to different uses and outcomes in a specific context. Therefore, these relations are not determined solely by the IT system; instead, what the IT system affords to a potential user and what the user has made of it is an open negotiation between the IT system and the user. Thus, the concept of affordances allows for non-deterministic outcomes (Markus & Silver, 2008). Affordances and constraints emerge when users engage with technology (Majchrzak & Markus, 2012).

In IS, scholars have addressed affordances and constraints as relational concepts (Jones, 2014; Leonardi, 2011; Orlikowski, 2010). They propose focusing on interactions between material agency (i.e., technology) and human agency (i.e., people) rather than on technological features or human attributes separately to afford or hinder (i.e. enact). Affordances and constraints have been shown to emerge when users engage with technology (Majchrzak & Markus, 2012). IS scholars of TACT agree on the fact that having a relational concept of technology affordances and constraints distinct from features and purpose, facilitate the organisational understanding of the potential of technology as well as it sometimes unintended use (Majchrzak & Markus, 2012).

Affordances have diverse attributes, and these attributes can enable different possibilities that various users' actions will accomplish their goals in a specific context (Leonardi, 2011b, 2013). Affordances are constituted through the relationship between users and IT features. The affordance on an artefact or feature can vary, depending on use and context (Koroleva & Kane, 2017). Prior IS research has used the affordances concept to investigate the relationship between users and IT uses (Sheer & Rice, 2017). While technological features stay the same, user's perceptions about the same artefact vary (Leonardi, 2011). That is to say, different users may use technologies in different ways and may form different types of ties in different contexts (Dong & Wang, 2018).

### 3.2 Concepts of Technology Affordances and Constraints Theory

Following Gibson, the fundamental concepts of TACT are technology, actor(s), affordance and constraint (Markus & Silver, 2008b; Thapa & Sein, 2018). In IS context, technology refers to IT artefacts including hardware, software and communication; actors are users who interact with technology; affordance are action possibilities that emerge from interactions between technologies and goal-oriented actor(s) or user(s) while constraints are hindrances that prevent actors from using the technology to achieve intended goals.

For this study, technology refers to smart objects such as smart gates, smart CCTVs and centralized database systems. Actors are user groups who interact with smart systems. They include importers, customs officers, security personnel and management. Actors have intended goals to manage, operate and control system environments. Affordances are actions that emerge from interactions between the smart seaport service systems and actors towards achieving the intended goals. Constraints are hindrances that prevent them from achieving their goals.

The fundamental principles of TACT are relational nature of affordances and constraints related to goal-oriented actions. From relational perspective, affordance or constraints reside in neither the technology nor in actors but emerges from relations between the two (Majchrzak & Markus, 2012). Following these principles, this study views affordances or constraints as emerging from relations between smart technology and people. Another principle is that affordances are processual beginning from perception to actualisation and effects (Pozzi et al., 2014).

### 3.3 Principles of Technology Affordances and Constraints Theory

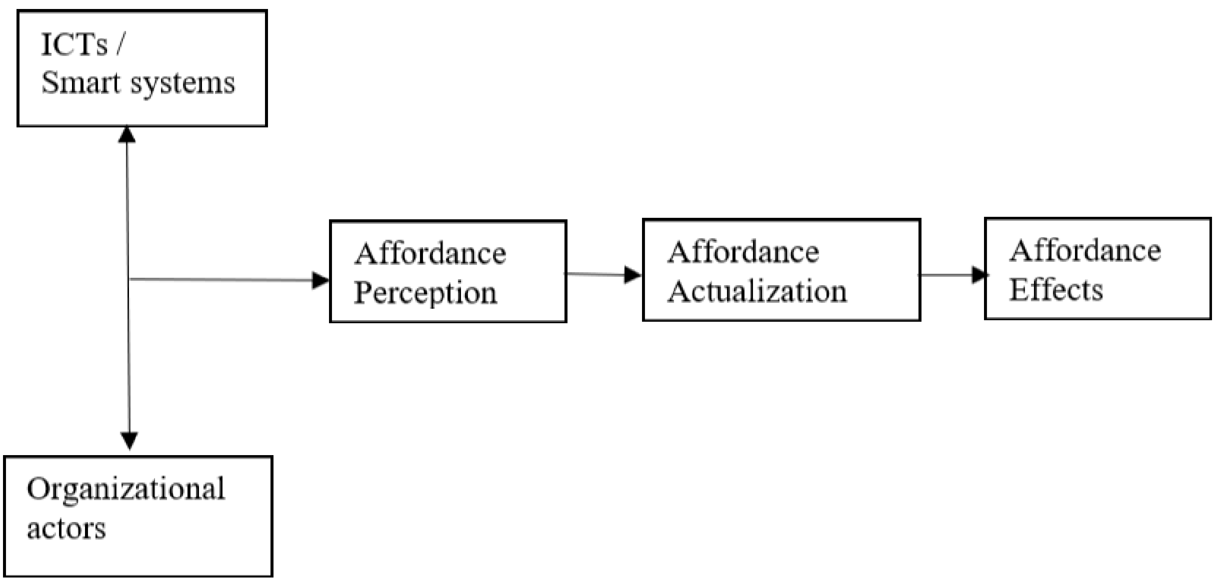
The key principles of TACT are based on: (a) user-artefact relation, (b) distinction between perception and actualisation and (c) action orientation (Volkoff & Strong, 2018). TACT principle focuses on the user/artefact relation. Affordances arise from the relation between technology and actor. A technical artefact does not have any affordances except in relation to a goal-directed actor. Secondly, TACT maintains a distinction between affordance and its actualisation affordances as relates to potential actions and the purpose they are intended to achieve, actualisation relates to a particular individual actor and details regarding the specific actions that actor will take or has taken. Thirdly, the theory focusses on the action, not the state or condition reached after taking the action. An affordance is about potential action, not about the state or condition that is reached after an action is taken.

Finally, TACT recognises social forces that affect affordance actualisation. Affordances are not actualized in a vacuum, but rather in a social context. Thus, social forces, arising from the groups within which the actors operate, also affect how, how well, or even whether any affordance will be actualized. In addition to analysing traditional social mechanisms such as group or cultural norms that can enhance or constrain the actualisation of an affordance (Bloomfield et al., 2010), we need to consider how the presence of other people using the same artefact for similar or related purposes will affect an actor's behaviour.

### 3.4 Affordances Process

The affordance is a four-stage process: affordances existence, affordances perceptions, affordances actualisation and affordances effect (Pozzi et al., 2014).

Figure 3.1: The Affordances Process




Adapted from Pozzi et al. (2014); Thapa & Sein (2018); Venkatesh et al. (2010); Wang et al. (2018)

#### 3.4.1 Affordance Existence

Figure 3.1 shows the processes of affordances in IS. Affordances are prerequisites for action to occur (Pozzi et. al., 2014). Affordances are properties of the actor's interactions with an object in a way that a goal can be achieved (Greeno, 1994). In this case, an affordance can be described as a mental process (Davern et al., 2012) which actors to perceive objects in terms for action possibilities, and analysed as relations involving actors and the object (Greeno, 1994). Affordances exist whether or not actors can perceive their existence. For example, a door affords passing to go into another room (Pozzi et. al., 2014).

In Figure 3.1, the bi-directional arrow shown in the theoretical framework indicates the relational concept of affordances (Majchrzak & Markus, 2012). Therefore, affordances are not properties of the organisation or the IT artefact alone, but rather their dynamic interactions (Majchrzak & Markus, 2012) between them. This implies that affordances are specific to an actor and the technology (Strong et al., 2014). The affordance of a door is a function of its width and an actor's ability to go through the opened door. The affordance also depends on the actor's size.

IT artefacts refer to hardware, software components and communication objects; actors are users who interact with technology, while affordances are action possibilities that emerge from interactions between IT artefacts and goal-oriented actor or user (Markus & Silver, 2008b; Thapa & Sein, 2018). In terms of this study on affordances of smart service system, technology refers to smart objects; actors are user groups who interact with the smart systems and affordance refers to action possibilities that emerge from such interactions towards achieving security-related goals.  Therefore, affordances emerge from interaction between technology artefacts and actors and do not reside in either the technology or the actor (Majchrzak & Markus, 2012).

Affordances are viewed as functional because they can enable and also constrain. These are factors organisations attempt to engage in an activity (Leonardi, 2013). In the defining functional affordances, Markus and Silver (2008) extended the analysis to a higher-level analysis by considering the intentions of the actor to perform an action. The authors described affordances as possibilities for goal-oriented actions afforded by technical objects to specific actors or groups. For instance, if an actor's goal is to go to the next room, the actor must walk through the door. An affordance is mostly considered as action potential (Majchrzak & Markus, 2012; Zammuto et al., 2007). Affordance can equally prevent actors from achieving their goals. An actor's capabilities and characteristic together with the features of an object give rise to an affordance. Therefore, these potentials can enable and constrain an actor. As portrayed in the example given above, while an actor may desire to go through the door, if the door opening is too small for the size of the actor, the same door can become constrained. Many researchers ignore the dual nature of affordance that enable and constrain action possibility (Volkoff & Strong, 2013).

In IS research, using affordance theory produced two key consequences. The first consequence is that researchers and practitioners do not have to consider actors as only individuals but also organisations, teams, business unit as actors who originate perceive and enact affordances to ensure the achievement of organisational goals. Consequently, a group of actors that have the potential to coordinate an action can be considered as an organisational affordance (Volkoff & Strong, 2013; Zammuto et al., 2007). The second consequence is that in affordances when all the above characteristics are considered, and which are referred to a technology affordances, the potentials for action by an organisation with a particular goal can do with an Information System (Savoli & Barki, 2013; Seidel et al., 2013).

### 3.4.2 Affordance Perception

An affordance perception requires that an actor need to perceive an action potential to exploit. An affordance perception can be defined as s a process of cognition (Greeno, 1994) that affordance existence is influenced by (1) the actors' goals (2) actor's capabilities (3) features of the objects and (4) external information. Therefore, an affordance perception is a requirement for affordance actualisation and represents an important antecedent of the intention to use a certain technology (Junglas et. al., 2013).

However, not all the affordances of an object are totally available for immediate perception (Hutchby, 2001). Goal-oriented actors perceive affordance as an opportunity to act. This implies that the process of an affordance recognition must be analysed as the interactions between a particular actor and a specific technology. In the door example mentioned above, though the actor has the intention to go to the other room, the actor must consider the door's opening in relation to the actor's size. opening. In other words, the actor must answer the questions whether or not she will be able to go through that particular door. Does the door afford her the possibility to pass or is it a constrain to her movement? Does she have to size to pass through that door?

Affordances, which real and have generative mechanisms with IT  artefacts that are used in organisational settings do not need to be perceived (Volkoff & Strong, 2013). In other words, by taking the functional affordances into consideration, Markus and Silver (2008a), averred that affordances exist only in relation to the goal or intention of an actor. Actualized affordances have been observed as phenomena underlying the effect of action (Volkoff & Strong, 2013). Thus, a perceived affordance may be actualized if the action takes place. An actualized affordance may have effects (intended or unintended). Similarly, a constraint may be perceived, actualized and produce effects. Also, constraints may hinder perceived affordance from being actualized to produce effects. This study draws on Technology Affordances and Constraints Theory because its concepts and principles are considered appropriate for analysing how smart service systems afford or constrain seaport security activities.

### 3.4.3 Affordance Actualisation

Affordances are actualized through a three-step process (Bernhard et. al., 2013). The first step is affordance existence. This is when the action potential emerges for the particular user (Lehrig et. al., 2019). The action potential may emerge because a new artefact or a new user capability now allows the user to perform an action that was impossible or more difficult before. Although the affordance exists, it may or may not be perceived by the user. The second step is affordance perception. This is when the user becomes aware of the action potential (Bernhard et. al., 2013). Although the user now knows about the potential to perform a particular action with the object, this does not imply that the user will actually perform the action (Lehrig et. al., 2019).

The third step of affordance actualisation describes the actions taken by actors as they consider possible advantages while using a particular technology to achieve immediate concrete results to achieve organisational goals (Strong et. al., 2014). Affordances do not guarantee results, because they refer to action potentials rather than actual actions or final outcomes (Du et. al., 2019). To transform potentials into results, actors must take goal-oriented actions to use the technology to achieve an outcome, a process known as "affordance actualisation" (Burton-Jones & Volkoff, 2017; Strong et al., 2014). This implies that an affordance is a potential for action, whereas its actualisation is the particular use of this potential (Rico & Xia, 2018). IS research on affordances have focused more on the actualisation process (Anderson & Robey, 2017).

Affordance actualisation comprises actors actions taken they use the features of technology to achieve the goals of the organisation (Strong et. al., 2014). An actualisation is an iterative and a goal-oriented process (Leonardi, 201; Strong et. al., 2014). The interest in actualisation process has received research interest  (Bernhard et al., 2013). Ecological psychologists

(Gibson, 1977; Greeno, 1994) and scholars who introduced the concept of affordance into IS discipline (Hutchby, 2001; Zammuto et al., 2007) did not acknowledge its potential through goal-oriented actions or on the outcome, but assumed that actors had the capabilities actualize an affordance.

At an individual level of an actualisation, few empirical studies are presented which vary between different actors (Strong et al., 2014). Strong et. al., (2013) introduced actualisation concept at the level of an organisation. understood as the combination of the actualisation processes of different at each individual level. Therefore, actualisation as an organisational process developed as the totality of the various individual actor level. Affordance was considered at the organisational level by Leonardi (2013) who introduced the concept of shared affordance. This concept showed that an affordance is shared by members of a group where actors show the same use of technology features. Leonardi (2013) notes that when actors agree to use a similar technology, the affordance created can be actualised at the organisational level.

### 3.4.4 Affordance Effect

Affordances effect is the potential to make an event to occur. Affordance actualisation is a product of actual activity. This implies that the decision of an actor to use a particular technology can result in the affordance actualisation and the immediate concrete outcome (Strong et al., 2014). Therefore, it is important to realize the ultimate goal of an organisation goal, as the affordance effect. Therefore, the immediate concrete outcome can be considered as a link between effect of the actualisation and final goal of an organisation (Strong et al., 2014). An affordance actualisation can result in (1) the development of additional technological features, (2) enable conditions for additional affordances, and/or (3) help achieve changes to improve organisational processes.

Also, an actualized affordance can be used to explain the causal relationship at a specific level of organisation and their technology (Volkoff & Strong, 2013). In terms of organisational changes associated with technology, studies result from affordance actualisation process. Majority of these studies have focused on cross-functional communication (Leonardi, 2013; Sebastian & Bui, 2012), and efficient operations after implementation of IS in an organisation (Strong et al., 2014).

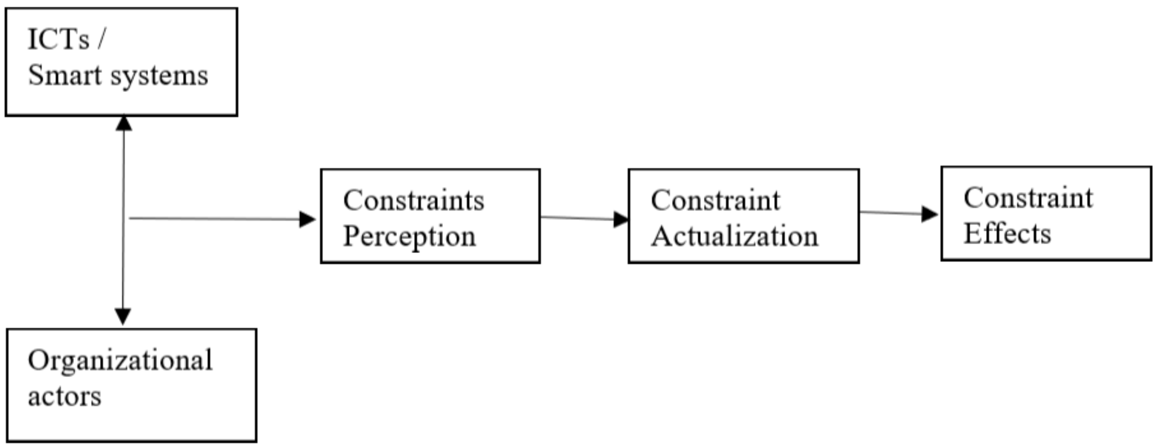
### 3.5 Affordance Constraint Process

This section introduces the affordance constraint process as complementary to the affordance actualisation process. An affordance is mostly considered as an enabling concept, a potential to perform an action to achieve a positive outcome (Zammuto et al., 2007; Leonardi, 2011; Majchrzak & Markus, 2012). However, affordance can also be an obstacle to actors to achieve a goal-oriented action (Pozzi et. al., 2014). Technology Affordances and Constraints Theory (TACT) suggests that along with the action potential that affordances offer, there are constraints that limit an individual from realizing goals (Majchrzak & Markus, 2012). This implies that technology is not only perceived as opportunities it offers but also as constraints or barriers it can create to perform an action towards desirable goals (Leonardi & Barley, 2008). Therefore, technology constraints refer to different ways in which technology use can hinder a user from accomplishing a specific goal (Faraj & Azad, 2012; Hutchby, 2001).

Previous studies, using an affordance (and constraints) perspective, have in particular focused on affordances, action potential, enabled by technology (Mesgari & Faraj, 2012; Abhari et al., 2017; Treem & Leonardi, 2013; Majchrzak et al., 2013). Consequently, few studies acknowledge both affordances and constraints enabled by the technology, which is vital in order to understand organisational practices (Leonardi, 2011; Leonardi & Vaast, 2017).

Constraints are ways in which a user(s) can be held back from accomplishing a particular goal (Majchrzak & Markus, 2012, p.1). Information technology has historically posed constraints to its users, since often the language or content is limited, as seen in educational usage (Ryder & Wilson, 1996), but constraints have been often neglected in the mainstream IS research (Pal et. al., 2018). From figure 3.2, affordance constraints process is a four-stage process: constraints existence, constraints perceptions, constraints actualisation and constraints effect.

Figure 3.2: Affordance Constraint Process in Information Systems




Constraints exist in Gibson's formulation because people do not interact with an object prior to or without perceiving what the object is good for (Leonardi, 2011). Technology not only affords but also constrains actors from achieving certain goals (Majchrzak & Markus, 2012). Constraints exist before intersections of IT artefacts and actors, and together with affordances, help explain a phenomenon (Leonardi, 2011). IS scholars have argued that just as technology affords, it can also constrain actions of its users (Leonardi & Barley, 2010; Leonardi, 2011). User's goals are formulated by their perceptions of what technology can or cannot do (Leonardi, 2011).

### 3.5.1 Constraints Perception

Constraints perception is similar to affordance perception, where individuals may also perceive a constraint that technology imposes on them and that confines their ability to achieve desired outcome (Leonardi, 2011; Majchrzak & Markus, 2012). Affordances of an object can change across contexts, though its materiality can be the same (Hutchby, 2001). Likewise, people may perceive that technology constrains their ability to act (Leonardi, 2011).

Therefore, perceived constraints limit potential usages to those intended (Université & Sébastien, 2020). Extant literature shows perception of affordances is a key activity and whether information is available to perceive them (Gibson, 1979). Extending this view, constraints perceptions are based on existence and correctness of information (Gaver, 1991). Instead of affordances, users may perceive constraints that limit their ability to act (Leonardi, 2011). Affordances can be misperceived and actors may not know until actualisation fails (Shaw et al., 1982).

### 3.5.2 Constraints Actualisation

The affordance relates to features of both the actor and the object (Gibson, 1986) and exist relative to action capabilities of an actor (Gaver, 1991, p. 79). IS scholars have distinguished between affordances as potential for action and actualisation as actions taken to achieve those potentials (Strong et al., 2014). Although IS studies considered both technology affordances and constraints (Leonardi, 2011a; Mettler & Wulf, 2018; Ciriello et al., 2018), research has focussed less on constraints actualisation.

### 3.5.3 Constraints Effects

The effects of using an IT depends on how it is applied towards particular goals (Savoli & Barki, 2019). Although IS literature on affordances and constraints feature use offer valuable perspectives on affordance effect, theoretical explanations and empirical evidence related to constraints effects are scarce in IS literature. The introduction of new information systems have consequences for users (Vowels, 2016).

Extant research has not comprehensively addressed constraints effects. Recent IS studies used affordance effects to propose a framework to explore the effects of affordance actualisation as a result of users' goal-oriented actions (Hafezieh & Eshraghian, 2017). As a result of interactions between IT artefacts and actors, perceived and actualised by goal-oriented actions finally produce effects. While extant studies provide evidence about affordance effects (Pozzi et al., 2014), constraint effects of technology have received less attention.

## 3.6 Application of Theories in IS on Smart Service Systems Research

Application of theories in smart service systems research cut across many disciplines. Among the theories commonly used in smart service systems research include practice theory (Feldman & Orlikowski, 2011; Orlikowski, 2000). Practice theory has been used in IS research on smart service systems to explain how practice elements and capabilities of smart technologies become mutually configured (Wessel et. al., 2019). Practice theory has been considered in relation to three ways of studying practice (Orlikowski, 2000). These are the empirical focus, a theoretical focus and a philosophical focus. While an empirical focus of practice theory concerns how people act in organisational contexts, a theoretical focus, on the other hand, takes on understanding relations between the actions people take and the structures of organisational life, and a philosophical focus on the constitutive role of practices in producing organisational reality (Feldman & Orlikowski, 2011).

IS literature has also studied how smart service system can be used as a theoretical lens through which digital value co-creation by service consumers and service providers can be understood, analysed, and designed (Beverungen, Mueller, Matzner, Mendling, & vom Brocke, 2019). In this context, smart service system assumes the role of boundary objects (Carlile, 2002; Star, 2010; Star & Griesemer, 1989) that digitally mediate the interactions of service providers and service consumers and enable the co-creation of individualized value propositions. Prior research into 'smart service systems', network studies played an increasingly important role including studies of resource allocation (Frels et. al., 2003) and the advantages of collaboration, alliances and cooperative strategies (Gulati, 1998). According to network theory, functional interdependencies exist within service systems (Barile & Polese, 2010; Håkansson & Östberg, 1975; Mele & Polese, 2010).

IS literature reviewed shows that smart service systems research has been mostly conceptual without theoretical foundation. Research that uses theories is from other disciplines such as Service Science (Barile & Polese, 2010; Medina-Borja, 2015b; Larson, 2016). Therefore, IS studies on smart service systems conclude that there have been no smart service system studies in IS that has used TACT. There is a need to address this theory limitation. This study addresses the gap by using technology affordances and constraints theory (TACT) (Majchrzak & Markus, 2013).

Also in IS studies that use TACT, existing conceptualisation and applications on affordance actualisation processes (Sein et. al., 2019; Thapa & Sein, 2018; Wang et. al., 2018) focus mainly on the perception, use and effects of human-technology interactions without much attention to how such interactions can be constrained by their environment. This study, therefore, introduces the affordance-constraint process as a complementary concept to the affordance actualisation process. The novel concept of affordance-constraint process is introduced as an integral theoretical construct in TACT, helping to explain both actualisation s of IT in use. This contribution provides a nuanced yet powerful way of understanding smart service systems in a seaport context.

### 3.6.1 Application of Theories in IS on Smart Service Systems Research

TACT has been applied by a number of researchers in Information Systems discipline (Koch, 2017; Pal et. al., 2018; Wallace et al., 2018; Ho, 2010; Wang & Nandhakumar, 2016). In these studies, TACT was used as a theoretical lens to study the interactions between the users and the technology to understand how technology afford or constrain users. For example, Koch (2017) used TACT to examine what aids and inhibit a shadow analytics initiative. The author revealed that internal IT departments are both enablers and constraints of shadow analytics project. He showed that IT departments enable shadow IT initiatives when the IT department is a cost centre that frustrates functional departments (Jasperson et. al., 2002).

The research model of Pal et. al., (2018) employed TACT to study technology contextually. Their study used TACT to examine the merits and demerits of mobile payments technology. Moreover, Ho (2010) used TACT to investigate the effect of trust on two E-payment gateways, thus, online credit card payment system and the hypothetical online Octopus card (a stored-value smart card) payment system in their research that Hong Kong consumers use various trust-building processes to find their adoption as gateways for e-payment. They added that their results in the adoption of the online credit card payment system and the online Octopus card system indicate an measurable relationship. In addition, Wang and Nandhakumar (2016) investigated users' perceptions of adaptive use possibilities, in a case study of a large chemical company. By drawing on the concept of affordances, they presented an affordance-based model of adaptive use.

### 3.6.2 Application of Technology Affordances and Constraints Theory in this Thesis

In interpretive research, the choice of a theory is subject (Walsham, 2006). The first level of justification is based on the researcher's belief that Technology Affordances and Constraints theory (TACT) is the best to study affordances and constraints of seaport smart service systems in the context chosen because the phenomena being examined are smart services. In IS, TACT has been used to study how people and organisations use technology and how the use of technology affects individuals, organisations, and their performance (Majchrzak & Markus, 2012). The TACT is very important to research into how people in organisations interact with IS to meet their information requirements and for investigating their affordances and constraints towards the use of an IT artefact (Koch & Peters, 2017).

This study aims at understanding the affordances and constraints of seaport smart service systems. To enable the researcher to gain more insights and understand the affordances and constraints of using seaport smart service systems, the researcher relied on TACT as a theoretical lens to understand this phenomenon. TACT served as a sensitizing device to explain the interactions between the humans, the organisation and technology. Moreover, TACT has been used in IS research to study the consequences of using technology (Volkoff & Stron, 2013). Since this study also intended to explore the consequences with the use of seaport smart service systems, TACT becomes a suitable approach to exploring this phenomenon. More so, TACT provides a comprehensive insight for the diverse ways in which the users explore the smart service systems and the affordances and constraints that they encounter.

### 3.7 Chapter Summary

This chapter presented technology affordances and constraints theory (TACT) as the theoretical foundation for this study. The chapter began by examining technology affordances and constraints theory. The chapter discussed the principles and concepts of the theory and its application in IS studies, as well as the limitations, were presented. The chapter also discussed the affordance process of affordance comprising affordance perception, affordance actualisation and affordance effect. The chapter also discussed the application of IS theories in smart service systems research and the limitation, which this study addresses using a lens of TACT. The main approaches to applying the theory in this study were also discussed. The chapter provided a justification for choosing TACT. The next chapter on research methodology presents the philosophical stance and approach that informed data collection and analysis for this study.

# CHAPTER FOUR

# RESEARCH PARADIGM AND METHODOLOGY

## 4.1 Introduction

The preceding chapter, Chapter Three, presented the Technology Affordances and Constraints Theory as the theoretical foundation that underpins this research. The section following presents the research methodology and the justification for choosing interpretive case study. The section following presents research methodologies and the justification for choosing interpretive case study as methodology for this study. The section thereafter provides details on the two cases for this study. The subsequent section describes how the researcher gained access to the case organisation, and how data was collected and analysed. Finally, the last section presents the principles for evaluating interpretive research and the ethical considerations that guided this study.

## 4.2 Research Paradigms

This section presents the predominant research paradigms in IS research. Every research is based on some paradigm whether or not it is disclosed (Myers, 2009 p. 23). Kuhn (1970) is acknowledged as being the first researcher for using paradigms in the context of a framework to understand inquiry. He perceives a research paradigm as a collection of principles and techniques held by members of a scientific community that serve as a guide, influencing the kinds of issues that scientists will answer, and the types of appropriate explanations (Kuhn, 1970, p. 175). Research is premised on philosophical assumptions, which are related to the researcher's view or perception of what constitutes reality (Turyasingura, 2011). The various philosophical assumptions associated with a point of view in a study are referred to as paradigm which defines what 'valid' research is and the appropriate methods that can be applied in that research (Myers & Avison, 2002). In IS, research paradigms are the fundamental assumptions, beliefs and practices adhered to by groups of scholars for the design and conduct of research (Bunniss & Kelly, 2010; Krauss & Putra, 2005; Kuhn, 2012). A researcher can differentiate between the underlying philosophical assumptions serving as a guide for the research (Myers, 2013) that could either be disclosed or not (Myers, 1997).

There are three dominant paradigms in IS research. These paradigms are interpretivism, positivism and critical research (Orlikowski & Baroudi, 1991; Myers, 2013). These belief systems have different foundational assumptions of ontology, epistemology, axiology, and methodology (Cecez-Kecmanovic, 2011; Myers, 2013; Jokonya, 2016) that guide the research process. An understanding of ontology is the starting point for every research (Adam, 2014). This is followed by the epistemological and methodological positions. An ontology refers to assumptions and claims made about the nature of social reality, about what exists, what it looks like, what component make it up and how these components interact with each other (Blaikie, 2000). In essence, ontology concerns the nature of reality (Cecez-Kecmanovic, 2011). It systematically describes how a diverse community of researchers have considered as reality in different periods (Kroeze, 2011).

While ontology is defined as the foundational views concerning 'what is real' to be studied (Mingers & Willcocks, 2004), epistemology, on the other hand, is the study of the nature and scope of knowledge (Myers, 2013) and refers to the various assumptions of knowledge and how it can be obtained based on a particular paradigm (Walsham, 1995). More than one epistemology can be derived from the same ontology (Mingers & Willcocks, 2004). Methodology refers to the specific process by which empirical and logical studies are carried out (Mingers & Willcocks, 2004; Orlikowski & Baroudi, 1991).

The choice of a particular paradigm determines the ontology of a phenomenon under study. This can be viewed as external and free of human construction, or internal and constructed by humans (Walsham, 1995). Epistemology refers to the nature of knowledge about reality and how we come to know (Holden & Lynch, 2004a; Myers, 2013) and the assumptions about knowledge and how it can be obtained (Hirschheim, 1992). Axiology is about the role of values within the research process (Saunders et al., 2011). The methodology is the research strategy that informs the techniques and tools for data collection and analysis (Grix, 2002).

This thesis chooses the interpretive paradigm as the most appropriate for the study for three main reasons. First, the study seeks a contextualised and in-depth understanding of the phenomenon being studied. This conforms to the notion that interpretive research enables IS scholars to understand human thoughts and actions in their social and organisational contexts. Interpretive paradigm has the potential to produce deep insights into information systems phenomena including its deployment and use. Second, the research purpose and the research questions informed the choice of interpretive paradigm. Thirdly, social phenomena are made up of complex interactions between systems and stakeholders, an interpretive paradigm is considered most appropriate to study a research phenomenon such that of a seaport smart service system in Ghana.

### 4.2.1 Interpretivist Paradigm

To interpretivists, reality is a product which socially constructed (Klein & Myers, 1999; Walsham, 1995). From their perspective, interpretivists seek knowledge by understanding phenomena as driven by the meaning people assign to them (Klein & Myers, 1999). Interpretive researchers start out with the assumption that access to reality is only through social constructions including shared meaning, language and consciousness (Myers, 2004). The philosophical foundation of interpretive research is hermeneutics and phenomenology (Boland, 1985). Interpretive studies typically seek to explain phenomena through the interpretations people attribute to them. In addition, interpretive researchers do not predefine independent and dependent variables but concentrate on the complete nature of human sense-making as the situation arises (Kaplan & Maxwell, 1994).

Interpretive research seeks to understand social phenomena in its natural context through the meanings that people assign to the phenomenon (Walsham, 1993; Orlikowski & Baroudi, 1991; Myers, 1997b). Interpretive paradigm is a way to gain insights through discovering meanings by obtaining an understanding of the subjectively created social world "as it is" (Mattila & Aaltio, 2006). It explores the richness, depth, and complexity of phenomena (Abdel-Fattah & Galal-Edeen, 2009). It aims to explore how people experience and interact in the real-world situation (Packer, 1999). This is an inductive paradigm and meanings are argued from the particular to the general (Guba & Lincoln, 2001). A naturalistic inquiry which leads to qualitative research methods, in-depth face-to-face interviewing and participant observation (Ponterotto, 2005).

As a paradigm, interpretivism has an ontological, epistemological and methodological perspective. The paradigm of the researcher determines what is considered real, knowledge and methodology. Epistemologically, interpretivists regard knowledge from research as value-related and subjective (Walsham, 1995). These social phenomena are in particular contexts and allow researchers to understand them based on meanings assigned by people (Myers, 2013; Walsham, 1993). Therefore, both the interpretive researcher and the research phenomena influence each other. This is achieved as the researcher considers the historical, cultural, political and social contexts and behaviour of the people during the study. These elements make research findings from interpretive perspective socially and inter-subjectively constructed between researchers and the people involved subjective meanings assigned by participants (Chua, 1986).

Methodology is the philosophical framework within which the research is conducted or the foundation upon which the research is based (Brown, 2006). It refers to the specific process by which empirical and logical studies are carried out (Mingers & Willcocks, 2004; Orlikowski & Baroudi, 1991). The paradigm of the researcher determines what is considered real, knowledge and methodology. Methodology describes the framework associated with a particular set of paradigmatic assumptions that we will use to conduct our research (O'Leary, 2004, p.85). In fact, interpretivists view the world as a social process (Orlikowski & Baroudi, 1991). To them, social systems are not independent; they are influenced by others. According to them, social systems come about as a result of the unique requirement of individuals, organisations and groups that need to be addressed (Weber, 2010). Qualitative research is the main research method associated with this paradigm (Gregg et al., 2001; Orlikowski & Baroudi, 1991).

Interpretive research considers that the world is constructed and interpreted by the human actions and beliefs and that the main aim of interpretive research is to understand the phenomena and make sense of the research problem through accessing the meanings that are assigned by humans (Orlikowski & Baroudi, 1991). Interpretive research, therefore, considers that scientific knowledge is not captured in hypothetical deductions, but through the human and social interactions by which the subjective meaning of reality is constructed and understood

(Walsham, 1995a). Meaning is socially constructed, resulting in multiple and diverse interpretations of reality.

The focus of interpretivism is that it views reality as human construction which can only be understood through subjective meanings (Kroeze, 2011). IS Interpretive researchers understand human activities in organisational and social contexts with the assumption that humans interact with the world and make subjective meaning (Orlikowski & Baroudi, 1991). Therefore, understanding social and organizational contexts require interpretive researchers to view knowledge as social constructions. These social constructions include shared meaning, shared consciousness and beliefs (Myers, 1997; 2013). These bring an understanding of the phenomenon through the meanings assigned to them by people (Orlikowski & Baroudi, 1991).

Therefore, in interpretivism, the aim is to produce understanding of the context of the study or phenomenon, information system, the process that influence the information system and how the system is influenced by the context (Walsham, 1993; 2006). This also implies that in interpretivism, reality is viewed as social phenomenon influenced people's subjective experiences of the object of investigation or the phenomenon being studied. This is because the best way a social phenomenon can be really understood is when the researcher looked from the inside. The double hermeneutic feature was identified (Giddens, 1993). Double hermeneutics relates to a condition in which the researcher is also used as a research subject.

In interpretivism, the world is seen as a social phenomenon affected and influenced by subjective experiences of human not as a fixed constitution of objects (Burrell & Morgan, 1979; 1994). Moreover, interpretive researchers do not predefine independent and dependent variables but rather focuses on how the situation emerge through a holistic approach to human sense making (Kaplan & Maxwell, 1994). The supporters of the interpretive paradigm see the world as a social process (Orlikowski & Baroudi, 1991). Social systems cannot be regarded independently and without the influence of their members. Individuals, organisations or groups construct the social systems because every user has special requirements that must be addressed by the system (Bergmann et al., 2008). These researchers seek to understand and interpret the social process. The methodologies used in this paradigm are mainly qualitative research and the exposure of special sets of constructs to social effects (Gregg et al., 2001; Orlikowski & Baroudi, 1991).

The ontology of interpretivism views the nature of reality as the essence of the interpretive researcher. The subject of reality as an individual's own construction or not is fundamental to the interpretive researcher. Here, the ontology of the researcher is that the form and content of reality depend on the researcher's own construction (Guba & Lincoln, 1994), therefore, ontology is subjective. This subjective reality is highlighted as phenomenon created through social interactions (Burrell & Morgan, 1979). This is referred to as the 'constructivist ontology' (Goldkuhl, 2012) which implies that the social world comprising organisations, division of labours and social relationships is not "a given", but The world is created and improved through action and interaction of human. In interpretivism, reality can be seen from two positions. The first position considers reality as intersubjective which is constructed by the researcher and participants and the second position, views reality as subjective and constructed by an individual or an organisation (Walsham, 1995).

In terms of epistemology, interpretivist considers scientific knowledge can be attained through the understanding of human and social interaction and subjective meaning by which reality is constructed (Walsham, 1995). The researcher and the researched phenomenon are assumed to be connected interactively with the beliefs of the researcher influencing the study (Guba & Lincoln, 1994a). In interpretive research, ontology and epistemology are entangled (Goldkuhl, 2012). This is because the understanding and meaning of knowledge are very important in the assumptions of reality. The main concern of IS research is the understanding of a phenomenon through the processes of interpretation. Therefore, researchers are expected to interpret existing meaning of systems as shared by the actors (Orlikowski & Baroudi, 1991a, p. 15).

For methodology, Interpretivists engage with participants to create understanding of a phenomenon. The research work involves researchers in the real-world setting considered more appropriate to generate an interpretive understanding of social phenomenon (Orlikowski & Baroudi, 1991). In effect, interpretivists believe that knowledge can be gained through social interactions (Walsham, 1995). Therefore, interpretive analysis is on subjective interpretation of the phenomenon (Myers, 2013). To the interpretivist researcher, meanings are assumed to emerge from the context of the study.

### 4.2.2 Choice of Interpretivism

In information systems research, there is no right or wrong paradigm (Holden & Lynch, 2004b). The choice of one paradigm over the other and associated methods indicate the philosophical position of the researcher, the research topic and purpose (Chen & Hirschheim, 2004; Orlikowski & Baroudi, 1991). Given that the purpose research was aimed at understanding the deployment and use of seaport smart service systems in the real-life setting of a developing country, the interpretive paradigm was found to be appropriate for three reasons.

First, the interpretivist approach of inquiry is more appropriate to understanding complex, conflicting and emergent Information Systems phenomena (Jain, 2003). In this study, the purpose is to understand how the uses of seaport smart service systems are enabled or constrained. This phenomenon is a complex interaction of human actors and smart technology, which the researcher believes is best understood through the subjective meanings of individuals and groups within the context. Second, the study aimed to have a deeper understanding of seaport smart service systems within the organisational context of the participants involved. Such understanding involves accessing the affordances, constraints and consequences of the information system phenomenon that influence the interpretations and actions of participants (Kaplan & Maxwell, 2005).

Third, the interpretive researcher tends to have an open mind, choosing not to impose prior knowledge at the start of the study, but to explore the phenomenon and gain insight as the study unfolds (Schwartz-shea & Yanow, 2013). Therefore, the deterministic orientation of the other paradigms was not appropriate for the study. The flexibility of the interpretive approach enables the researcher to respond to field conditions as the study unfolds. Since interpretive research is useful in understanding the context of an information system, the interpretive paradigm is the best option for this study (Walsham, 1993;1995b). This paradigm enables the research in IS to understand human reasoning and actions in organisational and social contexts (Klein & Myers, 1999).

### 4.3 Research Methodology

A research methodology is an approach to acquiring knowledge about a phenomenon (Becker & Niehaves, 2007). A research methodology is an approach and the procedural framework within which research was conducted (Neuman, 2007; Sullivan & Irby, 2014). The research design describes the step-by-step processes on how the entire study will be accomplished (Myers, 2013). It serves as a plan of action on how the research is carried out. The choice of a particular research method is the reasons behind the methodology (Crotty, 1998). Although there are several ways to classify research, the three most common classifications are quantitative qualitative and mixed methods (Creswell, 2013; Myers, 2013).

### 4.3.1 Qualitative Research

Qualitative research methods were developed in the social science discipline to enable researchers to study cultural and social phenomena. Examples of qualitative methods are action research, case study research and ethnography. Qualitative data sources include observation and participant observation (fieldwork), interviews and questionnaires, documents and texts, and the researcher's impressions and reactions (Klein & Myers, 1999). Therefore, it presents the point of view of research participant and offers an explanation of a phenomenon 'from the inside'. In so doing, qualitative research provides explanation on the meaning, processes and patterns within a context and a better understanding of the social reality (Creswell, 2014).

Methodological approaches may be categorized into quantitative, qualitative and mixed (Myers, 1997). Although qualitative research seems more popular in interpretive IS research, quantitative approach is equally acceptable (Walsham, 2006a). However, as this study seeks in-depth understanding from the emergence and formation of digital innovation of port systems, a qualitative approach was found more appropriate (Patton, 2002) as it offers a better opportunity to gather richer and more contextualised data than does a quantitative approach (Myers, 2009). Moreover, it is noted that the goal for understanding a phenomenon from the viewpoint of participants and its context is largely lost when data are quantified (Kaplan & Maxwell, 1994).

Four types of qualitative approaches have been outlined. These approaches are commonly discussed and used in IS and organisation studies: case study, grounded theory, action research and ethnography (Myers, 1997). Case study concerns the research phenomenon in its context; ethnography involves a situation where researchers spend a significant amount of time in the field, immersing themselves in the lives of the people they study and seeking to place the phenomenon of study in its social and cultural context; action research investigates a phenomenon with the aim to address practical problems and contribute to knowledge at the same; and finally, grounded theory seeks to systematically build theory from gathered data. Any of these research methods can be used under any of the three research paradigms discussed above.

Among the three qualitative approaches, a case study is noted to be the most popular in IS research (Myers, 2009; Orlikowski & Baroudi, 1991; Alavi & Carlson, 1992). A case study is also recommended for phenomena that involve interaction between technology and its context (Alavi & Carlson, 1992; Orlikowski & Baroudi, 1991). Myers (1997b) points out that given the continuing expansion in IS research focus from purely technical to organisational issues, case studies have become more suitable for IS and organisation studies. In line with this, the researcher found smart service systems as one such research area where both organisational and technical issues are so important. Therefore, in line with the interpretive paradigm selected earlier, a qualitative interpretive case study was chosen for the study. The next section justifies the choice of using qualitative research.

### 4.3.2 Choice of Qualitative Research

There is no right or wrong paradigm (Holden & Lynch, 2004a). Rather the choice of a paradigm and the associated methods indicate the philosophical position of the researcher, the research topic and research purpose (Chen & Hirschheim, 2004; Orlikowski & Baroudi, 1991). Given that this research was aimed at understanding the deployment and use of public-sector biometric systems in the real-life setting of a developing country, the interpretive paradigm was found to be appropriate for three main reasons.

First, the interpretive approach of inquiry is more appropriate to understanding complex, conflicting and emergent IS phenomena (Jain, 2003). In this study, the purpose is to understand how the uses of seaport smart service systems are enabled or constrained. This phenomenon is a complex social interaction of people, smart technology, which the researcher believes is best understood through the subjective meanings of individuals and groups within the context. Second, interpretive studies emphasise context, because the meaning of a phenomenon is situated in its context to explain how, why and what questions (Myers, 2013). The study aimed to have a deeper understanding of seaport smart service system within the social context of the participants involved. Such understanding entails accessing the historical, political and cultural settings of the IS phenomenon that influence the interpretations and actions of participants (Kaplan & Maxwell, 2005).

Third, the interpretive researcher tends to have an open mind, choosing not to impose prior knowledge at the start of the study, but to explore the phenomenon and gain insight as the study unfolds (Schwartz-shea & Yanow, 2013). Therefore, the deterministic orientation of the other paradigms was not appropriate for the study. The flexibility of the interpretive approach enables the researcher to respond to field conditions as the study unfolds. For instance, in interpretive studies, theories serve as a guide in the initial stages of the research and are subject to change as more insights are gained from participants and documents.

**4.4 Research Methods**

A research method is a specific procedure for gathering and analysing empirical evidence about the phenomenon (Myers & Avison, 2002). Interpretive research methods in IS are designed to produce understanding of the context of an information system, the processes that influence information system and how the information system influences the context (Walsham, 1993. p. 4-5). In IS studies, research methods outline four types of qualitative approaches. These are case study, ethnography, action research and grounded theory (Myers, 1997).

A case study can be defined as empirical inquiry that studies a contemporary phenomenon in-depth and in its real-life context, particularly when the phenomenon and context boundaries are not clearly defined (Yin, 2009). A case study is therefore appropriate for explaining relationships in real-life which are too complex for other research strategies (Yin, 2009) and use to persuade other researchers of the applicability or inapplicability of a particular theory by providing empirical evidence in a particular context (Myers, 2013).

The case study approach is particularly useful to employ when there is a need to obtain an in-depth appreciation of an issue, event or phenomenon of interest as it allows researchers to test theories in very complex real-life context (Myers, 2013). Therefore, a qualitative interpretive case study (Walsham, 2006) was chosen for the study. The next section further describes the qualitative interpretive case study and why it is relevant for the study of seaport smart service systems in a developing country. In this study, interpretive case study (Walsham, 2006) was found as the most appropriate method. Interpretive case studies assume that reality is a socially constructed phenomenon which can be understood through the lenses of participants (Myers, 2013; Walsham, 2006). This study uses the qualitative case because it offers rich insights into the interaction with the deployment and use of seaport smart service systems in developing country context.

A case study uses empirical evidence from a context regarding a phenomenon of interest (Myers, 2013). In case studies, evidences are obtained from multiple sources. These sources may come from interviews, observation and documents. The interpretive case study was chosen because of three mean reasons. First, it offers opportunity to gather rich data that will lead to rich insights on the phenomenon and its context (Myers, 2011). Secondly, a case study gives an in-depth understanding of how seaport smart service systems are used in developing countries, the consequences and the broader organisational and societal context (Walsham, 1993). Third and finally, case studies provide a contextual intersubjective understanding between the researcher and the researched participants (Orlikowski & Baroudi, 1991).

### 4.4.1 Case Study Research

Case study research (CSR) in information systems (IS) research has gained acceptance (Keutel et al., 2014) as a tool for the study of social and organisational phenomena (Gordon & Blake, 2013). Complex and broad phenomena that are not widely known are explored using CSR (Benbasat et al., 1987; Paré, 2004; Yin, 2009). Again CSR makes it possible to investigate thoroughly phenomena that are difficult to be studied independently (Keutel et al., 2014). Consequently, this means that CSR allows for a system to be studied within the context that it finds itself (Orlikowski, 1992).

The case study approach refers to a group of methods which emphasize qualitative analysis (Yin, 1994). Data are collected from a small number of organisations through methods such as participant-observation, in-depth interviews and documents (Burchardt et al., 1994). In

Information Systems, case study research is one of the most widely used approaches (Keutel et al., 2014) as it enables us to study complex social phenomena in their natural context (Walsham, 1995; Yin, 1994; Dubé & Paré, 2011). A case study method, therefore, offers researchers opportunities to examine the phenomenon of interest in its real-life contexts (Løkke & Sørensen, 2014; Miller & Tsang, 2010). Furthermore, case studies enable researchers to understand relationships that otherwise might not be possible through quantitative methods (Benbasat et al., 1987; Cavaye, 1996; Doub et al., 2016; Lee, 1989; Yin, 2017; Paré, 2001) and provide additional insights into theoretical relationships specific to contexts (Maxwell, 2004; Miller & Tsang, 2010).

Using case studies offer researchers the benefit of an in-depth understanding of chosen phenomena of interest (Dubé & Paré, 2003) and are suitable for investigating phenomena in their natural settings (Yin, 2017). The use of case studies in IS has increased substantially (Keutel et al., 2014), especially single, explorative case studies (Ng & Gable, 2010; Spagnoletti et al., 2015; Trier & Richter, 2015). Case studies are employed for theory development purposes where the boundary between phenomena and context are not clearly evident (Yin, 2017). There is a growing interest using case studies in organisational issues where researchers seek to understand the interaction among people, technology and organisations (Dubé & Paé, 2003; Gallivan & Benbunan-Fich, 2005). Such organisational studies provide insight into the implementation of information technology (IT) artefacts in organisations and how such artefacts can be enhanced (Croni, 2014; Dubé & Paré, 2003; Gallivan & Benbunan-Fich, 2005).

Case studies can be classified into a single case or multiple cases; a single case provides all needed information about a research question from one organisation. In a single case, information and data from one unit are enough to achieve the aims of the research. Multiple case studies require data from more one unite to achieve research objectives (Kilani & Kobziev, 2016). A single case can be used where it represents a critical case or, alternatively, an extreme or unique case while multiple cases are used when more than one case is required to compare whether the findings of the first case occur in other cases (Saunders et al., 2009). The next section justifies using an interpretive case study.

### 4.4.2 Choice of Interpretive Case Study Method

The choice for a particular research method in IS, it is important for researchers to choose appropriate methodologies for their studies. Among the criteria suggested for such choices are epistemological and the ontological stance of the researcher (Guba & Lincoln, 1994) and the research questions for their study (Mumford, 2006; Yin, 2003). In general, the choice of a research method is closely related to the above underlying philosophical assumptions (Keutel et al., 2014).

The defining feature of an interpretive case study research is its focus on 'how' and 'why' questions (Myers, 2009) and for this reason is appropriate for descriptive and exploratory studies (Mouton, 2001). A case study can focus on describing process (es), individual or group behaviour in its total setting, and/or the sequence of events in which the behaviour occurs (Stake, 2005). The case method supports both theory building (Yin, 2009) and theory testing (Eisenhardt, 1989). The case study method's support for theory building is particularly useful in areas where existing theoretical and conceptual frameworks are inadequate (Chetty, 1996).

Usually, no hypothesis is formulated but "general ideas" or "expectations" can act as a guide to empirical research (Mouton, 2001, p. 150). The insights arising from case-based theory-building research can be used as hypotheses or propositions in further research. Case study research, therefore, plays an important role in advancing a field's body of knowledge (Merriam, 2009).

Although traditional hypo-deductive research has the widest applicability in IS research, an interpretive case study research is also advanced (Galliers, 1992; Myers, 1997). By its nature, seaport smart service systems cannot be studied outside of their natural setting focuses on contemporary events, the theoretical knowledge on the phenomenon under investigation is limited and not yet mature. The case study method was thus a suitable method for my study. Studies without a qualitative component cannot be used as a basis to recommend actions to management to inform policy (Merriam, 2009), a contribution that research into seaport smart systems seeks to make. The choice of research method reflects a particular epistemological stance and not just the "mere application of a specific data-gathering technique" (Perren & Ram, 2004, p. 85). Qualitative research and case study research can be conducted within different research paradigms.

**4.5 Fieldwork and Case Selection**

This section presents the fieldwork and case selection for the study. The setting for this study is in Ghana, a developing country on the West Coast of Africa. All the fieldworks were for the study were carried out at the Team Port in Ghana. The Tema Port is the bigger of the two seaports in Ghana. The port spans a land area of 3.9 million square meters and is flanked by an industrial city. The port receives an average of over 1,650 vessel calls per year. These comprise container vessels, general cargo vessels, tankers, roll on/off (Ro-Ro) and cruise vessels amongst many others with shipping routes and vessel calls to and from all continents through both direct and transhipment services. Clinker, oil products, aluminium, vehicles, container cargo, rice, wheat and alumina are the major commodities handled by the port. In addition, plug-in refrigerated containers are found at the reefer's terminals at the port. Also, there are bunkering services and dry dock facilities available at the port.

Set within the industrial city of Tema and 30 km from the capital city of Ghana, the port's environs serve as a logistic point for activities of Inland Clearance Depots (ICDs), warehouses, transport and haulage companies, freight forwarders, factories and related service centres. The port thrives on the multiplicity of businesses that grow the Ghanaian economy and that of regional neighbours. The goal of the port is to provide efficient facilities and services to make Tema the leading trade and logistics hub in West Africa.

Administratively, the Ghana Ports and Harbours Authority (GPHA) is responsible for the planning, building, managing, maintaining and operating the seaports of Ghana. Currently, GPHA is the landlord port authority concerned with the responsibility of providing all needed port infrastructure. It controls the marine approach canal, navigational supports, basins and quays of the ports.

The researcher gained access to the Tema Port through the help of social contacts working there. After the initial discussion of the researcher's desire to study paperless port, an official letter requesting interview access was submitted which was subsequently approved. With the approval, a maiden meeting was arranged between the Director of Port and the researcher was held to gather more information on exactly what the researcher wanted to do. From there, the researcher was introduced to the various directors and heads of the organisation. After speaking to the General Manager in charge of Marketing and Corporate Affairs, it was agreed that the best place for the researcher to begin his inquiry was from the IT department.

Through a series of detailed discussions, it was finally agreed that the researcher could start gathering data from the container allocation office. With time, the various container terminals were added where the researcher could seek more information. The first phase was from October 2017 to August 2018. This phase provided the researcher with the opportunity to familiarise himself with the members of the case organisations as well as the business processes going on. During this period, initial case selections and data gathering were done. While gathering the initial data, the analysis was also being carried out to determine to follow- up findings on the themes and concepts that were emerging. Once some findings that needed further clarification were known, the researcher went back to the port to talk to another officer who had knowledge in smart service deployment and use for more explanation.

This second clarification process took place between December 2018 and May 2019. Two smart service systems were chosen based on the study: Security services and container handling services. These cases were selected based on how interesting they were, how well they displayed sufficient evidence, how well they were going to contribute to knowledge and how well the researcher's supervisor and the researcher found the stories and their implications interesting (Myers, 2013) and most importantly based on the research purpose and questions (Mason, 2017).

The selection was made in such a way that each phenomenon represented a group of people, the type of functionality and the different ways of interaction during the deployment and use phases. In other words, to be selected, the phenomena ought to have been fully functional (i.e. deployed and were used) as well as provide no security issues to the country. There were, therefore, some services which did not meet these criteria hence not selected.

The selection process began with an informal conversation with some users of the port services including clearing agents, importers, truck drivers and staff of GPHA. Informal conversations led the researcher to visit the https://www.ghanaports.gov.gh to download some documents and read further on the various port services and what they sought to achieve.

Further reading and downloading of information from the website promoted the researcher's understanding of the various smart service systems. The researcher further interviewed the heads of the various services for clarification and onward selection. Other users were Also contacted to find out how well such services were being used. Using an introductory letter from the Operations and Management Information Systems Department of the university, the researcher introduced himself as a PhD researcher from the University of Ghana. Apart from this, the introduction of the social contact of the researcher who worked at GPHA to the directors created room for more trust, thereby leading to access to all units within the port.

Other factors such as the researcher's interest in the work of the case organisations also created excitement on the part of participants. A formal meeting between the researcher and the Director of IT and some officers of GPHA to finally agree on the approach to be used to gather the data and how they can benefit as an organisation from the experiences of the researcher was held. It was agreed that findings would be shared with the organisation involved at a final meeting when the research is over. This will help them ascertain what information is going out and also give them enough information to streamline the needed processes if necessary. From one participant who was in charge of IT, the researcher gained access to other participants whose roles offered the opportunity to access rich data and finally leading to rich insights on the subject matter being studied.

Participants in GPHA introduced the researcher to other participants including importers, shipping lines agents and private firms and government agencies that used the port services. In most cases, trust became one of the issues to discuss even before a gathering of data. On the part of the employees and other government agencies, the researcher had to promise participants of anonymity. This was to allow participants to boldly and freely give out information. In the end, two smart service systems for security and container handling were selected. The following section describes data gathering sources for the study.

### 4.6 Data Sources and Collection

In gathering data for this research, a lot of data sources was resorted to (Myers, 2013). These sources included using a semi-structured interview guide to conduct face-to-face interviews, online sources, participant observation, and documentary evidence. Table 4.1 below is outlined of the use of multiple sources and techniques for data gathering.

Table 4.1: Sources of Data Gathering

| **Data Sources** | **Description** |
|---|---|
| Semi-structured Interviews | Face-to-face interviews were conducted with heads of departments, importers, clearing agents, officials of stakeholder institution and others who played significantly in the deployment and use of the smart service systems. |

| | |
|---|---|
| | The interviews relied on flexibly designed semi-structured interview guides which accounted for emergent views, concepts and themes from field participants and settings. Each formal interview lasted between 45 minutes and 1 hour, was taped-recorded following participants' consent, and subsequently transcribed and coded. Table 4.2 provides more detail on the interviews |
| Document Analysis | The researcher gathered internal data from the Tema Port, which is case organisation and their websites and from the general internet, online and newspaper searches.<br><br>Among the internal documents were project plans and activities; brochures, advertising materials and invoices, correspondence and consultants; shipping lines, importers/exporters, truck drivers, terminal operators, security personnel.<br><br>External documents from general Internet search and newspaper sources included articles, commentaries, and reviews written about the port, their services and their technologies. The external sources also provided rich background data about the seaport smart service system that emerged and got formed. |
| Informal discussions | Informal discussions were undertaken with the staff of the ICT department, shipping agents and clearing agents. These discussions were written into field notes and subsequently transcribed. |
| Observation | Through participant observation, the researcher examined CCTV Monitoring Room including their websites, intranets and back-end applications. Moreover, the researcher participated in demonstration and walk-through sessions to understand online and offline processes. |

Source: Author's construct

For example, the researcher conducted face-to-face interviews with heads of departments, importers, clearing agents, officials of stakeholder institution and others involved in the deployment and use of the smart service system. Although semi-structured interview guide and documents search served as the main data collection methods, informal discussions and participant observation were also used. In interpretive studies, the primary data source interview. This is because the interpretations of participants can best be accessed by the researcher through this method in regards to the events and actions under observation. This method also allows the researcher to observe issues that are not readily visible (Rubin & Rubin, 2011).

The participants for the interviews were selected through purposeful and snowball sampling (Patton, 1990) by identifying people who participate in the deployment and use of the smart service systems and had knowledge about their use. Semi-structured questionnaires served as initial guides for the interviews. The interviews touched on broad areas of the reasons for digitalisation, motivation to use smart service systems, enablers and constraints of using the smart service systems and the consequences thereof. However, as data was being gathered, there were more questions, which were generated out of the information being given by the participants to solicit further clarification. The interviews were recorded with permission from the participants, averagely lasted between 45 minutes and one (1) hour. Interview notes were taken where interviews objected to being recorded. Recorded interviews were later transcribed and analysed.

Informal discussions were very fruitful in gathering the information that is normally taken for granted. Based on the high level of trust generated from the introduction by the researcher's old schoolmate and also the involvement of the researcher in some of the activities of the lead organisation such as attending some of the sensitization and training programs, participants freely shared information without hesitation. Information gathered through these means was not tape-recorded. However, the researcher wrote them down immediately after the discussion. This happened across almost all the institutions visited by the researcher.

There were internal and external document reviews. Internally, data was gathered through reports of meetings and training sessions from other beneficiary institutions, reports of the services from users and feedback from other stakeholders. Other means of gathering internal data was through the websites of the case institution, technical documents on system planning, and other reports. Externally, documents were gathered through online portals, newspaper search, some receipts generated by users of the system, general internet search, reviews by users of the service, and reviews written by other organisations concerning their services. On the whole, the external document reviewed provided a broad understanding especially concerning the benefits and challenges while using the smart service systems.

The researcher participated in meetings with various project teams as well as users of the systems. The researcher participated in training sessions for the employees of the various stakeholders. Table 4.2 provides details on the number of interviews conducted research.

Table 4.2: Stakeholders Interviewed

| Stakeholders | Description | Number of interviewees |
|---|---|---|
| Importers /Exporters | Entrepreneurs and business men and women who buy and move goods into and out of Ghana. The focus of this study is on importers | **5** |
| Ghana Customs Division | Government enforcement/ implementation agency | **3** |
| Clearing agents | Intermediary/customs declarants who connect traders. | **7** |
| Ghana Ports and Harbours Authority | Implementation agency which manages and operates facilities of port and all related infrastructure. | **8** |
| Truck drivers | Drivers who deliver and pick up cargo | **4** |
| Terminal operators | Officials within the various inland container terminals. | **5** |
| Shipping line agents | Agents of container carrying vessels | **4** |
| Port Security | Personnel of the security department. | **4** |
| IT Manager | An officer who played significant roles during the conception, deployment and use stages of the paperless port. | **3** |
| | Total | **43** |

Data gathering came to an end when it was discovered that there was a saturation point. This was determined when there was no new information coming from the various interviewees (Patton, 2002). There were, however, follow-up interviews alongside the analyses for further insight through telephone and email conversations as well as periodic visits to the case institution. Websites of the cases were continuously monitored to scout for new information in case of any. Interview recordings gathered were further transcribed.

### 4.7 Data Analysis

In line with interpretive case study principles, the data collection and analyses were done concurrently (Myers, 2013; Orlikowski & Baroudi, 1991; Walsham, 1995b). The analysis was done inductively allowing themes to emerge. The hermeneutic cycle was used as the mode to analyse the two cases and the principles and concepts of technology affordances and constraints (TACT).

### 4.7.1 Thematic Analysis

Thematic analysis is the process of identifying patterns or themes within qualitative data (Stranges et al., 2014) by showing how concepts emerged to produce the case description. This study used the thematic analysis for its flexibility and freedom to engage a theory to provide rich and credible insights into a phenomenon under study (Boyatzis, 1998). The analysis was, therefore, based on a set of thematic analysis principles (Braun & Clarke, 2006).

First, data analysis began with data immersion (Green et al., 2007). Data immersions involved listening to the interview audios of each interviewee right after recording and transcribing. Interview transcripts were read and re-read right after each interview to gain new and insightful themes. The reason was to avoid reading large amounts of data. The detailed understanding in examining the interviews were conducted and interpreted. Clarity was brought to the researcher through the data immersion by bringing together meanings assigned by different participants of the phenomenon under study. In practice, the preliminary analyses of the data led to further data gathering to obtain clarity and deeper insights. Therefore, in reading, the researcher looked out for concepts that described the main themes participants were describing. This approach enhanced the classification of similar descriptions and insights to be captured in the first instance.

Next, initial themes based on the concepts of TACT gave further insights while reading the data generated. The empirical data was then coded according to the initial themes. Notes that were taken out of observation and document analysis were also coded and analysed. Coding involved the context where interviews were conducted, and labels of single words, phrases and paragraphs that contained components of TACT where needed.

There were instances where codes were assigned to more than a word, phrase, or paragraph. Documents were analysed to give an understanding of the context, backgrounds, stakeholders involved and activities, and the underlying socio-cultural issues that emerged out of context. The process of coding was iterative as codes were added in instances where more information from interviews, observation, and document analysis were discovered. Information gathered from informal discussions with participants were quickly written down and later coded. The hermeneutic circle was used to determine how the words, phrases, and paragraphs related to each other. The final outcome of this process was the case description.

### 4.7.2 Theory-Driven Analysis

The theory-driven analysis shows how the concepts of the Technology Affordances and Constraint Theory were used to analyse the case descriptions to produce findings of this study. Empirical research that does not take theory into consideration produces anecdotes (Walsham, 1993), which this study seeks to avoid. Therefore, TACT was used to guide the data collection and make way for synthesizing and communicating the findings of this study. The theory, therefore, provided an avenue to critically understand the phenomenon and a premise to organise what is unknown. Here, codes created earlier were examined to provide ways by which they could be linked to create categories that are coherent. This was done by reflecting on the data and reviewing documents on the key relationships among smart systems and human actors as well as issues relating to interpretive flexibility as well as technology affordances and constraints theory lens. It is most important to identify, understand and explain why a developing country would deploy seaport smart service systems, how smart service systems afford or constraints seaport services and outcomes.

### 4.8 Principles for Research Evaluation

This section provides the general principles of how interpretive studies are evaluated. Klein and Myers (1999b) provided the seven principles evaluating s into interpretive research. These seven principles begin with the hermeneutic circle as the fundamental principle. The principle of hermeneutic circle proposes that to understand research phenomenon, it is important to be derived through a process of iteration where the understanding of the interdependent provide meaning to understand the individual parts and the whole. This is the fundamental principle on which all the other principles stand. The next to consider is the principle of contextualization.

Contextualization offers the research audience a greater understanding of how the research phenomenon occurred. This show that the phenomenon is not 'given' but created through interactions of people (Orlikowski & Baroudi, 1991). Contextualisation offers the research audience a greater understanding of how the research phenomenon occurred. This show that the phenomenon is not 'given' but created through interactions of people (Orlikowski & Baroudi, 1991). This principle of interaction between the researcher and the researched subjects is a reflection on how data was created through interactions between participants and researchers.

The next is the principle of abstraction and generalisation. This principle recounts how data reveals interpretation of IS phenomenon. This principle of dialogue and reasoning creates a possible contradiction between the preconception of the theory which informed the study and what the actual findings may be. The Researcher's attention is drawn by the abstraction and generalization theory. This theory helps the researcher to be mindful of inconsistencies should they arise. Related to the previous principle is the principle of multiple interpretations. This principle requires the attention of the researcher to be sensitive to the multiple interpretations of participants narrations of the interpretations. The principle of suspicion is the final principle. This principle requires the researchers' sensitivity to prejudices and errors in the narratives gathered from interviewing the participants. Table 4.3 shows the application of these principles are in this study.

### 4.8.1 Principles for the Conduct and Evaluation of Interpretive Field Research

This section presents the principles for the conduct and evaluation of interpretive field research. Information Systems scholars (Guba & Lincoln, 1994; Myers, 2013; Walsham, 2006) have expounded on the various ways by which interpretive researches are evaluated. For example, Myers (2013) and Walsham (2006) suggest that different perspectives from multiple participants should be included in the study to make it complete, the case must be credible and the study must contribute to knowledge. Klein and Myer (1999) provide seven principles in conducting and evaluating IS interpretive research which has been accepted and recommended for use by other authoritative and well-known interpretive researchers (Myers, 2009; Myers, 2013; Walsham, 2006).

Table 4.3: Evaluation Criteria Principle

| Principle | Application in this study |
|---|---|
| Hermeneutic Circle | In this research, the understanding of seaport smart service systems is derived through a process of iteration to understand the meanings and influence of individual activities on the group activity the seaport smart service system and how the meaning of the seaport smart service systems also shapes the actions of individual. The understanding of the various components of the seaport smart service systems and how each component influences the overall is also examined. |
| Contextualisation | The contextual interpretation of the seaport smart service systems requires an understanding of the social and the historical context in which the seaport smart service systems occur. Therefore researcher, provides the historical and social context in Chapter Five as part of the results chapter |
| Interrelationship between the researcher and the participants | The research participants give their perceptions of the present phenomenon. The interactions between the researcher and the researched participants influence the study. Also, the selection of documents as evidence to complement interview transcripts comprises interpretations of the phenomenon. Finally, the researcher drew upon experience for data gathering. |
| Abstraction and Generalisation | In generalising specifics to abstract categories including generalizing to the technology affordances and constraints theory concepts and principles as related to the fieldwork, the interview guides, the analysis and the discussion and implications. |
| Dialogical Reasoning | This involved the critique of the initial assumptions and preconceptions. It acknowledges the participants may have their own biases against the researcher and vice-versa. due to that document's searches, online searches and observations were made. The initial case reports were shared with the participants who gave their inputs and comments showing whether or not the interpretations were biased. The comments of the interviewee were added to the initial versions of the case. |
| Multiple Interpretation | different participant might have different interpretations of the phenomenon. Multiple interpretations are explained in terms of the identities of various interest groups. There were different groups of |

| | |
|---|---|
| | interviewees whose statements were added to data from documents and online searches. For instance, the use of smart service systems from the viewpoint of custom officers was not the same as that from the clearing agents on a number of some issues. |
| Suspicion | This study focused on various participants who offered different interpretations of the use of smart service systems and reflected their various interests. |

Source: Author's construct

In qualitative or quantitative research, a number of criteria are available to judge the quality of the research (Myers, 2013). There has been disagreement on the use of a particular criterion to evaluate the conduct of interpretive research. A number of reasons account for this contention. This is because some researchers are of the view that having a particular criterion conflict with emergent understanding in interpretive research. A middle position has been adopted by Klein and Myers (1999c). The authors accept that it is inappropriate for interpretive research to follow predetermined standards. They also proposed a set of guidelines to determine the conduct of interpretive work in that direction. To complement the principles of Klein & Myers (1999), Malaurent & Avison (2017) argue that a reflexive account may lead to the rigour. The principles of Klein & Myers (1999) are applied with  reflexivity drawn.

### 4.8.2 Principles for Ethical Considerations

The study adopted proper ethical considerations of confidentiality and anonymity, in specific areas of the research. These areas are working with the organisation, and reporting in the literature (Walsham,2006b). At the start of each session of the interview, the researcher explained the interviewee and sought their consent. Confidential information or observations were treated as such. Misrepresenting the purpose of the research or publishing confidential information is considered unethical.  The research did not adopt covert observation of participants as this could be an invasion of the privacy of the participant privacy and may bring harm. Also, such conduct will violate the principles of informed consent (Miller, 1995).

The researcher may be confronted with a dilemma while working within the organisation. Power play may characterise reporting on organisational issues. Internal wrangling and power play, which are things an organization will not like to reveal. Feedback constitute another issue that the researcher may have to provide the organisation. For example, where superiors are affected superiors, who to submit the report may raise questions. and when it affects subordinates, reporting to the superiors may create organisational tension. It is therefore recommended that such feedback may be reported on a light note (Walsham, 2006b). Negative feedback may be reported during verbal presentations and taken out of any written report.

To avoid plagiarism, the researcher must make sure that whatever is reported is properly acknowledged. Where the organisation owned the data collected and it is important to ask permission from official source before it can be used in the study. All of these mean that interpretive researchers are likely to face ethical dilemmas in their studies. There are, however, no well-defined ways to address them.

### 4.9 Chapter Summary

In this chapter, the research philosophy that guided the study was presented. The interpretivist paradigm was chosen as the best paradigm for the study. Among a number of reasons why this paradigm was chosen was because the interpretivist approach of inquiry is more appropriate to understanding complex and emergent Information Systems phenomena (Jain, 2003). Also, a justification for selecting the case study method was outlined. In addition, the chapter discussed how the data analysis was carried out. Finally, the evaluation principles used for the study were presented. In the next chapter, the case descriptions are provided.

# CHAPTER FIVE

# CASE DESCRIPTION

## 5.1 Introduction

The previous chapter presented the research methodology and selected interpretive case study approach. The current chapter presents the case description involving two embedded cases. The first case is on the seaport security service systems and the second case is on container handling service systems. In describing the case for this thesis, the chronological order was resorted to. Thus, the historical situations of the port before the process of 'smartization' and after it are discussed. Finally, a summary is given at the end of the case description.

## 5.2 Case Study Organisation: Tema Port

This case study concerns the Tema Port in Ghana. The Tema Port was built in 1962. The port the largest port in Ghana. Situated on the eastern coast of the country, it stretches over 3.9 million square metres of land area. The port receives an average of over 1,650 vessel calls per year. These comprise container vessels, general cargo vessels, tankers, Ro-Ro and cruise vessels among many others. About 85% of Ghana's trade is done through the port. Shipping vessels come to the port from all continents for direct and transshipment services. The seaport serves Ghana and other landlocked countries in West Africa. Its unique location, infrastructure and services have made Tema Port the gate-way to West Africa.

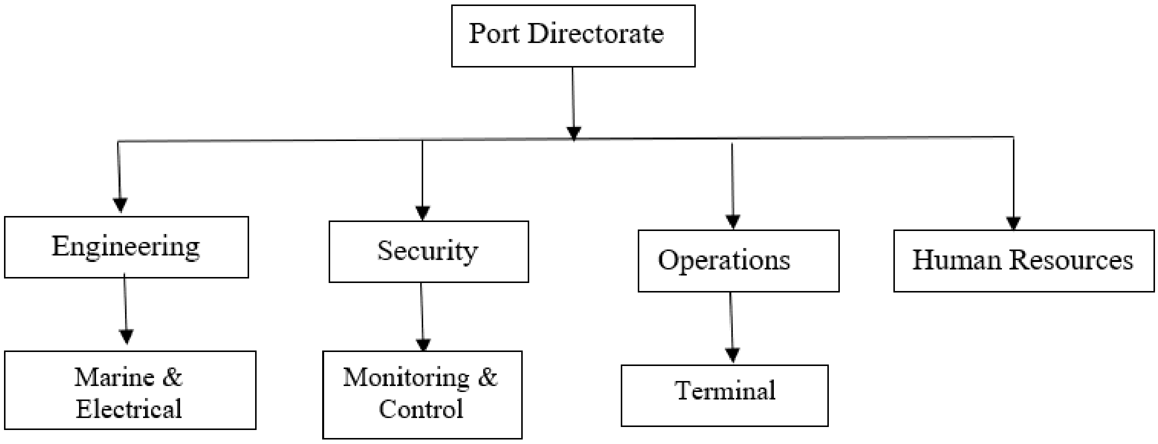
The port is located within the industrial city of Tema, which is 30 km from the capital city of Ghana. The port's environs serve as a logistic point for activities of Inland Clearance Depots (ICDs) and warehouses. In addition, transport and haulage companies, freight forwarders, factories and related service centres can be found within close proximity of the port. According to the Sector Report of Port Development Ghana (2015), key importing commodities are clinker, cement, grain, general cargo, processed food, machinery and steel. Key exporting commodities are: manganese, bauxite, cocoa beans, timber, and cocoa products. Important trade corridors are Far East, Europe, Middle East, North America and Inter Africa trade.

The Tema Port is under the administration of the Ghana Ports and Harbours Authority (GPHA). The authority is responsible for constructing, developing, handling, sustaining and operating of seaports in Ghana. According to the Ghana Ports and Harbours Authority Law 1986, PNDC law 160, GPHA is responsible for planning, building, developing, managing, operating, and controlling the port. Currently, GPHA is the landlord port authority concerned with the responsibility of providing all needed infrastructure and controls the marine approach canal, navigational supports, basins and quays of the ports.

To achieve its mandate, the port has administrative structures and instruments to regulate operations and services. The efficiency of Tema Port to execute its duties well depends on the relationship among port authorities, service providers and agencies responsible for the various roles in port operations and management. Among the departments are marketing and customer service, port personnel and administration, stevedoring, security and finance.

Port security department provides security for the seaport. To enhance their operations, they are assisted by the Ghana Police Service and the Customs Excise and Preventive Service (customs) at the landside and the Ghana Navy at the waterfront. The department is concerned with the responsibility of ensuring the security of goods and vessels. It is headed by the port security manager. Figure 5.1 shows the organisation structure of GPHA.

Figure 5.1: Organisational Structure of GPHA

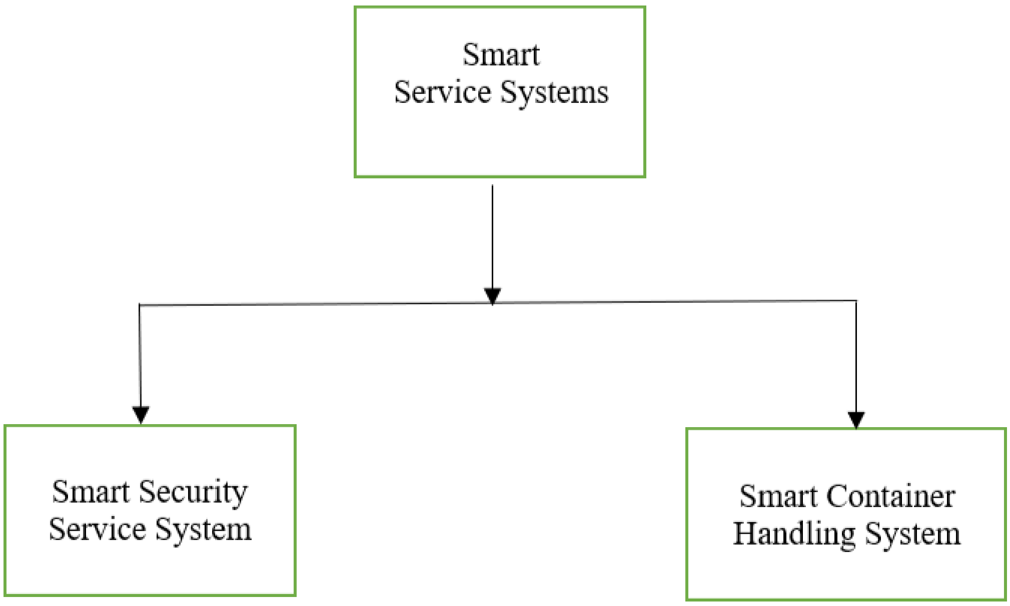



Source: Author construct

There are departments for various operations at the port. These departments include the materials, engineering, marketing and customer service, port personnel and administration, stevedoring, port security, finance and port audit departments. The functions of these departments are coordinated directly under the director of ports (GPHA). Before 2015, Tema Port operated Destination Inspection Scheme (DIS) provided by Destination Inspection Companies (DICs). The DICs were contracted by port authorities to inspect imports at the port of clearance in Ghana rather than prior to export. In September 2015, the Ghana Revenue Authority took over all destination inspection processes at Ghana's ports. Major services offered by the port include - vessel handling marine services, stevedoring, shore handling and conservancy services.

To improve port efficiency and quality, port authorities adopted the internationally preferred landlord model. Under the landlord model, the port authority owns and manages port infrastructure and private firms provide the rest of the port and maritime services. The efficiency level of landlord model is characterized by public-private partnership. Over the last decades, there have been significant increases in volumes of trade due to its strategic location. The Ghana Ports and Harbours Authority (GPHA) is the national port authority responsible for operation and management of Tema Port. The authority manages and operates seaport in collaboration with a host of other service providers in import clearance, container handling and security and safety. The Ports of Ghana were the first to introduce far-reaching innovation into the Maritime industry in West Africa. Ports have since seen significant improvement and efficiency through the adoption of smart system systems. Example of seaport smart service systems are the automatic ship identification systems, terminal operating systems and container scanning systems.

Figure 5.2: Relationship between seaport smart service system and two smart service systems




Source: Author construct

Figure 5.2 is a diagrammatic representation showing the relationship between seaport smart service system and two smart service systems. Tema Port has recently deployed smart service systems as part of an overall strategy to go paperless. The following sections describe how this innovation was achieved.

### 5.2.1 Tema Port Stakeholders

The stakeholders of Tema Port are port authority, customs, shipping lines, importers, clearing agents, scanning and terminal operators.

Table 5.1: Stakeholder and their interests

| Stakeholders | Interests |
|---|---|
| Port authority | GPHA facilitates the physical clearance process and ensures collection of rent and handling charges. |
| Customs | Undertake valuation of certain category of items (importations without invoices, used items, and commercial items found in personal effects) and ensure that the appropriate duty is collected. |
| Shipping lines | Transport cargo with their vessels to and from the port. |
| Importers and exporters | Importers and exporters respectively ship goods to or from Ghana. |
| Clearing agents | Facilitating clearing and export processes on behalf of individuals who are not self-declarants |
| Scanning and terminal operators | Manage containers in the inland containerised depots whiles scanner operators are in charge of scanning containers going through the port to determine their contents. Shipping lines transport cargo with their vessels to and from the port. |

Source: Author construct

The GPHA is a logistics service provider offering port facilities and services to its customers. Port authority manages and operates Tema Port in collaboration with a host of private service providers. These service providers are in charge of vessel handling, stevedoring, transfer, storage, receipt and delivery of containerized and general cargoes. Others are safety, security and conservancy services. The GPHA also leases out plant and equipment to a wide range of service providers.

There are a number of internal and external stakeholders within Tema Port. The internal stakeholders are port authorities, customs, regulatory bodies, and scanner and terminal operators. Port authorities are responsible for managing container movement, security, and inspection schedule for import clearance and collection of statutory fees. Customs to ensure collection of taxes and duties. Regulatory bodies are responsible for issuing permits and ensuring users of the port follow legal processes. The terminal operators work with port authorities to manage containers in the inland containerised deports whiles scanner operators are in charge of scanning containers going through the port to determine their contents. Shipping lines transport cargo with their vessels to and from the port.

The external stakeholders are policymakers, Ministries, Departments, and Agencies (MDAs). The MDAs are the Ministry of Trade and Industry, Ghana Standards Authority are responsible for enforcing laws on import or export of goods under their jurisdiction. Freight forwarders are agents who facilitate clearing and export processes on behalf of individuals who are not self-declarants. Lastly, importers and exporters respectively ship goods to or from Ghana. As international trade increased, vessel sizes and cargo volumes have surged upwards, placing additional pressure on port services. To optimize operations, promote efficiency and reduce logistics costs, Tema Port deployed smart service systems. The next section presents the security service system.

### 5.3 Case Study 1: Security Services System

Security at Tema Port forms part of entire maritime security of Ghana. As a complex transnational infrastructure, the port is prone to a number of security threats associated with the marine industry. These threats include terrorism, piracy, smuggling of stowaways and drugs, cargo theft and fraud, bribery and extortion. Sea robbery provides an excellent example of the complexity of port security issues. The nature of sea robbery necessitates that port security controls include both the waterside and the landside access of ports. Port security service can be classified into three as gate access control, deterrence and detection, and surveillance and monitoring.

Access control is one of the many security challenges facing Tema Port. Therefore, the port needs a firm, consistent security service system to efficiently manage employees, vendors and visitors who pass through gates. The foremost security concerns are access control since large areas and facilities are restricted to public access which needs to be both policed and well secured. A port security officer explained that:

> Access control procedure at Tema Port details the responsibilities and actions required to regulate and control the movement of personnel into and out of designated areas of the port. It applies to all personnel and visitors within the perimeter of these port facilities.

Access control procedures ensure that all personnel and visitors to the port are granted access only to the extent of their authorisations; this includes all maritime security zones to only personnel who have successfully completed the relevant site induction gain access. These will enable port security to account for all persons on-site during an emergency situation. Another reason is to protect the port from actions by unauthorised persons and provide a system to determine who has authorised entry and exit permits. Deterrence and detection at the port are measures deliberately aimed at discouraging would-be perpetrators and/or their facilitators (individuals who provide support and thereby make it possible for perpetrators to carry out their attack). High concrete fence walls installed with barbed wires on top and metal gates with locks increase time difficulties for the would-be perpetrator(s).

Monitoring involves a systematic and continual observation of persons, places and activities. In contrast, surveillance is used to indicate targeted monitoring of activities by police or port security officials for specific evidence of crimes or other wrongdoing. According to a senior security officer at the port:

> Surveillance focuses on individuals, buildings and properties, or vehicles deemed suspicious on the basis of credible information that they are connected in some way to illegal or otherwise inappropriate activity.

Seaport security includes the defence, laws and enforcement of treaties. In addition, counterterrorism undertakings lie within the scope of seaport security in the port and the Ghana maritime enclave in general. It includes the protection of the seaport infrastructure and the protection and inspection of cargo movement within the port. Unauthorized and illegal activities such as cargo theft, smuggling, piracy, terrorism and sabotage can happen at the port since it is a major entry point to Ghana. The deputy port security manager explained that:

> It is vital that ports are given the necessary security infrastructure and surveillance strategies and technologies to limit illegal activities and minimize threats. This will help facilitate trade, enhance the ability to assess cargo for

> risk, examine high-risk shipments at the earliest possible point, and increase the security of the Tema Port.

Traditionally, security at Tema Port involved manual processes and paper-based documents and records. However, port authority has introduced smart technologies into security operations in Tema Port. The introduction of these smart systems has enabled seaport smart security service system. The next three sections discuss the traditional paper-based and the smart security processes for planning and conducting the daily operations of port security as well as the outcome of using smart security at Tema Port.

### 5.3.1 Traditional Security Service System

In the traditional security, system era involved manual processes and paper-based records. The manual processes were driven mainly by humans. Security personnel were in charge of access control and patrolling the port yard and container terminals. From the landside, security personnel focused on preventing unauthorised access and exit of people, vehicles, containers, and cargo. People accessing the port had to go through pre-gate security procedures by completing access requisition forms, which were sent to security managers for approval. Those whose forms got approved were given identity (ID) cards, which permitted them to enter and exit the port while those whose forms were denied were not permitted to do so. One security manager commented on data collected for the pre-gate registration process as follows:

> The application forms were physically vetted for accurate information. These included name, date of birth, nationality, address, telephone number, organisation and purpose of visit. Applicants also provided hard copies of their passport pictures.

After the registration, the applicant could only enter and exit the port gates after thorough physical body check. The gate was then manually opened for people. These gates were manned by security personnel whose duty was to identify and permit authorised entry and exit and prevent unauthorised entry and exit. As was the tradition, authorised port users entering or leaving the part had to wear their ID cards on their neck for identification purposes. Security personnel inspected the ID cards to distinguish authorised from unauthorised port users. After this, they would use handheld detectors to search the port users for any unauthorised objects such as guns and other weapons. After going through security checks, port users were made to log their visit in a notebook, indicating name, date and time, ID number and purpose of visit. Inside the port, users had to continue to wear their ID cards as tags and show to security personnel on patrol whenever it became necessary.

For vehicles, drivers had to show their IDs as permits and in addition, provide all necessary documents on their vehicles as well as loaded containers and cargo for inspection and approval for entry or exit. In addition, security personnel conducted physical inspection of containers and cargo to detect any form of smuggling, theft and weapons before vehicles could be allowed to enter or exit the port. Similarly, from the seaside, crew members and passengers from vessels were also subjected to similar security checks and inspection before being allowed to enter or exit the port. Port security personnel manually inspected and verified containers and other cargo with their ID numbers and related documents before allowing them to enter the port. Physical seaport security involved deterrence, prevention and control of activities such as stealing, tampering, stowaways, smuggling vandalizing, loitering and other illegal activities. These activities included prevention of disasters such as fire, terrorist and attacks from ships and airplanes as well as bombing within and outside the port premises.

Physical security process can be considered from six areas: (a) outside the port gate (b) registration (c) the entrance gate (d) inner perimeter (e) waterside entry (f) exit gate. These components work together to efficiently and effectively accomplish the overall task of maintaining seaport security.

Security process for trucks and persons began from outside the port perimeters. To enter the port from the land side, prospective users first reported at the main entry security gate for screening and registration. At the gate, users were subjected to physical screening by security personnel using hand-held metal detector devices. After initial screening, forms were given to port users to fill and indicate the purpose of the visit. The filled-out forms were physically sent to the main office of the security department for approval. After approval was obtained, the prospective port user went through registration procedures. The procedure involved filling a paper-based application form with information in a prescribed format. The applicant was given a port entry permit with a unique code number. Commenting on the requirement for registration, the deputy director of port security indicated that:

> The application form contained information of port user's personal details. These included name, date of birth, nationality, address, telephone number, organisation and purpose of visit and a passport picture. In addition, foreign nationals were required to show their passports. Photocopies of the passport were made and filed.

This ID card was displayed at all time while in the port premises by hanging on the user's neck and was expected to be produced on demand by port security personnel. At the entrance of the main gate, port users showed ID card to stationed security personnel for inspection. They were then made to fill a notebook ruled with lines showing, date and time, name and ID number and purpose of visit. After that, the port user was subjected to further screening before allowed to enter the port. Within the inner perimeter, loitering is strictly prohibited. Port security personnel stationed at vantage positions randomly stopped to question to search and monitored movements and activities of port users. Others use security vehicles to patrol the port. Sometimes K-9 dogs were made to accompany the patrol team. All persons with suspicious movement were immediately apprehended and searched.

The port is protected by concrete walls with barb wire on top. Both the entrance and exit gate were made of iron gates and manned by 24-hour professionally-trained security personnel. In addition, other security personnel monitored all port zones and the perimeters of the port. The goal of physical security is to protect the physical infrastructure of the port and all assets, installations and people (port personnel, workers and visitors). The security personnel also patrol the port vicinity to detect and prevent intruders on the land side and the waterside. The deputy port security manager explained that:

In the past security processes were mainly carried out by trained personnel were stationed at the entrance and exit gates to physically inspect IDs, search people and vehicles entering and leaving the port. This was to ensure that no illegal goods entered the port. At the docks and storage areas, security personnel were deployed to track vessels at sea. In terms of procedural standards, a number of security measures were put in place at the port to ensure that only authorized persons entered or left the port vicinity. The process began when prospective port users filled a written application with a passport picture at the offices of port security. At the offices of the port security department, a visitor presented a form of ID to personnel and goes through security checks. Port users receive a pass to enter the gate if they are granted access. A gate pass was also issued to all trucks and vehicles before access was granted. These gate passes were paper printouts showing, date, time, name of the driver, and list of equipment brought into the restricted areas of the port. After going through security procedures, details of the visitor were recorded in a notebook with ruled lines showing the time of entry/exit, date, name of the user, car number, container number and content as appropriate. A truck driver indicated that:

> We are issued with a laminated identity card bearing the name and other details. At the point of entry, this ID card must be shown to security personnel who entered details into a notebook before the gate opened. The process was characterized by manual processes and paper records.

The truck driver presented paper authorization documents to port security personnel and it is physically signed and stamped. Photocopies of the documents were made and filed in metal cabinets. The truck driver then moved to the container terminal to be loaded or unloaded. After loading or unloading, the truck driver then proceeds to the exit gate. At the exit gate, stationed security personnel cross-checked paper documents with details written on the cargo.

As a result of the paper-based system, port authority annually suffered huge revenue losses due to connivance between security personnel and truck drivers. The processes caused delays due to paper-based documents requirements. It was time-consuming, burdensome and prone to petty and arbitrary charges.

At the gates, the driver is required to pull over for inspection before proceeding. These mandatory stops force trucks entering and exiting the port with cargo to wait at gates for both clearance from customs and the security checks. All paper documents were physically inspected and signed before the driver was made to proceed. These trucks end up in a queue at the gate causing roadblocks to other road users. Commenting on the issue, a truck driver had this to say:

> The number of stops and the time spent at the gate for inspection also increases the trans-shipment time for the cargo which decrease the product value in the case of perishable products.

Tema Port cover large geographic area varied perimeters that are not capable of being secured the same way as most perimeter security applications. For example, fences are not feasible for the waterside segment of the port perimeter. Physical barriers also do not provide the necessary situational awareness over the large areas of the port. Lighting is often poor or unavailable, and ports are often adjacent to public areas or neighbourhoods where pedestrian intruders represent both security and safety threats.

At the waterside, entry and exit port-security includes a range of activities, of preventive character, ultimately aimed at controlling who and what enters the port area from the waterside. It includes crews, passengers and cargo entering on-board of large announced vessels, on-board of small un-announced surface crafts, swimmers, divers or even small submersibles.

Armed security personnel patrol the waterfront of the port. After a ship berthed, port security went on board to inspect documents and passports of the crew and passengers on board. Upon disembarking, passengers and crew were taken through security screening and body searches using hand held metal detection devices. Their details were recorded into a book. If no contraband goods were found, the passengers and crew were directed to the immigration desk to go through arrival formalities. Their passports and other travel documents were inspected, signed and stamped.

At the exit gate, two main types of security procedures were conducted. One for individual pedestrians and for vehicles. For individual pedestrians, physical body checks were conducted by stationed security personnel. Port security measures could be infiltrated by terrorist or illicit traffickers, if appropriates mechanism are not put in place to verify identities, credentials, and the intention of individuals, ships or cargo arriving at or leaving the port. Though physical security regime had some enhanced some parts of port security, it was not able to detect vulnerable aspects such as terrorist and smuggling.

Despite the fact that there is strong physical security at the ports, as well as the strict inspection rules for the containerized cargo, the absence of mechanisms to verify the identities and credentials of every individual who has access to the ports, secure non-containerized cargo, and prevent criminals from accessing and exploiting the port facilities, the whole port security measure can be undermined. Physical port security measures have achieved significant success over the years. However, prevention of risks to perimeters of the port, increase cargo volumes and sophisticated threats compelled port authority to improve security by introduction of smart technology.

### 5.3.2 Introduction of Smart Security

The introduction of the smart security service systems began in 2015 when management of Tema Port began the plan to adopt smart technologies to address the inherent problems of the existing manual security system. At the planning stages, management perceived that deployment of seaport smart security service system could enable autonomous access control and monitoring, real-time data capturing and transmission. In addition, management were of the view that deployment of smart security system could enable autonomous identification of trucks and containers and also enable real-time data capturing and autonomous dashboard data analytics.

The port assessed their entrance requirements. Port security facilitate entry without going through long queues to get harbour passes. The port went through re-registration for all stakeholders into a database and issued them with biometric cards. A senior officer explained further:

> We have also provided optical character recognition systems at the various gates at our main ports and golden jubilee terminal to be able to take information on the cargos and containers that are coming in and out of our ports. This initiative is also to speed up the processes we have at the gates both security-wise and then to be able to take information on the deliveries we have done and the vessels that are entering the ports.

The move was to automate the previous entry and exit procedures where drivers presented several paper documentations to stationed security personnel. To achieve these objectives, A number of ICT consultants were invited to bid for the project. After interacting with potential ICT consultants, the management viewed smart technology as an opportunity to improve the existing security systems and therefore decided to replace it with a smart service system. In doing, the intention was to replace the security personnel with smart technology for the access control, environmental monitoring and data gathering.

The management also envisaged potential challenges such as the high cost of the project and whether they could afford it. Based on their experience, they were concerned about difficulties of getting government approval and timely release of funds. Another hurdle was potential delays in public sector procurement processes. Fortunately, they succeeded in convincing government to approve funds for the project notwithstanding the costs. They experienced some delays in procurement, which delayed the project from starting on time. The smart security system setup started with the installation of a database platform to store the data to be captured and used to support decision making. Subsequently, a central monitoring facility was set up and equipped with smart CCTV monitors, smart cameras, and mobile devices for real-time video surveillance system. Electric barb wires equipped with sensors and CCTV cameras were also installed on the perimeter fence walls, ship berths, stacking, loading and transit areas to monitor activities and respond to physical intrusion from outside the port.

Figure 5.3: CCTV Monitoring Room

Source: https://www.ghanaports.gov.gh/

In addition, the port installed automatic gating systems, turnstile and biometric readers to authenticate and verify authorised users before allowing them to enter or exit the port. The physical gates at the landside and container yards were replaced with smart gates embedded with sensors, RFID readers, OCR readers, actuators and wireless communication devices to capture data on vehicles and their movements. The smart gates were expected to manage access control for containers, trucks and people coming into and exiting the port. Unlike physical gates that were opened and closed by security personnel, smart gates were expected to be autonomous. In addition, the smart gates were expected to capture data and identify and permit authorised entities for entry and exit. They were also expected to transmit captured data through a wireless network to the database system for storage and analytics.

Inside the port, terminal gates were fixed with smart objects containing OCR readers to identify and collect data on trucks and containers entering or leaving the terminals. In addition, automatic scanners were installed to screen trucks, containers and their content. A senior security officer commented on the smart security setup as follows:

> As part of modernizing security processes, CCTVs with video recording functionalities have been installed at vantage positions within the seaport perimeters. The devices offer long-range detection and thermal imaging in both sub-sea and extreme conditions. The smart CCTVs are connected to the central monitoring room where personnel monitor footages on large screens.

In addition, smart CCTV cameras and monitors installed to take over monitoring of people, vehicles and containers within and outside the ports. At the waterside, new boats were procured for security patrol equipped with smart CCTV cameras and monitors as well as OCR cameras and wireless communication devices to detect and deter unauthorised vessels from entering or leaving the port. Finally, analytics software was installed to help analyse the big data repository capture from the various security activities. The intention was to replace the existing manual recording of security incidents in paper-form and to make security-related data available for management decision making.

#### 5.3.3 Use of Smart Security Service System

In 2017, Tema Port began the use of smart security service systems. Since then, prospective users of the port facilities are required to go through a number of processes use to protect the port against unlawful entry and illegal activities. These processes include (a) e-registration, (b) outside gate, (c) entrance e-gate, (d) inner perimeter, (e) waterside entry and (f) exit e-gate. Before gaining authorization to enter the port from the land area, a prospective user is required to register online. To register online, a user opens an online portal and fill out details such as name, date of birth, nationality, address, telephone number, organisation, the purpose of visit etc. Require documents such as ID card is also uploaded. After registration, the user is given the right to gain access to a dashboard. The dashboard contains the personal information of the user and information about containers that are available can also be accessed. After online registration, the user book appointment through the "Truck Appointment System" (TAS) online by logging into the system with the username and password to open the TAS dialogue box, clicking on « Gate » and selecting « Appointments » in the dropdown list. The gate is selected by default. The user then selects the transaction type from the drop-down menu and click on the Unit Information tab.

Truck drivers swipe their valid biometric card at entry points into the secure or restricted area. They also must have port access approved truck license plate already registered online, and have a valid gate transaction before entry can be granted to the facilities. As part of the requirement, RFID tags are embedded on license plates of trucks. This is read by an RFID reader installed alongside the e-gate systems and roadways within the port. The RFID enable access control and secure parking lots at the port yard. A Senior security personnel further explained the access processes as:

> At the entrance, access is approved to only truck license plate already registered online, and have a valid gate transaction before entry can be granted to the facilities. Unregistered trucks or drivers asked to pull aside and refused entry. Security personnel then conduct further checks on the truck and driver.

If no appointment can be found, the truck will be placed in a queuing system for the next available slot by a clerk using a handset. This manual processing is used by subjecting to a comprehensive visual check, involving several CCTV photographs being taken. For validly registered drivers and trucks, the truck is allowed to be weighed using automatic weighing bridges. Thereafter, the truck goes through an electronic gate with scanning features. This captures the truck number and scans the truck. After a metal gate automatically opens and the truck drives through toward the terminal where it is to be loaded or offloaded. Soon as the truck enters Tema Port premises an automated workflow is initiated in the background. A senior terminal officer reiterated thus:

> All data is captured and verified in real-time when the truck drives through the automated portals, without stopping, towards the Terminal gates. By the time the truck reached the Terminal gates, all captured data is processed, and the weight is taken through automated weighbridges.

All cargo trucks are ascertained or recognized via the RFID. They can only proceed to the container yard after this initial identification. After the truck has been identified and moves towards the yard, the operator of the eRTG will be informed automatically via the digital TOS. This is how one of the officers of the control room puts it:

> Once the cargo is (off) loaded the visiting truck proceeds to exit lane and onward journey. According to the terminal operation manager, using the digital infrastructure has greatly improved the efficiency of container handling.

In the inner perimeter, CCTVs are mounted at vantage positions within the port. Tucks are given a defined route to follow in the yard. As the truck travels through the inner perimeters of the port, its movements are captured by the CCTVs and the data sent to a central monitoring base and where security personnel view the footages on large multiple TV screens. When trucks deviate from its predefined route, an alert is raised and the truck driver apprehended by patrolling teams who receive real-time information in their patrol vehicles for further investigation. The truck is then directed to follow route toward the terminal if no major security breaches are detected.

At the terminal, the eRTG loads or offload immediately and truck continues its journey towards the exit gate. At the exit gate, the truck goes through an automatic weighing and appropriate scanning process depending on the risk level of the consignment. These risk levels are colour coded. Green colour indicates trucks that are not required to go through scanning because it is of low risk. Yellow codes show consignments that are required to go through an electronic scan. Red code is for those consignment considered as high risk. The red coded containers are subjected to mandatary scanning and sometimes physical checks before being allowed to exit the port.

After picking or dropping cargo, the truck moves towards the exit e-gate. As the truck moves toward the gate, CCTV camera capture data and transmit data in real-time. The truck is weighed at an automatic weighing bridge and data is transmitted to the central data repository. On approaching the exit gate, the RFID reader installed at the gate reads the number plate of the car and immediately the metal gate opens for the truck to exit the port. The movement of the truck is monitored throughout its journey and data captured for analysis and decision making. At the waterfront, passengers and crew who disembark are taken through security checks. Travel documents are scanned and users pass through a smart gate where they are automatically scanned. At the waterfront of the port, armed security personnel patrol. These personnel are sometimes supported by drones which fly to capture audio/visual data on activities along the waterfront. In addition to carrying firearms, these security personnel have smart mobile devices for communication purposes.

When a ship berths, port security goes on board to inspect documents and passports of the crew and passengers. If these crew disembarked, they were taken through arrival formalities. This includes security screening and body scan done by going through the e-gate. Fingerprints are taken and data automatically sent to the central database for analysis. The details are compared to the data already in the systems and any suspected person is flagged and sent to the main security office for further interrogation. The stationed security personnel stated that:

> All details are automatically recorded and transmitted into the central database. Bags and other possessions and belongings are also scanned. If no contraband goods are found, the passengers and / or crew are directed to the immigration desk to go through arrival formalities. Their passports and other travel documents were inspected and scanned.

In addition, a Vessel Traffic Management Information System (VTMIS) connected to remote sensor sites each have communication towers and equipped with marine radars. There is also Automatic Identification Systems (AIS) and CCTVs for detecting and identifying ships and boats. Marine communication radio equipment with smart technologies and infrared frequencies and in compliance with the International Maritime Organisation (IMO) mandated Global Maritime Safety and Distress Systems (GMDSS) and Long-Range Identification and Tracking (LRIT) requirements for receiving regular ship reports are used to monitor vessels.

The Remote Sensor Sites is equipped with meteorological and hydrological sensors to provide local weather data from the respective sites which will be transferred to the Control Centres for broadcasting. The port security manager indicated that:

> All data from the Remote Sites are transferred to the manned control centres where operators have display screens depicting vessel traffic.

At both entry and exit gates, two types of security procedures were conducted. One for individual pedestrians and one for vehicles. Pedestrians pass through a metal rotating gate equipped with scanners. For vehicles, as they approach the exit gate, the number plate is captured and automatically, the metal gate is opened for the truck to exit. These processes are not always smooth. Damage to installed equipment from tidal waves and the harsh environmental conditions at the port renders frequent malfunctioning of the CCTVs and other components of e-gate system.

Figure 5.4: Biometric Verification Process

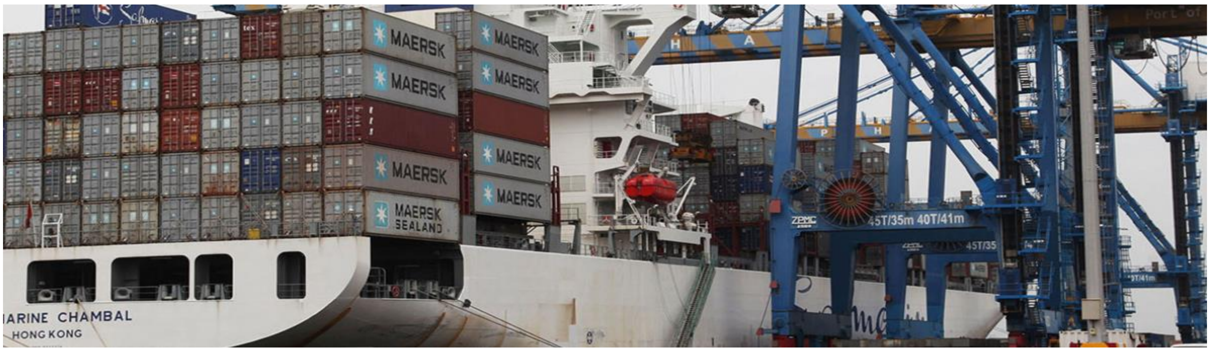

Source: https://www.ghanaports.gov.gh/

### 5.4 Case Study 2: Container Handling

Tema Port has the infrastructure for multipurpose vessels and dedicated container terminals. Major services offered by the port include vessel handling/marine services, stevedoring, shore handling and conservancy services. Stevedoring services for loading and discharging of vessels are provided by eleven (11) private companies in addition to the port's stevedore. According to a general manager:

> If you look at the vessel handling, it is largely between us and the few of the private operators we have licensed so we are able to determine the terms and conditions for their operations.

Figure 5.5: Container vessel berthed




Source: https://www.ghanaports.gov.gh/

### 5.4.1 Traditional Security Service System

In the traditional era, container handling involved physical and paper-based processes. These processes began before the arrival of vessels. The captain sent a manifest through facsimile to container allocation department. The shipping lines sent their manifest by fax which indicated the vessel number, country of origin, the number of containers to be offloaded, the consignees, and the content of containers. It also showed the expected containers to be unloaded. A container allocation officer emphasised that:

> After submitting the manifest, shipping lines requested berthing space manually by filling paper documents to indicate the arrival of a vessel and other details such as tonnage and content. The shipping line agents filled the information on paper and took it to the harbour master's outlet.

The harbourmaster checked availability of berthing space and time slot that is convenient for the vessel taking into consideration type of vessel, size and cargo to be offloaded from or loaded unto the vessel. A berthing meeting is then held with stakeholders involved in the berthing process including. At the meeting, stakeholders confirm, and the process was approved. Then all stakeholders will agree on date and time to berth the vessel.

Subsequently, the container allocation office printed out multiple copies and physically sent to terminal and crane operators. When a ship berth, quay cranes (QCs) operators took import containers off the ship's hold. Next, the containers are transferred to trucks that travel between the ship and stacks. These stacks consist of a number of lanes, where containers can be stored for a certain period. A harbour master at the port emphasized thus:

> Container handling equipment, like cranes, or straddle carriers (SCs), served the lanes. A straddle carrier can both transport containers and store in the stack. It is also possible to use dedicated vehicles to transport containers.

If a vehicle arrives at the stack, it puts the load down or the stacking crane takes the container off the vehicle and stores it in the stack. After a certain period, the containers were retrieved from the stack by cranes and transported by vehicles to transportation modes like barges, deep-sea ships, trucks. To load export containers onto a ship, these processes were executed in reversed order. Container terminals make use of manned equipment, such as manned straddle carriers, cranes, and multi-trailer-systems.

Unloading and loading of the ship are handled by automated and manned terminals both use quay cranes. QCs are manned because automation of this process encounters practical problems, like the exact positioning of containers. Figure 2 illustrates a QC. The QCs have trolleys that can move along the crane arm to transport the container from the ship to the transport vehicle and vice versa.

### 5.4.2 Introduction of Smart Container Handling

Before 2013, the port implemented an Enterprise Resource Planning (ERP) System for administration functions such as Finance, HR and Operations/maintenance components. In 2013, these systems were consolidated with the E-Port Project. The E-Port Project was to address the challenges encountered with the traditional system with smart technologies.

To attract vessels, Tema Port is required to maintain international port standard. As a result, management of the port has been thinking about how to make activities in the ports computerized to eliminate delays and to bring about convenience to our customers. The port has an IT department at the Headquarters and the port units in Tema, the fishing harbour and all other units have the IT Departments. The port identified some operational areas that if we have to do it manually that involved the use and movement of large quantities of documents that cause delays which do not meet the modern ways of doing things.

Formerly shipping lines requested for berthing space in the port manually and the process. The process was to fill a paper document form indicating to the port particulars of the vessel to berth when it will have the vessel berth and all the other details like the tonnage, items it is carrying. The General Manager – Marketing and Corporate Affairs reiterated that:

> Shipping lines filled paper forms and take it to harbour masters' outlet, our harbour masters will look at the availability of births that is convenient for the vessel and schedule it whiles they go for what we call the birthing meeting to confirm and then that process is approved. Then all the stakeholders will be in agreement that on this day that particular vessel will be birth.

But out IT Dept. developed an in-house application which allows our shipping lines to apply for berthing allocation online and after it has gone through the electronic process, approval is given online without walking into our offices as it was done previously. The IT Manager highlighted some concerns thus:

> Our major concern was paperless so we formed two committees; an internal committee to look at our internal systems to ensure that we can handle the paperless and also a committee of stakeholders.

The internal committee was made up of the IT Department, Marketing & Corporate Affairs Department. Operations Department, Audit and Finance Department. Management also formed a stakeholders committee made up of terminal operators and other licensed private operators within the port. Other members of the committee were shipping lines, customs, Steve Dooring Companies, Clearing Agents Representatives and GCNet to provide the data interchange. Series of meetings were held in looking at planning and implementation.

The internal committee was set up to look at the port's preparedness. In doing that port outline their entire process and came out with a clear process which was communicated to all stakeholders about the roll-out of the system. Also, in doing that vendors and developers also contacted. The IT Officer highlighted:

> We had multiple developers working on different areas of the whole system. One was looking at the internal system that we were using thus the terminal operating system. They were to ensure that customer can make a request and if they had to make an electronic payment they can. They were to modify the system. There was a middleware which was also for confirmation from the shipping line, sending information from customs, banks and other stakeholders. So, we contacted some developers to work on that area as well.

After the committee had to look at the processes, a roadmap was developed for best options with existing software advantages over the existing paper-based systems. The perceived advantages were (a) autonomous access control, (b) autonomous digital data capturing, (c) data analytic and dashboard reporting, (d) online submission of trade-related documentation and (e) increased efficiency and transparency.

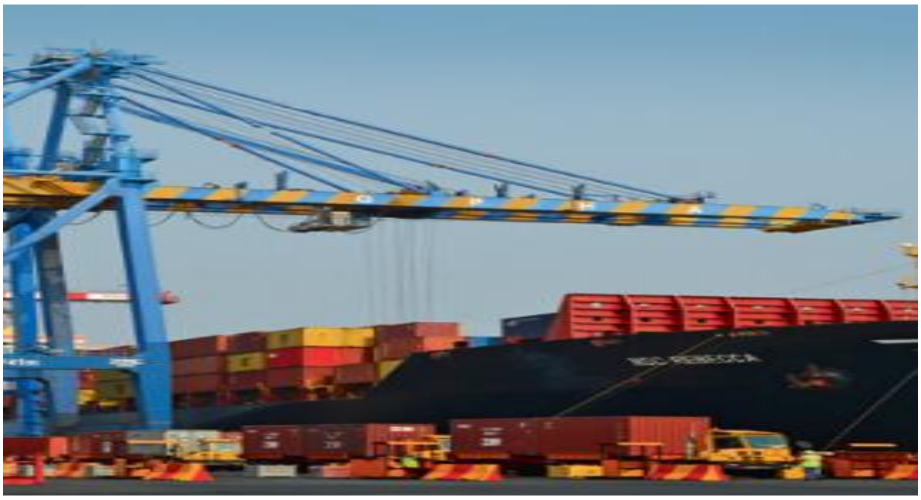
### 5.4.3 Use of Smart Container Handling System

The Tema Port provides container handling facilities via a dedicated container terminal managed and operated by a private company, Meridian Port Services (MPS). The terminal which consists of berths 1 and 2 has a quay length of 575 metres with the following facilities: 3 Ship to shore gantries, 4-yard gantries, 2 Mobile Cranes, Reach Stackers, 272 reefers plug points and a six-lane gate complex.

Figure 5.6: Quay Crane Operator


Source: https://www.ghanaports.gov.gh/

Figure 5.7: Quay Crane



Source: https://www.ghanaports.gov.gh/

## 5.5 Chapter Summary

This chapter described the two cases of seaport smart service systems deployment and use in Tema Port in Ghana. Each case description touched on the traditional service system, the introduction of the smart service system and usage processes, and the outcomes. The next chapter analyses the case descriptions using technology affordances and constraints theory as the analytical lens. This chapter described the two cases of seaport smart service systems deployment and use in Tema Port in Ghana. Each case description touched on the traditional service system, the introduction of the smart service system and usage processes, and the outcomes. The next chapter discusses how technology and affordances and constraints theory is employed as an analytical lens to describe the case.

# CHAPTER SIX

# CASE ANALYSIS

## 6.1 Introduction

Chapter Five presented the case description involving two embedded cases. This chapter presents an analysis of the case based on the technology and affordances and constraints theory presented in Chapter Three. The chapter begins with within-case analysis for the two cases in Chapter Five followed by their cross-case analyses. The first section presents an analysis of smart security service system, followed by its affordance and constraints processes. The second section presents analysis of smart container handling system followed by its affordance and constraints processes. The third section presents the cross-case analysis of two seaport smart service systems. The chapter ends with a summary.

Table 6.1: Concept of affordance as applied in the analysis of the cases.

| Concepts | Descriptions and examples |
|---|---|
| Technology | Technology is the information system that is used by the organisation users (Majchrzak & Markus, 2012). Examples include RFID, OCR, CCTV. |
| Goal-oriented actor group (s) | These are users who interact with the technology to achieve their goals' Example include importers, clearing agents, port security personnel, terminal operators. |
| Affordances | Affordances are action possibilities constituted through the relationship between users and IT features. The affordance on an artefact or feature can vary, depending on use and context (Koroleva & Kane, 2017). An example is an RFID to detect position and inscriptions on containers. |
| Constraints | Constraints are hindrances that prevent actors from using the technology to achieve intended goals. For example, electricity and internet downtimes. |
| | |

| | |
|---|---|
| Effects | According to Strong et al. (2014), an intermediary existing between the actualisation actions and the goals of an organisation is the immediate concrete outcome. As an example, the actualisation of an affordance may result in (1) enabling organisational changes, (2) development of additional IS features, and/or (3) enabling conditions for organisational changes. |

Source: Author's construct

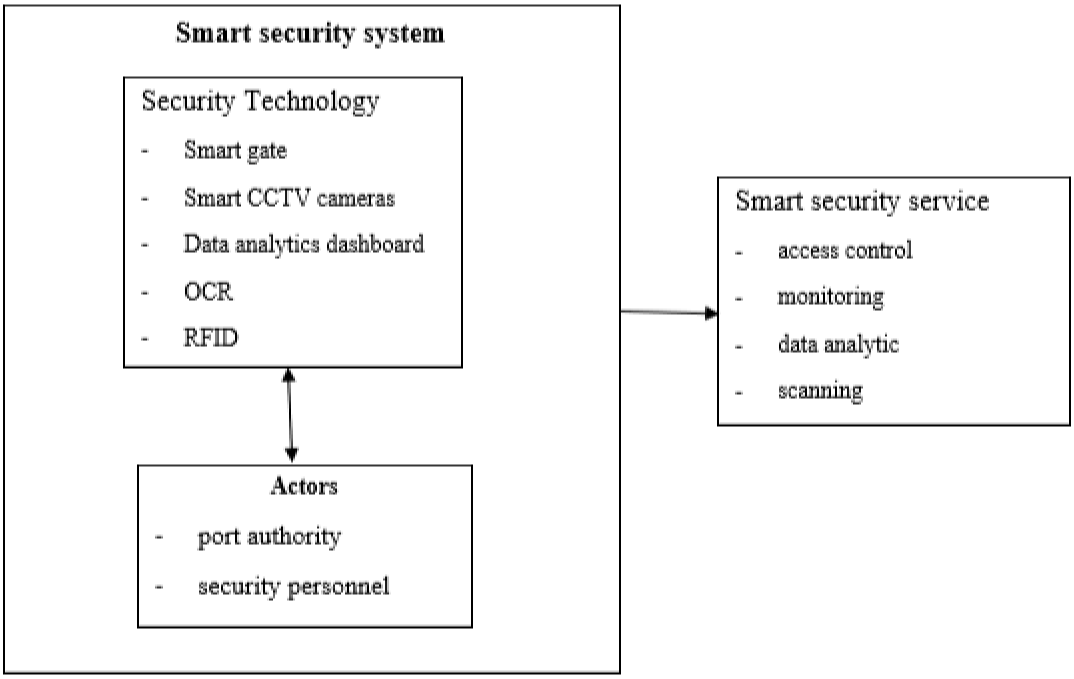
The analysis is in two parts, within-case and cross-case. For within-case analysis, the affordances and constraint of the seaport smart service system were unpacked by examining the interaction and outcomes. The cross-case analysis looked at the similarities and differences across the three cases.

In TACT, technology is the information system that is used by the organisation users (Majchrzak and Markus, 2013). From the case description, the components of smart security service system include (a) access control system, (b) CCTV cameras and monitoring system and (c) data analytics dashboard while the key principles (Strong and Volkoff, 2016) are: (a) user/artefact relation, (b) maintain the distinction between affordance and its actualisation, (c) focus on the action, not the state or condition reached after taking the action, (d) recognize social forces that affect affordance actualisation. The seaport smart security service system is a technical object with different parts.

### 6.2 Affordance and Constraint of Smart Security Service System

Smart security service system at the Tema Port has three components: access control system, monitoring and data analytic. The following section uses the concepts and principles of TACT to analyse the case description.

Figure 6.1: Constraints Process of Smart Container Handling System




Source: Author's construct

From figure 6.1, the smart security service system comprises the smart security technologies, seaport actors and the smart security service. The interaction between the smart security technology and the organisational actors is shown by the vertical double-headed arrow while the horizontal single arrow depicts the results of these interactions as the smart security service. The components of smart technologies are (a) smart gate (b) smart CCTV cameras monitors, (c) data analytic dashboards, (d) OCRs, (e) RFIDs, and (f) mobile devices and 3D Scanners. The actors are port authority and port security personnel. The interactions between the smart security technology and the port actors provide smart security services. These services are access control, monitoring and data analytic reporting.

The smart gates are embedded with sensors and actuators which enable autonomous access control and data capturing of trucks and human actors seeking to enter the port for a legitimate business transaction. The smart gates enable fast and smooth security control at both the entry and exit gates of the port. The smart gates allow only authorized people and trucks access to secure areas of the port.

As the RFID helps in collecting and verifying truck and deriver information automatically, the optical character recognition (OCR) enables automatic pattern recognition of alphanumeric and hand-written characters in scanned documents or images. Use of the cameras and CCTVs as smart devices enable screen monitoring personnel to remotely observe activities and events on mounted smart TV screens in a central control centre.

The data analytics make use of data mining and analytic tools to enable analysis of varied data captured by CCTVs, OCRs and RFIDs as well as sensors for analysis and dashboard reporting to management. The system enables management to access security reports from dashboards for effective planning and security-related policy decisions. Smart mobile devices are used for communication and tracking purposes. These devices are equipped with powerful computing, communication, and sensing capabilities including GPS, RFID, and mobile data services.

### 6.2.1 Affordance Actualisation Process of Smart Security Service Systems

The affordance process involves are (a) perceived affordance (b) actualized affordance and (c) affordance effect. Figure 6.2 shows the affordance process and their description. From figure 6.2, the first stage of the affordance process occurred at the perception. Here, port authority became aware of action possibilities that their interaction with smart technology can offer. At the planning stage for the smart security service systems, port authority perceived the using the following smart technologies: (a) smart gates, (2bsmart CCTV cameras, (3cmonitors, (4ddata analytic and dashboard reporting, (e) optical character recognition (OCR), (f) Radio Frequency Identification (RFI) and mobile devices.

Port authorities perceived the use of smart gates will afford autonomous access to authorized people and vehicles and autonomous prevent to unauthorize access. The use of smart gate was, therefore, to enable autonomous access to authorized people and trucks and autonomous prevention to unauthorised access. The smart gates have embedded sensors, OCRs and RFID functionalities. Systems. The licence plates of trucks and other vehicles are read by the OCR. When the OCR is integrated with video monitoring systems, they are able to track the movements of vehicles within the port and this enhances security. The OCRs were perceived to enable identification of container numbers without the need for human participation. It was expected to ensure that only designated containers are loaded or unloaded from the ship as well as allowed to enter or exit the port.

Figure 6.2: Affordance Process of Seaport Smart Service Systems

**Perceived affordance**

- management perceived that the use of *smart gate* will enable autonomous access to authorized people and vehicles and autonomous prevention to unauthorized access.
- management perceived that the use of *CCTV cameras and CCTV monitors* could enable the capturing and recording of port activities in real time and transmit the data to a central monitoring system.
- management perceived the use of *data analytic and dash board reporting* could provide information for policy and decision making.
- management perceived the use of Radio Frequency Identification (RFID) could enable identification of trucks that utilize the port.
- management perceived the use of Optical Character Recognition (OCR) could enable recognizing container numbers.
- management perceived the use of mobile device could enable real-time communication between monitoring security personnel and ground patrol team.
- Management perceived the use of 3D laser scanners to detect damages and content of containers.

**Actualised affordance**

- use of *smart gate* enable autonomous access to authorized people and trucks and autonomous prevention to unauthorize access.
- use of *CCTV cameras and CCTV monitors* could enable the capturing and recording of port activities transmitted to a central monitoring screens viewed by security personnel.
- use of *data analytic and dash board reporting* enables management to obtain information for security policy and decision making.
- use of OCRs enable autonomous container number identification
- use of RFID enable tracking of trucks entering or exiting the port.

**Affordance effect**

- Automatic digital security data capturing video, audio, image and text.
- manned security personnel replaced by smart gates.
- shifting from manual data collection and monitoring patrol to online platform.
- provide processing for access automation.
- eliminate congestion.

Source: Author's construct

Also, port authorities perceived the use of RFID tagged on trucks enabled autonomous entry and exit without the need for human intervention. Before the smart security service system, entry and exit gate were manned by security personnel who were physically positioned at the entry and exit gates of the port. The security personnel inspected ID cards and paper documentation of containers, trucks and persons entering and exiting the port. Details of entry and exit were also recorded in notebooks. This process was time-wasting and created possible collusion between truck drivers and security personnel.

Another perceived affordance of port authority was how the use of CCTV cameras and CCTV monitors could enable the capturing and recording of port activities in real-time. The data from these recordings could be transmitted to a central monitoring room where security personnel could view mounted digital screens in order to remotely monitor activities at the port. Long hours of viewing CCTV screen monitors could create fatigue and monotony.  The CCTV cameras were perceived to enable the capture of video, audio, image and text data.

Management also perceived data analytic and dashboard reporting could enable information gathering and analysis for policy and decision making. Data analytics involve using data mining and analytic tools to enable analysis of the big data from varied sources for dashboard reporting to management. Using data analytic and dashboard reporting enables management to obtain information for security policy and decision making.

At the perceived affordance, stage port authority expected the migration from physical access control to automatic access control by the replacement manned security personnel at the gates with smart gate. In terms of the smart monitoring system, the port security unit perceived affordance involved the interaction between the unit and the smart monitoring to enable remote monitoring of port activities. The possible constrains are internet disruptions, power supply downtime and maintenance challenges of equipment breakdowns. The interaction with the data analytics was expected to enable port authority to view dashboard information for security decision-making purposes.

From the perception stage, the interactions between port security personnel and the smart technologies may lead to actualisation of the action possibilities through use. From figure 6.2, the affordance actualisations are (a) autonomous access, (b) autonomous monitoring (c) data analytic and dashboard reporting, (d) autonomous identification and (e) autonomous tracking. The use of smart gate enables autonomous access to authorized people and trucks and autonomous to prevent unauthorised access. Prior to smart security service system, manned security personnel performed physical inspection of people and trucks entering and exiting the port. Secondly, the use of CCTV cameras and CCTV monitors could enable the capturing and recording of port activities to transmit in real-time data to a central monitoring screen viewed by security personnel. The actualized affordance is real-time monitoring and control within the port and its immediate vicinity. The CCTV cameras are smart devices that enable screen monitoring personnel to remotely observe activities and events projected on smart TV screens. Given the smart functionalities, security monitoring personnel can remotely direct and re-focus cameras to areas of interest and able to zoom-in and zoom-out of activities. Using the CCTVs footages, security monitoring personnel are able to detect security breaches in real-time and alert ground security personnel by communicating through smart mobile device for immediate action. Before the smart service system, port security monitoring was conducted physically where security personnel drove through the port in pickups and sometimes going with trained dogs.

Thirdly, the use of data analytic and dashboard reporting enables management to obtain information for security policy and decision making. The use of smart service system has enabled data analytics and dashboard reporting to management. Data mining and analytic tools enable analysis of the big data for dashboard analysis and reporting to management. The system enables management to access security reports from dashboards for awareness and effective planning. Before the use of the smart service system, data for security assessment were obtained from paper-based sources and physical meetings. However, data analytics based on big data has become part of smart service systems.

The fourth actualized affordance is autonomous identification and tracking using RFID. The RFID enables autonomous identification of trucks entering or exiting the port. RFIDs store mandatory data and transmit data to the monitoring centre. RFID is used to identify and track moving trucks. Finally, OCRs are used to enable autonomous truck and container identification. OCR systems are installed at terminal gates to automate port processes. OCR is used to identify vehicle licence plates. Video surveillance systems, help track the movement of vehicles and provide an audit trail for security checks within the port facilities.

Affordance effects are the positive consequences in terms of actual benefits that resulted from using the smart service system. The affordance effect for using the smart service system are (a) migration from manual data collection and patrol to online platform, (b) availability of a variety of security data (video, audio, image and textual) and (c) autonomous access control for entry and exit of humans and vehicles.

An affordance effect is the change in security data collection, monitoring and controlling. Security data is automatically captured and transmitted for data analysis in real-time. Port Authority has direct access to analysed security information anytime anywhere through mobile devices. Prior to smart security service system, security data were manually recorded in notebooks. Security data could not be accessed by management in real-time. Paper-based document incident reports were presented to management at meetings. This was time-consuming and made audit trail during security breach investigation difficult. During such situations, it was believed that some security personnel connived with unauthorized people to access the seaports or exit the port with unaccustomed cargo or contraband items.

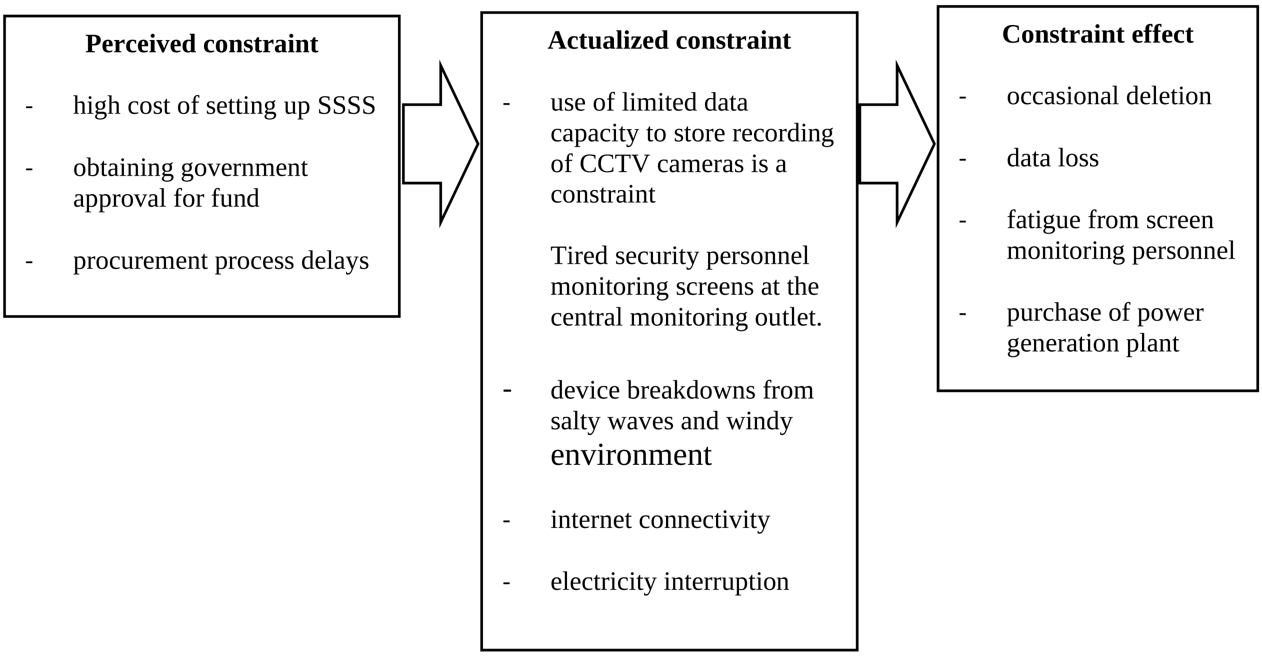
The next affordance effect is availability of a variety of security data in a form of video, audio, image and textual. Before the use of smart security service systems, data was only textual and physically written in books. The smart service systems, the seaport has enabled access to a variety of security information including video recordings, audio recordings, an image capturing and text. These serve as resources for multi-dimensional evidence for security breaches.

The other effect of smart security service is the autonomous access control for entry and exit of humans and vehicles. In the smart service system era, entry into and exit from the various gates have become automated. Only authorised port users are given smart access cards that enable them entry automatically without the need for physical checks for documents. Also, authorized vehicles have been given smart access cards which enable automatic access through the smart gates. Traditionally, security personnel physical inspected paper documents of people and vehicles. Some security personnel capitalized on this to collect bribes or are induced by unscrupulous persons to compromise security checks by allowing unauthorized persons or contraband items into out of the port. The new system effectively takes away the need for human intervention.

### 6.2.2 Affordance Constraints process of Seaport Smart Service Systems

Despite the benefits of smart security system, certain constraints can be identified which limit the full potential of the system. Three stages of constraint processes that result from interactions between the smart security technology and organisational actors can be identified. These are (a) perceived constraints (b) actualized constraint and (c) constraint effect.

Figure 6.3: Constraint process of seaport smart service system




Source: Author's construct

Constraints restrict people or organisations from achieving their goals. Perceived constraint involved were (a) cost of acquiring and implementing the system, (b) Getting government approval for funds and (c) procurement delays.

At the planning stage of the smart security service system, management perceived that the cost of acquiring the system may be potential constraints. For example, high cost of procuring smart gates, RFIDs, OCRs, CCTV cameras and setting-up become a significant barrier as it involved extra expenditure. Before the implementation of the smart security service system, monitoring and inspections were done manually by trained security personnel. This eliminated the need to procure these devices and equipment.

Another perceived constrain was getting government approval for funds. Tema Port is a government of Ghana organisation. In Ghana, government-funded organisations go through a rigorous budgetary process for approval. Management will have to convince the government about the need to implement the system. Also, the procurement process may delay the project. As a government organisation, bureaucratic and legal processes are required before contracts could be signed. These delays could cause constraints to the implementation and use of the smart security service system.

One of the actualized constraints is a limited data capacity storage for recorded data transmitted from the CCTV cameras, RFIDs and OCRs. The limited data storage capacity required that port authority to periodically delete past recorded data to create more space for new data. Deleting historical data constrains past data searching and analytics.

Another actualized constraint is tired security personnel monitoring screens at the central monitoring outlet. Security personnel sometimes get tired and lose concentration. Although incidents are recorded, screen monitoring personnel who must look for signal in real-time may not attentive and miss important security breaches. Under the physical system, monitoring activities were performed by patrol personnel who conducted physical monitoring and apprehend unauthorized persons.

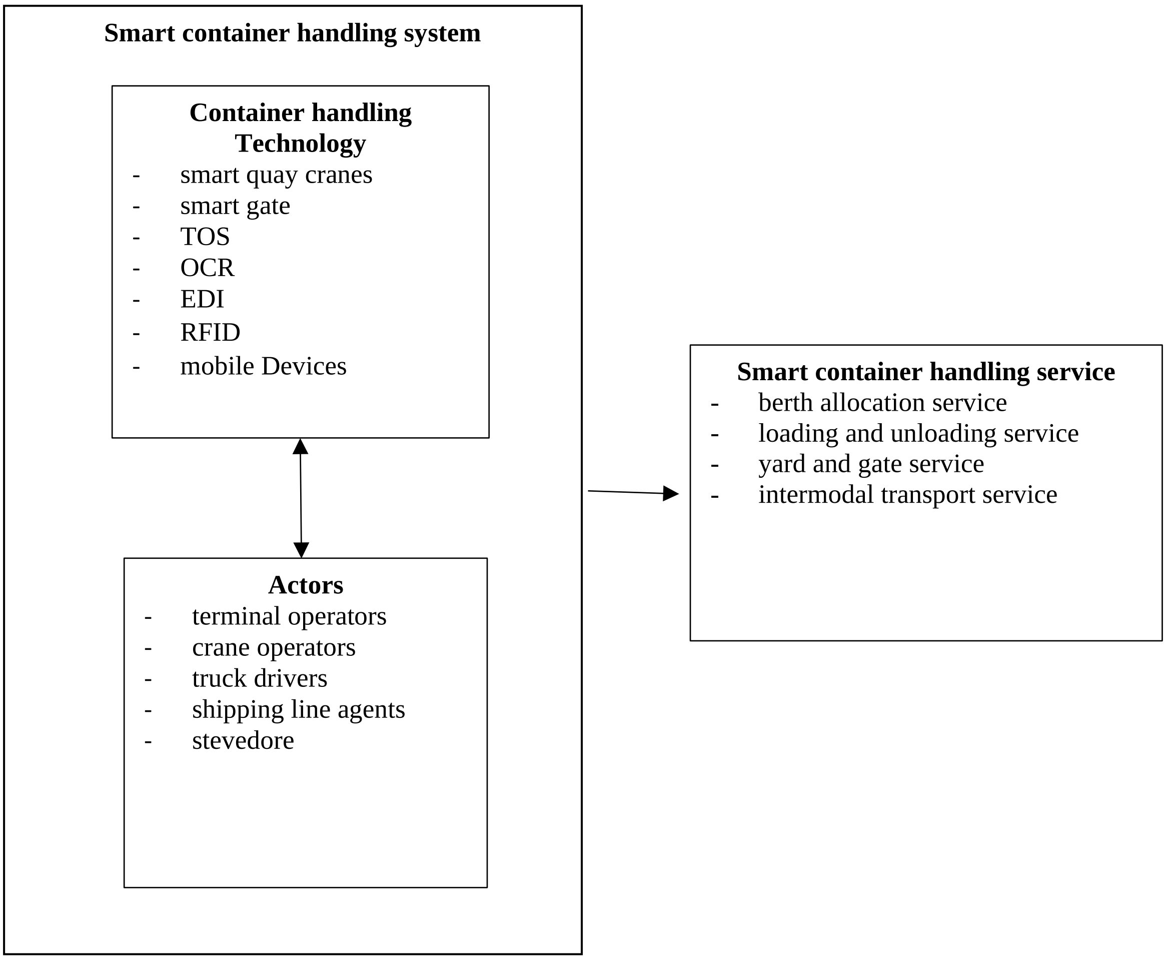
Some of the actualized constraints subsequently created effects, these constraint effects are limited storage capacity, fatigue of screen monitoring personnel and device breakdowns from salty waves and windy environment. Due to limited storage capacity constraint, the port is forced to periodically delete data to create space for new data. The new system capture data from video and audio content for storage. Sometimes, the seaport is forced to delete old data. The deletion also constraints big data which is important for long-term analytics and trend analysis.

Finally, the seaport environment presents constraints effect. Tema Port is situated close to the sea where the harsh sea waves and winds with high salt content cause corrosion to some of the equipment. The effects are a high rate of corrosion of installed equipment such as CCTVs, cameras and objects embedded in metals faulty. This situation leads to a frequent need for replacement. Going through a requisition process for replacement parts also delays, monitoring areas with faulty parts become impossible on smart service systems.

### 6.3 Affordance and Constraints of Smart Container Handling Service

Smart container handling service system at the Tema Port has three components: seaside operations, terminal operations and landside operations. The following section uses the concepts and principles of TACT to analyse the case description.

Figure 6.4: Smart container handling service system




Source: Author's construct

From figure 6.4, the smart container handling service system comprises the smart container technologies, seaport actors and smart container handling service. The interaction between the smart container handling technologies and the seaport actors shown by the vertical double head arrow, while the horizontal single head arrow depicts the results of these interactions as the smart container handling security service in figure 6.7. The components of smart container handling technologies are (1) smart gate (2) smart CCTV cameras monitors, (3) EDI, (4) OCRs, (5) RFIDs and (6) mobile devices.

In terms of demarcation, the quay and berth areas are considered to be part of the sea area. On the other hand, the gate and yard area are part of the land area. The intersection of the seaside and landside is designated as the transport side. From the seaside, container unloading process starts by assigning vessels to berths so they can moor upon arrival to the port. Shipping lines inform the port of the expected time of arrival of a vessel by sending a declaration EDI online prior to arrival. The declaration includes the date of arrival, the estimated time of arrival, the details of the vessel, the number of containers to be discharged, the number of containers to be loaded and information such as the type of cargo, the berthing and the draft specifications for the sailing, the necessary crane outreach and the air draft.

Stevedores and terminal operators access vessel information online and automatically assign allocation of berths to the vessel. At Tema Port, berth allocation by considering vessel size, storage location for containers. Smart quay crane with mobile devices for communication is used to unload and load containers from the ship holding. Unloaded containers are transferred onto a truck and transported to a terminal yard for temporal storage. The containers remain there till they are conveyed by outward-bound trucks or inward-bound trucks that move them to other vessels within the port.

Smart quay cranes embedded with OCR camera system accurately identifies containers during loading and discharge, without interrupting or slowing down crane operations. Seamless TOS integration ensures that the data is instantly sent to the TOS, ultimately improving vessel turnaround time. This advanced crane OCR solution provides full crane OCR, covering container ID, ISO code, seal presence, International Maritime Dangerous Goods (IMDG) label and door direction. The quay crane OCR System automates the process of manually verifying ISO containers to be loaded or discharged from dockside ship-to-shore (STS) gantry cranes.

Vehicles, drivers and container data are automatically identified by OCR and RFID. They also compare the data with other pertinent information in the Terminal Operating System (TOS). The RFID also help in tracking containers across the various location within the port.

Truck drivers use smartphones and other handheld devices equipped with GPS, RFID, sensing capabilities powerful computing and communication these devices use mobile data services to receive and transmit data. Truck drivers access information on schedule pick-up and delivery on their phone. The drivers also book an appointment and receive notification of container status on their mobile devices to perform intermodal services.

At the landside of the port, smart gates have been installed to automate access and exit to the port. The smart gates are embedded with sensors and actuators, CCTV cameras and RFID. These smart technologies enable autonomous control of container bearing trucks to enter and exit the site without the need for much human intervention.

### 6.3.1 Affordance-Actualisation Process of Smart Container Handling Systems

This section employs the affordance-actualisation process to analyse the perception, actualisation and effects of the smart container handling system in Tema Port. Figure 6.5 shows the three phases of the process. At the perception phase, management of Tema Port believed that smart container handling system is an opportunity to replace manual processes including human interaction with more efficient smart technology. Again, management perceived that the use of smart gate will enable autonomous access to authorized container trucks and autonomous prevention to unauthorize access. Also, management perceived that the use of CCTV cameras and CCTV monitors could enable the capturing and recording of container movements in real-time and transmit the data to terminal operating systems. Also, the use of smart quay crane was believed to autonomously identify containers during loading and discharge. Finally, management perceived the use of Radio Frequency Identification (RFID) could enable identification of trucks and containers at the port. In addition, the use of Optical Character Recognition (OCR) could enable recognizing container numbers, as well as the use of a mobile device, could enable real-time communication between crane operators and terminal operators.

In order to automate access control, monitoring and container movement data. It was expected that replacing the physical gate and the security personnel with a smart gate would improve access and exit controls as well as reduce the existing inefficiencies and congestion in the physical process. At the planning stage of the smart container handling service system, management perceived a number of uses. First, management perceived that the use of smart gate could enable autonomous access to authorized container trucks and autonomous prevention to unauthorized access. Preregistered trucks could be required to fix a dedicated RFID tag. Upon approaching the smart gates, trucks could be recognized through the RFID sticker to be allowed to enter the terminals. This is to enhance truck and driver identification.

Figure 6.5: Affordance process of smart container handling system

**Perceived affordance**

- management perceived that the use of *smart gate* will enable autonomous access to authorized container trucks and autonomous prevention to unauthorize access.
- management perceived that the use of *CCTV cameras and CCTV monitors* could enable the capturing and recording of container movements in real time and transmit the data to terminal operating systems.
- management perceived the use of smart quay crane could autonomously identify containers during loading and discharge.
- management perceived the use of Radio Frequency Identification (RFID) could enable identification of trucks and containers at the port.
- management perceived the use of Optical Character Recognition (OCR) could enable recognizing container numbers.
- management perceived the use of mobile device could enable real-time communication between crane operators and terminal operators.
- management perceived the use of EDI will enable the exchange of electronic document covering container details to be share with relevant actors.

**Actualized affordance**

- use of *smart quay cranes* enable autonomous identification of container to off load or load from vessel onto trucks and vice versa.
- use of the smart gates could enable autonomous access and exit of container bearing trucks
- use of *CCTV cameras and CCTV monitors* could enable the capturing and recording details of truck carrying containers and transmit in real time data to a central monitoring screens viewed by security personnel.
- use of OCRs enable autonomous container number identification
- use of RFID enable tracking of trucks entering or exiting the port.
- Use of smart quay cranes have increase container handling capacity

**affordance effect**

- migration from manual container handling process to online platform
- availability of multiple sources of container data capturing and movements
- autonomous access control

Source: Author’s construct

Secondly, management perceived that the use of CCTV cameras and CCTV monitors could enable the capturing and recording of container movements in real-time to transmit the data to terminal operating systems. The CCTV cameras recordings produce images and videos for surveillance purposes. The cameras features have motion detection sensors designed to reliably detect and record movements of people, vehicles and other heat-generating objects. These images and video recordings are then transmitted through wireless connectivity to a central CCTV monitoring centre.

Another perceived affordance of management is that the use of radio frequency identification (RFID) could enable identification of trucks and containers at the port. This could be done by enabling tagged objects to be quickly identified and communicate through radio waves without the need for cable network connections. The RFID readers could transmit data collected to other smart object and the central database system for analytics and further processing. Also, RFIDs enable automated security regulations compliance. This help to fulfil regulatory requirements promoted by the International Ship and Port Facility Security Code (ISPS Code). Also, management perceived that the use of optical character recognition (OCR) could enable recognizing container numbers. OCR systems could enable automatic recognition of alphanumeric and other written characters and images in scanned documents. The OCR at the gates is able to handle more containers without needing extra staff. The port entry and exit gates area could be congested: thus, OCRs could be used as part of a pre-gate's arrangement, OCR of automatic gates, in order to separate check-in procedures for guided access to terminal gates.

Again, management perceived the use of a mobile device could enable real-time communication between crane operators and terminal operator. The real-time communication could help build increased efficiency of port procedures, helps prevent human errors, and avoid the loading or unloading of the wrong container from the vessel. Mobile devices equipped with GPS capabilities were perceived to integrate positioning and sensor data on tagged containers to base stations and other data gateways. This allows contextual data to be transmitted from connections that communicate multiple containers. Also, the mobile device could provide mobile applications that can enable the exchange of information with truck drivers upon approaching the entrance of port to consider truck information, parking spaces, traffic congestion, from stakeholders that can enhance efficiency of port operations.

Finally, management perceived that the use of EDI will enable the exchange of electronic document covering container details to be shared with relevant actors. EDI support various operations of the port in different ways. For example, in stowage instructions for planning berth management, a gates activity report unstuffing or stripping orders, reports of customs on cargo, and notifications on dangerous goods. The multiple sources and exchange information is important for transportation to enable real-time processes in which different stakeholders can share information and collaborate efficiently.

The Terminal uses a Truck Appointment System (TAS) that was perceived to allow for clearing agents to pre-book appointments before accessing the port. This is fully integrated with the Terminal Operating System (TOS) to provide process automation for drivers, eliminate congestion and maximize deficiency levels without compromising on security at the port.

In terms of actualized affordance, the CCTV cameras monitor, capture data and record event details of trucks carrying containers and transmit in real-time to central screens viewed by security personnel. CCTV surveillance system capture images and video of the seaport for security purposes using video cameras. Video analytics enable automatic alarm generations that are filtered. The video streams are recorded for crime evidential reasons and for investigation purposes.

Another actualized affordance is the use of OCRs to enable autonomous container number identification. Incoming and outgoing trucks are processed through OCR gate systems. The intermodal transportation of containers from ship to various terminals and within the yard have OCR systems installed on rubber tire gantry cranes and rail mounted ship-to-shore (STS) and yard gantry cranes. improve procedural efficiency to prevent errors, such as the loading or unloading of the wrong container from a vessel.

The crane OCR automatically identifies container and equipment details during the loading and discharge at the quayside operations. Cranes have integrated OCR system that automatically reads and records the container ISO code number as it is handled by an STS crane. The system integrates with the crane's program logic control (PLC) system for triggering and data processing purposes. The sophisticated image capture and recognition system are installed directly on the crane and interfaces with the crane control system.

The benefits of installing OCR on the cranes are numerous; however, a significant one is found in the reduction of workers under the cranes, one of the unsafe work areas at a terminal. Those checkers or tally clerks who are responsible for recording container numbers that discharge and load can be seated remotely in a safe work environment.

Since OCR automatically tallies containers at an extremely high rate of accuracy, only the exceptions need be handled by human intervention and that exception management can be performed remotely in the safety of a building on or off terminal if necessary. The OCR has a set of features that can capture and record damage images, door direction, hazardous labels, as well as reading and reporting the UTR (terminal tractor) numbers onto which the container is transferred. The use of RFID enables tracking of trucks entering or exiting the port.

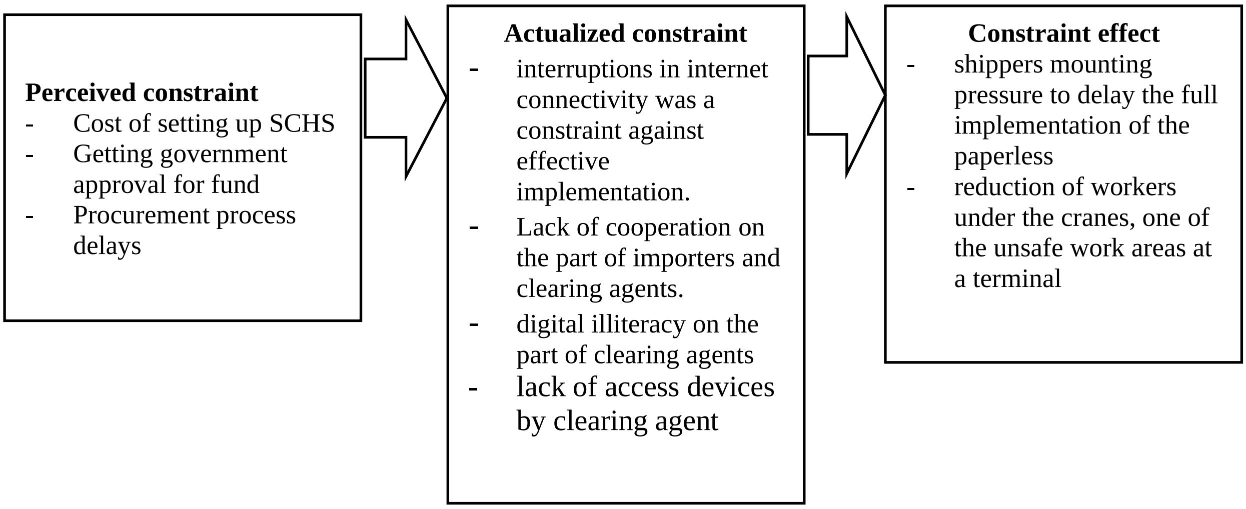
In terms of affordance effect, involved migration from manual container handling process to online, enabling consistency in container handling by reducing human errors and delays. Secondly, the availability of multiple sources of container data capturing and movements allow the smooth processing of trucks accessing the port. Thirdly, the gates are key checkpoints for identifying and recording details of containers entering or leaving the port. Autonomous access control for truck entry and exit enable trucks to pass through the gates without human intervention.

### 6.3.2 Affordance-Constraint Process of Smart Container Handling System

This section employs affordance-constraints process a newly introduced concept to analyse the constraints in each of the three stages of perception, actualisation and effects of the smart service systems for container handling in Tema Port. Figure 6.6 shows the affordance-constraint process.

At the perception phase, management perceived project cost, funding and procurement delays as potential constraints for acquiring and implementing the smart service system for security. Given that the Port is a public sector organisation, management was sceptical of getting approval from the government. Even if approval was sought, they were not sure of getting adequate funding. Even with the funding, management was worried about possible delays in going through the inefficient government bureaucratic process.

Figure 6.6: Constraints process of smart container handling system




Source: Author's construct

At the actualisation phase, the main constraints identified were interruption of electricity and internet connectivity, limited storage capacity, digital illiteracy on the part of clearing agents, lack of access devices by clearing agent and lack of cooperation on the part of importers and clearing agents.

In times of disruption to an electrical power supply and internet outages, smart service systems became dysfunctional, causing the port to revert to using generators to power the system. Actually, electricity and internet outages had become a national problem and not specific to the seaport. Another actualised constraint was the limited storage capacity for the voluminous data captured from video recording and RFIDs, OCRs and smart gate devices. Hence the port is sometimes forced to delete data to make way for new ones. Another constraint was frequent breakdowns of externally installed devices such as smart cameras and RFID devices due to the salty sea environment.

The constraint generated negative outcomes in terms of periodic deletion of historical data, periodic reverting to manual security process and non-capturing of data during outages and machine break downs. As a result of the increasing volume of data, especially from video monitoring and RFID recordings, coupled with the limited storage capacity, there was constraint effect of periodic data deletion. Thus, the port had to delete historical data to make space for new data thereby losing data for forensic security analysis.

Another constraint effect is the practice of reverting to a manual security system. Thus, the negative outcome of the power and internet outages was that the port was forced to resort to the service of the security personnel to provide manual access control and physical monitoring with all the associated problems that initially motivated the need for the smart security system.

In terms of digital illiteracy on the part of clearing agents, this posed initial constraint of the system as many of the clearing agents lacked knowledge and of using smart systems. Also, many clearing agents did not have access to digital devices and had to upgrade their computers. They resisted due to additional cost in internet data usage which was transferred to the importer. This created misunderstanding and lack of cooperation between importers and clearing agents. Moreover, during the times that these constraints persist, container handling became ineffective resulting in shippers mounting pressure. This is because shippers incur extra charges for delays in container clearance. This compels the port to revert to manual processes which are inefficient.

## 6.4 Cross-Case Analysis

In this section, a cross-case analysis of the separate analysis for each case is presented and generalisations are drawn for the Tema Port smart service systems deployment and use. The first part of the cross-case analysis looks at affordance and constraints of the two-case seaport smart service systems, while the second-part draws out the similarities and differences across the cases.

### 6.4.1 Affordance of Tema Port Smart Service Systems

This section presents a cross-case analysis of the affordances of the Tema Port smart service system. Findings from two cases show that in terms of affordances, management perceived that the deployment of the smart service system could afford advantages over the existing paper-based systems. The perceived affordances for the cases are (a) autonomous access control, (b) autonomous digital data capturing, (c) data analytic and dashboard reporting, (4donline submission of trade-related documentation, (e) increased efficiency and transparency and (f) increased revenue collection.

As the case analysis show, autonomous access control enabled by smart gates has common usage for all two case studies. For example, the smart gates control access by enabling autonomous access from the land side to authorized vehicles and persons while preventing access to unauthorised access. In terms of security, the smart gate ensures that only authorized persons and vehicles gain access to restricted areas of the seaport. The smart gates are embedded with OCR and RFID readers that capture data in real-time of persons and vehicles entering or leaving the port. Data captured are transmitted in real-time for analysis. The results of the analysis are displayed on the data analytic dashboard. This information can be accessed by management for policy and decision making. In the smart container handling, as containers move in and out of the port, the smart gates autonomously capture data at the entry and exit gates to ensure that the right containers enter or leave the port.

This implies that containers are only allowed to enter or exit when they meet all the required conditions. Container carrying trucks are recognized by the smart gate system through the RFID sticker issued at the point of registration. The RFID enables compliance to security regulations to be automated. This reduces costs for hiring extra security personnel and meet the requirement of international security regulatory bodies. RFID readers exchange their data with other smart systems for processing.

Another perceived affordance is data analytics and dashboard reporting. Data analytic tools were used to analyse data extracted from monitoring devices onto screens where detailed information about port security, container handling and import clearance services by providing up-to-date in-depth analysis to help policy decision-making. The dashboards compile tracking data from multiple sources into user-friendly interfaces focused on key phases of the shipping process. Monitoring real-time data can be accessed with just a few clicks with implemented intelligent data alarms. In this past searching through endless files was time consuming, inefficient and expensive. The smart service systems enable autonomous real-time digital data capturing. The data captured are used for security purpose, container handling and import clearance processes. For example, all loaded trucks are mandated to go through the Optical Character Recognition (OCR) portal.

The OCR is designed to automatically recognize trucks carrying containers through high definition cameras. Data captured are:  the container number, the ISO code, IMDG labels, presence of a seal and the truck license plate number. This information is collected while the truck passes through the OCR portal. The data is captured automatically by the gate operating system without human intervention, eliminating errors and making the transaction much faster. The data captured provide real-time information used for security, container handling as well as import clearance processes. The captured data is sent to a central repository for data analytic and dashboard reporting. The data is also retrieved from CCTVs and RFID embedded in the smart gate and use as a base for analysis. The RFID is an automatic identification tag use to track, capture, and transmit data on tagged containers. Therefore, installing RFID readers at gates help automate the collection and verification of information on drivers and trucks. Using RFID are also used to improve control of access at the entry and exit gates.

With the mobile devices such as mobile phone and tablets, real-time communication to enable an exchange of information and assist truck drivers with parking spaces, individual position, traffic congestion information and provide other data for security, container handling and import clearance services to be utilized to enhance port operations. Moreover, the port authority perceived autonomous identification. While port authority perceived the smart service systems could enable autonomous access control, autonomous digital data capturing and data analytic and dashboard reporting, the actualized affordances were achieved.

Information about movements of trucks and containers are verified and recorded accurately using the gate information systems. The gate information systems are integrated with the other terminal operating system (TOS). At the gates, the processes involve checking container to identify possible damages of hazardous cargo for special handling classifications. The processes also involve giving permissions to the truck driver to enter/exit the terminal with a particular container. These processes are also enabled by smart technologies such as OCR and RFID. These systems were installed to automatically identify truck drivers collect data on containers and cross check with their records in the TOS. These processes are relevant to security service, container handling and import clearance.

In terms of effects, the deployment of the seaport smart service systems eliminated congestion at the port and real-time data capturing for analysis. Prior to the smart service system, the port experience congestion due to the manual processing of security-related issues such as data collection and analysis. In the container handling process, manual checking to identify containers and recording of container details created congestions and delays at the seaport. Autonomous container handling significantly cut container ship turnaround time as well as the cost and number of workers needed in high-risk manual positions.

The second effect of the seaport smart service is the shift from manual processes to online interactions. The smart system is automating the monitoring of processes in real-time and enabling quick adjustments while the manual systems were difficult to coordinate.

### 6.4.2 Constraints of Tema Port Smart Service Systems

This section presents a cross-case analysis of the constraints for the use of the Tema Port smart service system. Findings from all two cases show that management perceived that the deployment of the smart service system could be constrained by (a) high setup cost, (b) obtaining governmental approval for funds and (c) electricity and internet downtime.

In terms of setup cost, management perceived that the deployment of smart service system could involve a high cost to the seaport and users. The cost of introducing system include the cost of hardware, software and advocacy and training. The process of moving from a paper-based system to a smart system involved engaging the services of consultants with associated high cost who provided technical assistance for the smart service system project. The purchase of smart devices such as RFIDs, OCRs and mobile devices involved huge financial commitments.

In addition, clearing agents were required to set up offices, purchase computers and other electronic devices as well as train staff to use such systems were perceived as constraints to a successful deployment of the smart service systems. Also, smart equipment requires higher maintenance and operational costs in comparison to the paper-based system. Another cost element of the smart service systems is the need for importers and clearing agents to migrate to the web-based systems. The migration to a web-based system meant that business owners were required to set-up their offices with the computer software and hardware as well as hiring new staff with requisite qualification and skills as well as training their staff to be able to use the new system.

The second perceived constraint was obtaining government approval for funding the project. However, this perception was actualized because of the public-private partnership agreement reached between the port authority and their private partners. These private partners, West Blue Consults and GCNet Ltd provided full financial support for the entire project. Finally, the smart service systems depend on electricity and internet connectivity to function.

The main constraint is electricity and internet downtime. During the downtime periods for electricity power, generators are used to sustain the process. The seaport smart service systems rely on the national electricity grid and private source of internet connectivity, there have been interruptions of these services. Smart devices and various autonomous functions, including data sensing, transmission and storage are hampered during such periods, until the power or internet is restored.

On the paper-based systems, electricity and internet interruptions were managed given that most of the activities had manual and physical processes. After the deployment of the Tema Port smart service system, the constraints that were actualized were limited digital data storage capacity and fatigue of screen monitoring personnel. An actualized constraint of limited storage capacity for the capturing of huge operational data was evident capturing. This resulted in the deletion of data to create space for new data. The deletion of data constrains audit trail and data analytics.

The significance of data for smart analytics means that it is important to keep historical data for future use. However, findings from this study show that limited storage capability can constraint data analytics in the Tema Port smart system. Also, the running of the data centre is an expensive operation. The cost of the initial setup, ongoing maintenance, and paying of personnel responsible for maintenance is high.

Another actualized constraint is the fatigue of the screen monitoring personnel who work in the security monitoring control rooms. The security personnel watch large-screen displays of events to see in real-time. This enables them to make quick decisions and responses to events. It is ergonomically designed to keep operators comfortable and alert through long working hours. However, both physical and mental fatigue affect the performance of personnel watching the monitors. In order to ensure high quality viewing, reduce personnel fatigue, staff in the CCTV monitoring are allowed to take a break every two hours, TV monitors are arranged in curved configuration, lighting adjusted over to prevent glare on the screens.

### 6.5 Chapter Summary

This chapter employed the concepts and principles of technology affordances and constraints theory to analyse the two seaport systems, which were presented in the previous chapter. The analyses were in two parts. The first part looked at each case by examining the affordances and constraints and their effects and outcomes. The second part was a cross-case analysis, which looked at the similarities and differences between the three cases. In the next chapter, the findings from the case descriptions and the analysis in this chapter are discussed in conjunction with the literature review in Chapter 2.

# CHAPTER SEVEN

# DISCUSSION OF FINDINGS

## 7.1 Introduction

Chapter Six presented the within-case and cross-case analysis of the smart security system service and the smart container handling service. Chapter Seven discusses the literature review in Chapter Two and the research findings in Chapter Five concurrently. The discussion in this chapter commences with why a developing country may deploy smart service system in a seaport context. The section that follows focusses on how smart service systems enable or constrain seaport services. The section thereafter looks at the effects of using seaport smart service systems. The final section in the chapter presents the reflection of the researcher on use of technology affordances and constraints theory for this study. The chapter concludes with a summary.

## 7.2 Reasons for Deploying Smart Service Systems in a Developing Country Seaport

In relation with the first research question which bordered on why a developing country will adopt and deploy smart service system in a seaport context, the research findings show the reasons in relation to perceived affordances to solve the challenges of the paper-based system. The study's findings show that at the planning stages, the developing country seaport perceived that the deployment of smart service systems could enable autonomous access control. This is supported by literature which shows that smart service systems act independently of human interaction (Brogt, 2020) to monitor, control and optimise activities (Paukstadt et al., 2019; Porter & Heppelmann, 2015).

These technologies enable remote and real-time connectivity and interactions (Shim et. al, 2019) for real-time data capturing and data analytic dashboard reporting. In the study, the main affordances of seaport smart service systems were autonomous access control and real-time monitoring.

Other affordances in the study are autonomous data capturing, analytics for dashboard reporting, transparency, increased efficiency and revenue collection. Information Systems literature on smart service systems has focussed less on perceived affordances and constraints.

First, the management perceived that the use of smart service systems could improve access control by replacing the manual access control system with automatic access control systems. Under the manual era, human security personnel managed access control. These created delays, traffic congestion, and sometimes connivance with authorised people to gain access. However, with the use of smart service systems, there has been an improved efficiency and effectiveness of the access control services. This finding supports the claims in existing literature where smart technologies replace human beings in performing activities (Baheti & Gill, 2011; Martin et al., 2019;Porter & Heppelmann, 2015). In the study, smart gates systems embedded with CCTV cameras, OCRs, actuators, and sensors technologies were used. This replaced the need for human security guards to physically inspect trucks and users.

The findings also show benefits of smart service systems in the extant literature as real-time data capturing using OCRs, RFIDs and smart devices and automatic identification of containers, trucks, and cargo and resulting in reducing congestion (Heilig et al., 2017b; Heilig & Voß, 2017). This is consistent with reviewed IS literature which shows the significance of using RFID and OCR technologies to automatically control opening and closing terminal gates in Croatian ports (Cimino et al., 2017). In the manual systems, access gates were controlled by human beings who physically opened or closed the gates. This created delays and congestions at the gates. Therefore, management perceived that the use of smart service systems could reduce the time that trucks enter or leave the port.

This supports extant literature which shows that using manual terminal entry and exit gates operations generates congestion (Heilig & Voß, 2017). IS literature shows that autonomous gate operations and verification of truck and driver information (Shi et al., 2011). For example, a driver is required to pre-register their truck with a company before they can to enter the Port of Seattle in the US (Heilig & Voß, 2017).

The study's findings also indicate that the constraint of electricity power and internet disruptions compel management to revert to the manual access control whenever electricity and internet go down. Another constraint of smart service systems discussed in extant literature includes cybersecurity vulnerability (Williams et al., 2008) and the absence of universal standards for system compatibility and interoperability (Garstone, 1995; Heilig & Voß, 2017). Due to their interconnections and dependency on information and communications technology (ICT) systems and the internet, ports are increasingly vulnerable to cyber-attacks.

Again, the capabilities of smart service systems to automate data capturing and transmission are well noted in existing literature (Lim & Maglio, 2019). The promotion of big data availability for analytics and reporting is also noted in the extant literature on smart service systems (Maglio & Lim, 2016; Medina-Borja, 2015). However, a negative finding in the case of Tema Port is how the organisation had to periodically delete data due to lack of storage capability. This finding on limited storage capability for smart service systems is novel, as existing studies rather discuss big data availability for reporting and analysis as benefits of smart service systems.

From the study's findings, the seaport smart service systems in a developing country can be constrained by unstable electricity and internet availability, limited digital data storage capacity, and fatigue of screen-monitoring personnel. In this study, a seaport deployed smart service systems to achieve a number of things. This includes facilitating communication and decision making, improving its competitiveness, and enhancing its visibility, reliability, efficiency and security.

From the case analysis, despite the numerous advantages perceived by the smart service systems, some constraints were perceived. The perceived constraints are high set up cost, difficulties in obtaining government approval for funding and suspected procurement process delays. Management also foresaw possible challenges such as high cost of the project and whether they could afford it. Based on their experience, they were concerned about the difficulties of getting government approval and timely release of funds. Another hurdle was possible delays in public sector procurement processes. Fortunately, the government was convinced to approve funds for the project notwithstanding the costs. However, management experienced some delays in public purchasing procedures that affected the project from starting on time.

In the study, management of the seaport perceives that the high cost involved in setting up the smart system could constrain its use. In the literature, high set up cost of smart service systems has been identified as a possible constraint to small organisations within the port community (Garstone, 1995). Engaging services of consultants at a very high cost to the port authority was seen as a possible constraint. In terms of government approval to fund the project, management perceived that difficulties in obtaining such approval could arise.

### 7.3 Affordances and Constraints of Seaport Smart Service System

Another reason why a developing country will deploy a smart service system is to replace manual processes with autonomous processes. Findings from this study show that a seaport in a developing country can use smart service to improve seaport services by replacing physical access control with autonomous access control, paper-based data capturing and analysis with digital data capturing, data analytic and dashboard reporting. The findings also show that smart service systems can be constrained by electricity and internet downtimes, limited data storage capacity, and fatigue of screen monitoring personnel.

First, the use of smart service systems shows benefits. These benefits include changing manual access control to autonomous access control. For example, smart service systems enable autonomous access control of both vehicles and people into and out of the seaport. The OCR systems installed at gates automate administrative and check-in procedures (Heilig & Voß, 2017). The activities at the entrance and exit gates create congestion at the terminal gates. Therefore, terminal operators have installed automatic gates (Bo¨se, 2011) to help eliminate such congestions. This has improved container movement and long waiting times for trucks and their container within the port terminals.

In the traditional era, security personnel managed the gates at the port. The effects of this were delays, traffic congestion, and sometimes connivance with unauthorised people to gain access. Moreover, the migration to the smart service system improved the efficiency and effectiveness of the access control service. This finding supports existing literature on autonomous capabilities of smart technologies to replace people in performing human activities (Baheti & Gill, 2011; Martin et al., 2019; Porter & Heppelmann, 2015). This is supported by findings from the extant literature which reveal various benefits of smart service systems (Heilig et al., 2017b; Heilig & Voß, 2017). The use of OCRs, RFIDs, and smart devices for automatic identification of containers, trucks, and cargo and the positive outcomes of reducing congestion (Baheti & Gill, 2011; Martin et al., 2019; Porter & Heppelmann, 2015). Some of the key advantages of smart technologies are to enable automated identification and location of assets (Attia, 2016).

In addition, the use of smart security system enabled autonomous monitoring of the environment for security. The use of smart CCTV cameras helps to monitor the inner and outer perimeters of the port to detect security breaches and suspicious activities. Prior to deployment of smart service systems, port depended on on-ground security guards to patrol the environment and that was found to be ineffective. However, the use of smart cameras provided autonomous monitoring and video recording of ongoing events in real-time. This is supported in the literature where smart technologies in which underly smart service systems are used to monitor and collect data from the environment (Allmendinger & Lombreglia, 2005; Maglio & Lim, 2016). In the case, the seaport used CCTV cameras to monitor, collect, and transmit data to a central location for data analytic and dashboard reporting.

Under the traditional era, the port was unable to record movements and activities in real-time. Only security incidents were recorded on paper after an incident had occurred. The autonomous monitoring and control capability of smart service systems are discussed in extant literature (Lim & Maglio, 2018, 2019). However, the findings, from this study, show the effects of seaport salty environment on monitoring equipment such as externally installed smart cameras and RFID devices. This is a new finding. This finding shows that a seaport environment can have negative effects on the performance of smart devices for environmental monitoring.

Additional findings indicate autonomous data capturing for analytics and reporting. Under the traditional era, the port used paper documents to record events and activities. Details of containers including content, container number, and other information were manually cross-checked by terminal operators. Other manual steps required included trucks stopping to deliver hard copies of documents to gate officers and waiting for access pass before restarting the truck (Cimino et al., 2017).

The consequence is that management is unable to obtain real-time data to support strategic decision-making. In addition, with the use of smart technologies such as RFID, OCR, sensors, and machine-to-machine communication, data is captured and transmitted autonomously in real-time. Therefore, smart service systems enabled data availability for analytics and dashboard reporting to management. Again, extant literature shows the capabilities of smart service systems to automate the capturing and transmission of data (Lim & Maglio, 2019). In the study, CCTV cameras, OCRs, sensors, and actuators automatically capture digital security data such as video, audio, image, and text formats. These are transmitted in real-time to a central data repository for data analytic and dashboard reporting. Such smart service systems are used by specific equipment for data capturing and transmission. An example of such equipment is sea-to-shore (STS) gantry cranes. These allow communication of signals between the fixed component and the moving parts of the equipment (Heilig & Voß, 2017).

It is also noted in previous literature that smart service systems allow seaport stakeholders to obtain easy and transparent access to data from different smart devices (Jovic et al., 2019). Smart service systems collect and analyse big data for organisations (Maglio & Lim, 2016; Medina-Borja, 2015). Previous studies in Croatian cargo ports show how smart technologies used in the port produce and exchange different types of data in the port (Belfkih et al., 2017).

Finding in the case of Tema Port reveals that the organisation is sometimes compelled to delete historical data due to lack of space for data storage. This contrasts existing studies that discuss how big data available for reporting and analysis are positive aspects of smart service systems. Limited storage capacity for smart service systems is a new finding.

Previously, the port depended on physical access control and that was found to be ineffective. However, the use of smart gates provided autonomous control and data capturing in real-time. Under the human control era, data capturing was manually written in notebooks. This created laborious paper trails for analysis. Extant literature has noted capabilities of smart service systems as autonomous monitoring and control (Lim & Maglio, 2018, 2019). Before smart service systems, the seaport experienced congestions due to manual processing of data collection of trucks and persons exiting and entering the port.

**7.4 Consequences of Using Seaport Smart Service Systems**

In line with the third research question on the consequences of using smart service systems in a developing country seaport, the findings show that after the deployment and use of the smart service systems, the effects are: (a) improved transparency through online submission of trade-related documentation, (b) increased revenue, (c) increased efficiency, speed and integration with back-end systems, (d) online tracking of documentation and (e) increasing port capacity and port efficiency.

This study's findings indicate that smart service systems enable increase efficiency levels, greater transparency, and traceability of seaport activities (Acciaro et al., 2020). Second, seaport smart service systems (SSSS) affords the submission of documents online between port actors without the need for physical or human interactions. This is supported by IS literature where EDI technologies enable the exchange of electronic documents for transactions in seaports (Heilig et al., 2017a; Shi et al., 2011).

A third consequence of deploying SSSS is the improvement of the operational efficiency of seaports. This is supported by the literature which shows quay cranes can be embedded with smart technologies. Such smart technologies can enable efficient ship-to-shore container handling (Bierwirth & Meisel, 2010). Also, RFID readers attached to quay cranes enable autonomous identification of containers to be loaded/offloaded from ships without the need for human interactions. In the case study, RFIDs, OCRs, and CCTV cameras enable efficient access control of container trucks and pedestrians to go through entry and exit gates.

### 7.5 Reflections on the use of Technology Affordances and Constraints Theory

The Technology Affordances and Constraints Theory, the theory underpinning this study, is reflected on in this section. The merits and the demerits of the theory as an analytical lens are examined. TACT was used as an analytical lens for this study; hence, this section provides a reflection on its application. Researchers apply TACT to study conceptual relations between people and organisations and their technologies (Majchrzak & Markus, 2012). As such, TACT is premised on organisation, technology, and the users of the technology. It took the researcher several iterations of reading and applying the theory to understand its concepts and principles. Technology affordances and constraints theory is used to study interaction between users and technology in an organisation. Though TACT is still in its infancy, the theory has been used to study how technology enable or hinder users from achieving their aim (Koch, 2017; Stendal et al., 2016; Majchrzak et al., 2016).

Moreover, ideas from TACT theoretical foundation have an increased understanding of affordance and constraints of smart service systems. TACT also enabled the researcher to understand why seaport smart service systems (SSSS) enable or constraint seaport services. It was revealed that the affordance seaport services such as security and container handling are improved by SSSS. Moreover, the researcher was able to study the consequences that accompany the use of SSSS using TACT as an analytical lens.

Further, TACT also aids the researcher in the data collection, analysis of the findings, and the discussion phases of the research. The constructs of TACT enabled the researcher to get data that solves the main research questions. It also provided insights on the analysis as it enabled the researcher to identify the relevant themes that will suit the purpose of the research.

In sum, TACT has been helpful as it aids the researcher to comprehend how users interact with technologies. As informed by TACT, technology can afford or constrain users from achieving their objectives. Therefore, TACT further explained what the users can use technology for and how it shapes their information and needs behaviour. It also revealed how technology can constrain or impede them from performing their tasks.

### 7.6 Chapter Summary

This chapter discussed findings from this study and the literature on smart service system deployment and use. The discussion gives insight into why a developing country seaport would deploy and use smart service systems. The discussions focused on the affordances and constraints of using the seaport smart service system. Finally, the consequences of using the seaport smart service system were discussed. The chapter ends with the reflection of the researcher on the use of technology affordances and constraints theory as the analytical lens for this study. The next chapter presents a summary and evaluation of this study, contribution to knowledge and final conclusion.

# CHAPTER EIGHT

# SUMMARY AND CONCLUSIONS

## 8.1 Introduction

The previous chapter presented the discussion of the findings from the literature review in chapter two and the case description in chapter five. The current chapter summarises the study based on the research purpose, research questions, contributions, limitations and recommendations. The next section gives a recap of the research purpose and research questions presented in Chapter One and how this study addressed them.

## 8.2 Review of Research Purpose and Research Questions

This study began with the purpose of understanding affordances and constraints of seaport smart service systems in a developing country. To address this purpose, the study set out to fill three research gaps identified in the literature. First, despite the increasing research on smart service systems, extant IS literature has focused more on conceptual papers (Geirbo, 2017; C. Lim & Maglio, 2018, 2019) and literature reviews of papers from other disciplines (Heilig & Voß, 2017). Therefore, there is a need to extend existing IS research beyond the focus of conceptualisations and literature reviews. One possible area to focus on is an in-depth empirical study using qualitative interpretive research.

Second, extant IS literature has focused on application areas such as smart health, smart building, smart government, smart grid, smart transportation, smart environment, smart home, and smart lifestyle (Caragliu et al., 2011; Pramanik et al., 2017). IS research on seaport smart security systems and smart container handling is yet to receive attention as a significant area of application.

Third, IS research on smart service systems has largely been conceptualisations and literature review without a theoretical foundation. A research gap, therefore, exists in in-depth and theory-driven studies to investigate smart service systems' use and effects in an organisational context. This study addresses this limitation by conducting an in-depth and theory-driven study using technology affordances and constraints theory (TACT) (Majchrzak & Markus, 2012) in a seaport environment. By addressing these gaps in extant literature, this research contributes to the body of knowledge in smart service systems using qualitative, interpretive case study methodology (Klein & Myers, 1999; Walsham, 1995, 2006) and Technology Affordances and Constraints Theory (Majchrzak & Markus, 2012) to achieve the purpose of this study.

The research questions that guided this study were:

a) Why would a developing country seaport deploy smart service systems for security and container handling?
b) How are the uses of smart service systems for developing country seaport enabled or constrained?
c) What are the consequences of using smart service systems in a developing country seaport?

These questions were addressed in the various chapters of the study.

Chapter Two reviewed existing IS literature on smart service systems and seaport. The review started with the broader subject of smart technologies within which smart service systems fall, then continued with the smart objects, features, and functions of smart service systems as well as the benefits and challenges of using smart service systems. The last part of the literature review focused on seaport systems.

Chapter Three presented technology affordances and constraints theory as the theoretical lens for the study. The chapter began with the theories that had been applied to information systems research. Thereafter, the chapter presented the purpose, background, justification, concepts, principles, application, and limitations of technology affordances and constraints theory.

Chapter Four discussed research methodologies and justified interpretive case study methodology as the choice for the study. The chapter's discussions covered interpretive paradigm, qualitative methodology, and case study methods. The chapter elaborated on the research process involving how the researcher gained access to field sites, collected, and analysed data. The chapter also presented the evaluation principles of interpretive studies and ethical considerations that guide research work.

Chapter Five presented the two cases of smart service systems in a seaport in Ghana, a smart security service system, and a smart container handling system. Each case description was constructed based on information on the historical background, the use of the smart service systems, challenges, and consequences.

Chapter Six presented within-case and cross-case analysis of the two cases using technology affordances and constraints theory. Each case description was analysed using the concepts and principles of the theory. The cross-case analysis examined the relationality, similarities, and differences with the smart security and container handling systems.

Chapter Seven addressed the research questions stated in the Chapter One with the discussion and interpretation of the findings from the study in relation to the IS literature on smart service systems presented in Chapter Two. The chapter also provided reflections on using technology affordances and constraints theory for the study. In Appendix B, a summary of the research findings and research questions is presented.

## 8.3 Contribution to Knowledge

In line with IS studies that follow the interpretive tradition, contribution to knowledge is based on four types of generalisation. These generalisations are development of concepts, generation of theory, specific implications, and rich insights drawn from the study (Walsham, 1995). Development of concepts refers to building new concepts in a domain. The generation of a theory is where the product of the research is a theory. However, the generation of a theory is not the only form of a theoretical contribution to knowledge. Alternative forms of theoretical contribution are theory extension and theory refinement (Snow, 2004). Theory extension is expanding existing theories to other groups, empirical contexts, or sociocultural domains (Snow, 2004). Theory extension also includes adding a new construct (Presthus & Munkvold, 2016) and challenging an existing point of view (Knopf, 2006). Theory refinement is modifying existing theories with new case material. This study's contribution to knowledge relates to extension and refinement of theory, specific implications, and rich insights. These are elaborated in the next subsections.

### 8.3.1 Contribution to Theory

The study contributes to TACT by distinguishing technology affordance from human affordance as well as introducing affordance-constraint process as a complement to affordance-actualisation process. In affordance conception, affordances are action possibilities that emerge from interactions between technologies and goal-oriented actor(s) or user(s) while constraints are hindrances that prevent actors from using the technology to achieve intended goals (Thapa & Sein, 2018; Markus & Silver, 2008a). There is lack of research attention on constraint process application to technology affordances and constraints theory. This study addressed two limitations of TACT in IS literature: a) smart service systems comprise smart technology, people, information working together. TACT considers human actors as affording or constraining and b) smart technology affordance helps us to understand that smart technology is an active participant in the affordance process and must be treated as human technology affordance as well.

In addition, the study questions the conceptualisation of actors as not only humans but also smart technologies, given that smart technologies are able to perform actions that are ascribed to only humans. By this, this study shows that in applying affordances and constraint theory in information systems, researchers need to acknowledge the performative role of technological artefacts as actors and not limit actors to only humans. The application of technology affordances and constraints theory in this innovative way is what the study considered a contribution to theory in IS studies (Myers, 1997; 2013).

### 8.3.2 Contribution to Research

For research, this study extends existing knowledge in smart service systems in two ways. First, the study provides an understanding of affordances, constraints and consequences of using seaport smart service systems in a developing country context. Second, this study has extended the literature from a limited focus on conceptualisations and literature reviews to theory-driven empirical studies on seaport smart security service and container handling service systems.

In line with extant IS research on smart technology (Bharadwaj et al., 2013; Matt et al., 2015), in organisations (Selander & Jarvenpaa, 2016), processes (Paulo et al., 2012), and culture (Karimi & Walter, 2015), new paths for value co-creation (Leijon et al., 2017). The key contributions of this thesis to smart service systems research are (a) the identification of affordances and constraint of smart service systems and (b) affordances and constraints are not only between people and technology but also between smart objects (c) the introduction of constraint process model as complementary to dominant affordance process model used in IS studies that use technology affordances and constraints theory.

Research on smart service systems has predominantly focussed on types of services (Gavrilova & Kokoulina, 2015) and service innovations (Geum et al., 2016) and mostly in the developed economies context. Finally, there is less focus on empirical and in-depth IS study on affordances and constraints of smart service systems in seaports. This study addresses these gaps.

#### 8.3.3 Implication for Practice

From the findings, smart service systems have capabilities to improve seaport security and container handling services. Notwithstanding these positive outcomes, such capabilities can be constrained by lack of adequate data storage capacity, equipment breakdowns due to harsh seaport environment, power and internet disruptions. Based on these research findings, this study contributes to practice by offering four implications.

First, on the issue of inadequate data storage capacity, seaport management can resort to cloud services to address the challenge. In the case of Tema Port, inadequate data storage capacity caused deletion of historical data to make space for new dada. Data is deleted to accommodate newly captured data in the form of audio, video, image and text. Cloud computing has been identified as a solution for storing and processing voluminous data in smart system environment (Ismagilova et al., 2019a; Singh et al., 2020).

Second, to address the problems of harsh seaport environment and machine breakdowns, port management can procure robust smart technology artefacts. Management can also establish and enforce continuous risks assessment and preventive maintenance practices to identify potential faulty components before they breakdown.

Third, problems of power outages and internet instability are worth addressing by management. Constant and reliable supply of electricity and internet will ensure effective and efficient smart service system operations. With electricity, management of seaports in developing countries that deploy smart service systems can in addition to the national grid use standby independent power supply. Port authorities can also provide smart generators that automatically switch on when the national grid goes off.

Finally, with the problem of internet outages, port authorities can provide multiple internet services from providers so that when one service is off, another can take over automatically. On that base, the payment agreement should not be fixed fees but per usage.

### 8.4 Evaluation of Research

This section presents the study's evaluation based on the widely adopted Klein and Myers (1999a)'s seven criteria on how to conduct and evaluate case studies in IS interpretive research. The criteria for evaluation outlined in Chapter Four are (a) hermeneutic circle, (b) contextualisation, (c) interactions between the researcher and the participants, (d) abstraction and generalisation, (e) dialogical reasoning, (f) multiple interpretations, and (g) suspicion. The section also evaluates the study through the lens of ethical standards for IS interpretive studies outlined in Chapter Four. Table 8.1 gives a summary of the evaluation of this study using the principles of interpretive studies.

Table 8. 1: Summary of Evaluation of this Study Using Interpretive Principles

| Principles | Application in this study |
|---|---|
| **Hermeneutic circle*:*** Human understanding of a text or phenomenon is gained by constantly iterating between the parts and the whole in a circular fashion. | The hermeneutic circle was applied at two stages of the study. In the first stage, the hermeneutic circle principle was used to construct the case descriptions, while the second stage was used to analyse the case descriptions. In the first stage regarding the construction of the case description, the "whole" referred to an overview of the two cases, and the main headers for each case. The "parts" were derived from the general notions of processes, actions, activities, and contexts associated with implementing and using IS. Details of how the two case descriptions were constructed using these "whole-parts" mechanisms are provided in Chapter 4. For the application of the principle at the second stage, the "parts" were derived from technology affordances and constraints concepts and principles helped to understand the phenomenon. |
| **Contextualization** Reality is understood in context, which is the historical and social context of the study's phenomenon. | This principle which is related to the first principle of the hermeneutic circle was applied to data collection and construction of the case descriptions. The principle was applied to data collection by eliciting information on the social, political, and historical background of the seaport smart service systems usage from interview participants and documentary sources. In the construction of the case descriptions, information about the context within which actions were taken was included as the "parts". This has been reflected in the case descriptions presented, where the two cases from manual systems to the smart system environments. |

| Principles | Application in this study |
|---|---|
| | Contextualization helped to understand smart service systems as part of an ongoing accomplishment over the years. Finally, smart service systems in Ghana presented in Section 1.3 of Chapter One and the case in Chapter Five provided the domain and country contexts for the study. |
| **Interaction between the researcher and the participants**<br>It requires the researcher to critically reflect on how data are socially constructed through interactions with interview participants. | In this study, interactions with the participants occurred throughout the research process, starting with face-to-face interviews, follow-ups through email and phone calls, feedback on the transcribed interview, and the initially constructed case descriptions. Documents were consulted for background information and to fill in the gaps of participant's narratives as indicated in Section 4.7 of Chapter four. |
| **Abstraction and Generalisation**<br>The use of theoretical concepts to understand social action and abstraction to generalize to other similar settings | In this study, the theoretical concepts of technology affordances and constraints were used to construct the case analysis in Chapter Six. The theoretical accounts helped to understand how smart service systems are enacted or can be enacted using the theoretical concepts, which helps to generalize to other similar settings. For instance, in this study, smart security and smart container handling were conceptualized as smart service systems. Finally, implications for research, theory and practice were generated by abstracting the study's findings. The abstracted findings provide the basis for generalizing to other similar settings. |
| **Dialogical Reasoning**<br>Dealing with possible contradictions between the theoretical conceptions and actual findings. | In this study, initially, the researcher used his prior knowledge regarding the life-cycle of ISs to construct the case descriptions. Reflectively, the researcher realized this was shaping participant's submissions rather than allowing their interpretations to inform case description and analysis. Subsequently, the researcher discarded the life cycle form of the account and applied the hermeneutic circle to the data sources to construct and interpret the case descriptions. In addition, the principle of dialogical reasoning allowed the researcher to reflexively go back and forth between theoretical accounts to the case description, interview scripts, and document sources. |
| **Multiple Interpretation**<br>Considers the possible different viewpoints of the phenomenon. | In line with this principle, the study used interviews complemented by documentary sources to access multiple interpretations of the phenomenon. The interview participants were drawn from varied backgrounds based on snowball and purposive sampling. Construction of the case descriptions also included multiple perspectives. For instance, in the smart security service case (in |

| Principles | Application in this study |
|---|---|
| | Chapter Six), views of security personnel, truck drivers and other port users were obtained. |

Source: Author's construct

### 8.5 Evaluation of Ethical Considerations

Ethical procedures exist to protect the researcher, participants, and the University's reputation (Myers, 2013). Undergirding these procedures are the principles of honesty, plagiarism, informed-- consent, and permission to publish (Myers, 2013) as well as confidentiality and anonymity (Walsham, 2006). These principles guided this study, starting with a letter of introduction and proposal to the case organisation to conduct the study.

The content of the letter and proposal reflected the University's ethical guidelines which were followed. Table 8.2 shows the key ethical standards and how they were followed in this study.

Table 8. 2: Summary of Evaluation of this Study Using Ethical Standards.

| Ethical Standard | Application in the study |
|---|---|
| 1. Ensuring confidentiality and anonymity | Confidentiality and anonymity were followed in this study by using participants' positions and not names. Where a participant's quotation was considered by the researcher to be sensitive or controversial, a general designation such as "an IT officer" was used. |
| 2. Participants signed off a form to indicate their willingness to participate in the study. | Participants were informed formally through the case organisation's head or delegate (Section 4.6 of Chapter Four) on gaining access for fieldwork. |
| 3. Permission to tape-record the interview. | Participants were asked for permission to tape-record interviews. Not all participants accepted to be recorded. In such cases, the researcher depended on notes-taking. |

| Ethical Standard | Application in the study |
|---|---|
| | |
| 4. Each participant is given the chance to confirm the accuracy of his or her interview transcript before and after the final write up. | Transcribed interviews were sent to participants to confirm the accuracy of the recordings. Initial drafts of case descriptions were also sent. Many of the participants did not give feedback, though. |
| 5. Protecting and using the information gathered solely for academic purpose. | All information gathered from participants for this study has been used solely for academic purposes. |
| 6. The case organisation will have a final look at the final report before publication | This is one key ethical dilemmas highlighted in the IS literature for which no straight forward answers exist (Walsham, 2006). The researcher sent drafts of the case description to participants to build trust in the respondents and to maintain continued access. However, due to the poor response in receiving feedback from respondents the researcher abandoned the process. |
| 7. Plagiarism | This ethical requirement was not included under ethical standards in the proposal to the case organisations, but it is included here because it is a fundamental ethical requirement of the university. The researcher used the university's plagiarism software, Turnitin to check the thesis' level of compliance. |

Source: Author's construct

### 8.6 Limitations of the Research

While considerable efforts were made to ensure the quality of this study, findings could be affected by a couple of limitations. First, this study's findings are no based on statistical generalisation but on theoretical generalisation. This is considered a limitation because the findings emerged from application of a specific theory (Yin, 2013). Often, statistical generalisations perceived as the only form of generalisation. Theoretical generalization implies making reference from a population sample and applying the findings to the aggregate. This is referred to as level 1 inference as described by Yin (2013).

In case studies, generalising involves a level 2 inference (Yin, 2013) which uses theory to generalise findings. In case studies like as this, the insights provided are generalisable in terms of theory from the aggregated description (Lee & Baskerville, 2013). In making a theoretical generalisation, this study is confined by the technology affordances and constraints theory applied in the analysis. This study examined seaport smart systems using technology affordances and constraints theory. Although this is assumed to be the best to explain the phenomenon, other viable options exist. As an example, this study could have used process theories used in organisational transformation research like actor-network theory (Latour, 1987; Law, 1987). This could have generated alternative insights.

Second, the study is limited by its two embedded case study in one seaport in a developing country. Seaports in developing countries have different systems and may use different kinds of smart technologies, and processes. However, generalisation under qualitative interpretive approaches follows theoretical generalisation and not logic (Myers, 2013). Therefore, the number of cases involved is not important when generalising from theory.  That is because of the possibility of generalising from a single case study (Walsham, 1995). Therefore, the study can be generalised to other developing countries that have similar settings as this is in line with interpretive studies.

Third, because empirical studies are retrospective, interpretations can be affected. Although such a limitation is a serious one, the researcher addressed it by using multiple sources of data collection and participants and supported the interpretations through documents when possible. With these limitations, the study proposed recommendations for further research into this emerging and important phenomenon.

## 8.7 Recommendations for Future Research

Though the study has offered rich insights, provided implications for research, theory, and practice, there are some limitations to the study. These limitations can, however, be a direction for further research by researchers and practitioners in the IS and other related disciplines. The limitations of the study presented in the previous section offer three main future research directions. First, regarding the limitation of the study's findings to one country, future research can explore other developing countries to establish similarities and differences.

In addition, future studies can also investigate seaport smart service systems in developed countries. Along the same lines, future research could also investigate the phenomenon using other theoretical lenses such as boundary object theory.

# REFERENCES

Abdel-Fattah, M. A. K., & Galal-Edeen, G. H. (2009). Why an interpretive paradigm is needed for evaluating e-government systems? *Proceedings of the European Conference on E-Government, ECEG*, *October*, 1–10.

Abhari, K., Davidson, E. J., & Xiao, B. (2017). Co-innovation platform affordances: Developing a conceptual model and measurement instrument. *Industrial Management and Data Systems*, *117*(5), 873–895.

Acciaro, M., & McKinnon, A. (2015). *Efficient hinterland transport infrastructure and services for large container ports*.

Acciaro, M., Renken, K., & Khadiri, N. El. (2020). *Technological Change and Logistics Development in European Ports*. Springer International Publishing.

Adam, I. O. (2014). The Ontological , Epistemological and Methodological Debates in Information Systems Research : A Partial Review. *Social Science Research Network*.

Adart, A., Mouncif, H., & Naïmi, M. (2017). Vehicular ad-hoc network application for urban traffic management based on markov chains. *International Arab Journal of Information Technology*, *14*(4A Special Issue), 624–631.

Alam, I., Khusro, S., & Naeem, M. (2018). A review of smart TV: Past, present, and future. *ICOSST 2017 - 2017 International Conference on Open Source Systems and Technologies, Proceedings*, *2018-Janua*(6), 35–41.

Alavi, M., & Carlson, P. (1992). A review of mis research and disciplinary development. *Journal of Management Information Systems*, *11*(4), 45–62.

Aliaga, M., & Gunderson, B. (2002). Interactive statistics. *America: Pearson Education*.

Allmendinger, G., & Lombreglia, R. (2005). Four strategies for the age of smart services. *Harvard Business Review*, *83*(10).

Anderson, C., & Robey, D. (2017). Affordance potency: Explaining the actualization of technology affordances. *Information and Organization*, *27*(2), 100–115.

Anthopoulos, L. G. (2015). Understanding the smart city domain: A literature review. In *Transforming city governments for successful smart cities* (pp. 9–21). Springer.

Attia, T. M. (2016). Importance of communication and information technology and its applications in the development and integration of performance in seaports. *Renewable Energy and Sustainable Development*, *2*(2), 137–146.

Atzori, L., Iera, A., Morabito, G., & Nitti, M. (2012). The social internet of things (SIoT) - When social networks meet the internet of things: Concept, architecture and network characterization. *Computer Networks*, *56*(16), 3594–3608.

Avison, D. E., Davison, R. M., & Malaurent, J. (2018). Information systems action research: Debunking myths and overcoming barriers. *Information and Management*, *55*(2), 177–187.

Avison, D., Lau, F., Myers, M., & Nielsen, P. A. (2013). Action research. *Qualitative Research in the Health Sciences: Methodologies, Methods and Processes*, 153–161.

Awa Uduma, I., & Sylva, W. (2015). A Critique of the Adequacy of Positivist and Interpretivist Views of Organisational Studies for Understanding the 21st Century Organisation(s). *International Journal of Business and Management Review*, *3*(8), 44–52.

Badinelli, R. (2010). A Stochastic Model of Resource Allocation for Service Systems. *Service Science*, *2*(1–2), 76–91.

Bagchi, P. K., & Paik, S. K. (2001). The role of public-private partnership in port information systems development. *International Journal of Public Sector Management*, *14*(6–7), 482–499.

Baheti, R., & Gill, H. (2011). Cyber-physical systems. *The Impact of Control Technology*, *12*(1), 161–166.

Bardaki, C., Kourouthanassis, P., Pramatari, K., & Doukidis, G. I. (2013). An Information Quality Evaluation Framework of Object Tracking Systems. *Thirty Fourth International Conference on Information Systems*, *1*, 1–21.

Barile, S., & Polese, F. (2010). Smart service systems and viable service systems: Applying systems theory to service science. *Service Science*, *2*(1–2), 21–40.

Barletta, G. L., & Bichou, K. (2013). Planning and implementing RFID technologies to enhance security in port operations. In *Risk Management in Port Operations, Logistics and Supply Chain Security* (pp. 97–116). Informa Law from Routledge.

Baron, M., & Mathieu, H. (2013). *PCS interoperability in Europe : a market for PCS operators ? 24*(1), 117–129.

Baskerville, R., & Wood-Harper, A. T. (1998). Diversity in information systems action research methods. *European Journal of Information Systems*, *7*(2), 90–107.

Becker, J., & Niehaves, B. (2007). Epistemological perspectives on IS research: A framework for analysing and systematizing epistemological assumptions. *Information Systems Journal*, *17*(2), 197–214.

Belfkih, A., Duvallet, C., & Sadeg, B. (2017). The Internet Of Things For Smart Ports Application To The Port Of Le Havre. *Proceedings of IPaSPort 2017, May*.

Bemgal, S. (2018). Technology Materiality and Individual. *Twenty-Fourth Americas Conference on Information Systems, New Orleans, 2018*, *1990*, 1–9.

Benbasat, I., Goldstein, D. K., & Mead, M. (1987). Strategy in Studies of. *MIS Quarterly*, *11*(3), 369–386.

Benbunan-fich, R. (2019). An affordance lens for wearable information systems. *European Journal of Information Systems*, *28*(3), 256–271.

Bergmann, G., Carnap, R., Feigl, H., Frank, P., Menger, K., & Schlick, M. (2008). Positivist Paradigm. *Sixteenth Americas Conference on Information Systems Lima*, *2*(Pat 2), 45523.

Bernhard, E., Recker, J., & Burton-Jones, A. (2013). Understanding the Actualization of Affordances: A Study in the Process Modelling Context. *Thirty Fourth International Conference on Information Systems*.

Beverungen, D., Breidbach, C. F., Poeppelbuss, J., & Tuunainen, V. K. (2019). Smart service systems: An interdisciplinary perspective. *Information Systems Journal*, *29*(6), 1201–1206.

Beverungen, D., Matzner, M., & Janiesch, C. (2017). Information systems for smart services. *Information Systems and E-Business Management*, *15*(4), 781–787.

Beverungen, D., Müller, O., Matzner, M., & Brocke, J. (2019). Conceptualizing smart service systems. *Electronic Markets*, 7–18.

Bharadwaj, A., Sawy, O. A. El, Pavlou, P. A., & Venkatraman, N. (2013). Digital Businesss Trategy : Toward A Next Generation Of Insights. *MIS Quarterly*. *Special Issue on Digital Business Strategy*, *37*(2), 471–482.

Bhattacherjee, A. (2012). Social science research: principles, methods, and practices. In *USF Tampa Library Open Access Collections*.

Bibri, S. E., & Krogstie, J. (2017). Smart sustainable cities of the future: An extensive interdisciplinary literature review. *Sustainable Cities and Society*, *31*, 183–212.

Bichou, K., & Gray, R. (2005). A critical review of conventional terminology for classifying seaports. *Transportation Research Part A: Policy and Practice*, *39*(1), 75–92.

Bierwirth, C., & Meisel, F. (2010). A survey of berth allocation and quay crane scheduling problems in container terminals. *European Journal of Operational Research*, *202*(3), 615–627.

Birks, D. F., Fernandez, W., Levina, N., & Nasirin, S. (2013). Grounded theory method in information systems research: Its nature, diversity and opportunities. *European Journal of Information Systems*, *22*(1), 1–8.

Blaikie, N. W. H. (2000). *Designing social research: the logic of anticipation/Norman Blaikie. Malden, MA*. Polity Press.

Bloomfield, B. P., Latham, Y., & Vurdubakis, T. (2010). Bodies, technologies and action possibilities: When is an affordance? *Sociology*, *44*(3), 415–433.

Böse, J. W. (2011). *Handbook of terminal planning* (Vol. 49). Springer Science & Business Media.

Boukhris, A., & Fritzsche, A. (2019). What is smart about services? Breaking the bond between the smart product and the service. *Proceedings of the 27th European Conference on Information Systems (ECIS),*.

Boyatzis, R. E. (1998). *Transforming qualitative information: Thematic analysis and code development*. sage.

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. Qualitative research in psychology. *Qualitative Research in Psychology*, *3*(2), 77–101.

Brown, A. (2014). The place of ethnographic methods in information systems research. *International Journal of Multiple Research Approaches*, *8*(2), 166–178.

Bunniss, S., & Kelly, D. R. (2010). Research paradigms in medical education research. *Medical Education*, *44*(4), 358–366.

Burchardt, P., Synowiec, T., Jerzykowska, S., Angerer, D., & Zurawski, J. (1994). Early renal dysfunction after iodine contrast administration: New insight into the actual problem. *European Journal of Information Systems*, *3*(2), 233–234.

Burrell, G, & Morgan, G. (1979). *Sociological paradigms and organisational analysis*.

Burrell, Gibson, & Morgan, G. (1979). Two dimensions: Four paradigms. *Sociological Paradigms and Organizational Analysis*, 21–37.

Burrell, Gibson, & Morgan, G. (1994). Sociological paradigms and organisational analysis: In *Heinemann*.

Burton-Jones, A., & Volkoff, O. (2017). How can we develop contextualized theories of effective use? A demonstration in the context of community-care electronic health records. *Information Systems Research*, *28*(3), 468–489.

Cai, X., & Li, Z. (2014). Regional smart grid of island in China with multifold renewable energy. *2014 International Power Electronics Conference, IPEC-Hiroshima - ECCE Asia 2014*, 1842–1848.

Capdevila, I., & Zarlenga, M. I. (2015). Smart City or Smart Citizens? The Barcelona Case. *Journal of Strategy and Management*, *AUGUST*, 1–16.

Caragliu, A., del Bo, C., & Nijkamp, P. (2011). Smart cities in Europe. *Journal of Urban Technology*, *18*(2), 65–82.

Carlan, V., Sys, C., & Vanelslander, T. (2015). Port Community Systems costs and benefits : from competition to collaboration within the supply chain. *WCTRS-SIG2*.

Carlile, P. R. (2002). A pragmatic view of knowledge and boundaries: Boundary objects in new product development. *Organization Science*, *13*(4), 442–455.

Cavaye, A. L. M. (1996). Case study research: a multi-faceted research approach for IS. *Information Systems Journal*, *6*(3), 227–242.

Cecez-Kecmanovic, D. (2011). On methods, methodologies and how they matter. *19th European Conference on Information Systems - ICT and Sustainable Service Development, ECIS 2011*, 12.

Cecez-Kecmanovic, Dubravka. (2005). Basic assumptions of the critical research perspectives in information systems. In *Handbook of critical information systems research: Theory and application* (pp. 19–46). Edward Elgar.

Cecez-Kecmanovic, Dubravka. (2011). On methods, methodologies and how they matter. *19th European Conference on Information Systems, ECIS 2011*, 233.

Cecez-Kecmanovic, Dubravka, Klein, H. K., & Brooke, C. (2008). Exploring the critical

agenda in information systems research. *Information Systems Journal*, *18*(2), 123–135.
Chan, Y. E., & Sadreddin, A. (2019). Technology Affordances in Digital Innovation Research : Quo Vadis ? *Twenty-Fifth Americas Conference on Information Systems*, 1–10.
Charmaz, K., & Liska, L. (2015). Grounded Theory. In *The Blackwell Encyclopedia ofSociology*.
Chatterjee, S., Khas, H., Kar, A. K., & Khas, H. (2015). Smart Cities in Developing Economies: A Literature Review and Policy Insights. *Ieee*, 2335–2340.
Chauhan, S., Agarwal, N., & Kar, A. K. (2016). *Addressing big data challenges in smart cities: a systematic literature review*. (pp. 73–90).
Chen, B. X. (2011). *Always on: how the iPhone unlocked the anything-anytime-anywhere future--and locked us in*. Da Capo Press, Incorporated.
Chen, J., Guo, Y., Su, C., Chen, J., & Chang, S. (2015). A Smart City System Architecture based on City-level Data Exchange Platform. *Journal of Information Technology Research*, *8*(4), 1–25.
Chen, W., & Hirschheim, R. (2004). A paradigmatic and methodological examination of information systems research from 1991 to 2001. *Information Systems Journal*, *14*(3), 197–235.
Chetty, S. (1996). The case study method for research in small-and medium-sized firms. *International Small Business Journal*, *15*(1), 73–85.
Chiehyeon, L., & Maglio, P. P. (2019). Clarifying the Concept of Smart Service System. In P. P. Maglio, C. A. Kieliszewski, J. C. Spohrer, K. Lyons, L. Patrício, & Y. Sawatani (Eds.), *Handbook on Service Science* (pp. 349–376). Springer.
Choi, H. R., & Park, N. K. (2006). An automated gate system based on RFID technology. *10th WSEAS International Conference on SYSTEMS, Vouliagmeni, Athens, Greece, July 10-12, 2006 (Pp251-257), February 2015*.
Chua, W. F. (1986). Radical developments in accounting thought. *Accounting Review*, 601–632.
Cimino, M. G. C. A., Palumbo, F., Vaglini, G., Ferro, E., Celandroni, N., & La Rosa, D. (2017). Evaluating the impact of smart technologies on harbor's logistics via BPMN modeling and simulation. *Information Technology and Management*, *18*(3), 223–239.
Ciriello, R. F., Richter, A., & Schwabe, G. (2018). Digital Innovation. *Business & Information Systems Engineering*, *60*(6), 563–569.
Cocchia, A. (2014). Smart and digital city: A systematic literature review. In *Smart city* (pp. 13–43). Springer.
Coghlan, D. (2000). Interlevel dynamics in clinical inquiry. *Journal of Organizational Change Management*, *13*(2), 190–200.
Corbin, J. M., & Strauss, A. (1990). Grounded theory research: Procedures, canons, and evaluative criteria. *Qualitative Sociology*, *13*(1), 3–21.
Creswell, J. W. (2013). *Steps in conducting a scholarly mixed methods study*.
Creswell, J. W. (2014). Research Design. *Sage*, 183–190.
Croni, C. (2014). Using case study research as a rigorous form of inquiry. *Nurse Researcher*, *21*(5), 19–27.
Crotty, M. (1998). *The foundations of social research: Meaning and perspective in the research process*. Sage.
Crowe, S., Cresswell, K., Robertson, A., Huby, G., Avery, A., & Sheikh, A. (2011). The case study approach. *BMC Medical Research Methodology*, *11*, 1–15.
Cu, T., Lamacchia, C., & Nguyen, T. (2017). The internet of things: Can a tree talk to you? *AMCIS 2017 - America's Conference on Information Systems: A Tradition of Innovation*, *2017-Augus*, 1–5.
Davern, M., Shaft, T., & Te'eni, D. (2012). Cognition matters: Enduring questions in cognitive

IS research. *Journal of the Association for Information Systems*, *13*(4), 1.
Davison, R. M., Martinsons, M. G., & Kock, N. (2004). Principles of canonical action research. *Information Systems Journal*, *14*(1), 65–86.
Demirkan, H. (2015). Innovations with Smart Service Systems: Analytics, Big Data, Cognitive Assistance, and the Internet of Everything. *Communications of the Association for Information Systems*, *37*(35).
Demirkan, H., Kauffman, R. J., Vayghan, J. A., Fill, H. G., Karagiannis, D., & Maglio, P. P. (2008). Service-oriented technology and management: Perspectives on research and practice for the coming decade. *Electronic Commerce Research and Applications*, *7*(4), 356–376.
DeSanctis, G., & Poole, M. S. (1994). Capturing the Complexity in Advanced Technology Use: Adaptive Structuration Theory. *Organization Science*, *5*(2), 121–147.
Dimitrakopoulos, G., & Demestichas, P. (2010). Intelligent transportation systems: Systems based on cognitive networking principles and management functionality. *IEEE Vehicular Technology Magazine*, *5*(1), 77–84.
Dong, X., & Wang, T. (2018). Social tie formation in Chinese online social commerce: The role of IT affordances. *International Journal of Information Management*, *42*(April 2017), 49–64.
Dontharaju, S., Tung, S., Hoare, R. R., Cain, J. T., Mickle, M. H., & Jones, A. K. (2008). Design automation for RFID tags and systems. *RFID Handbook: Applications, Technology, Security, and Privacy, Ed. S. Ahson and M. Ilyas*, 35–64.
Doub, A. E., Small, M. L., Levin, A., LeVangie, K., & Brick, T. R. (2016). Identifying users of traditional and Internet-based resources for meal ideas: An association rule learning approach. *Appetite*, *103*, 128–136.
Du, W. (Derek), Pan, S. L., Leidner, D. E., & Ying, W. (2019). Affordances, experimentation and actualization of FinTech: A blockchain implementation study. *Journal of Strategic Information Systems*, *28*(1), 50–65.
Dubé, L., & Paré, G. (2003). Rigor in Information Systems Positivist Case Research: Current Practices, Trends, and Recommendations. *MIS Quarterly*, *27*(4), 567–594.
Dubé, L., & Paré, G. (2011). Rigor in Information Systems Positivist Case Research: Current Practices, Trends, and Recommendations. *MIS Quarterly*, *27*(4), 597–636.
Dwarakish, G. S., & Salim, A. M. (2015). Review on the Role of Ports in the Development of a Nation. *Aquatic Procedia*, *4*, 295–301.
Eisenhardt, K. M. (1989). Building theories from case study research. *Academy of Management Review*, *14*(4), 532–550.
Elovic, P. (2003). Implementation of gate and crane OCR systems for container terminal automation and security. *Proceedings of Terminal Operations Conference ASIA (TOC ASIA 2003)*, 1–7.
Elwood, S. A. (2010). Embedding ubiquitous technologies. In *Ubiquitous and pervasive computing: Concepts, methodologies, tools, and applications* (pp. 511–519). IGI Global.
Faraj, S., & Azad, B. (2012). The materiality of technology: An affordance perspective. *Materiality and Organizing: Social Interaction in a Technological World*, *237*, 258.
Feldman, M. S., & Orlikowski, W. J. (2011). Theorizing practice and practicing theory. *Organization Science*, *22*(5), 1240–1253.
Fernández, P., Santana, J. M., Ortega, S., & Trujillo, A. (2016). *SmartPort : A Platform for Sensor Data Monitoring in a Seaport Based on FIWARE*. 1–24.
Fetterman, D. M. (2019). *Ethnography: Step-by-step* (Vol. 17). SAGE Publications, Incorporated.
Finkenzeller, K. (2010). Fundamentals and applications in contactless smart cards. In *Radio Frequency Identification and Near-Field Communication*,.

Fiss, P. C. (2011). Building better causal theories: A fuzzy set approach to typologies in organization research. *Academy of Management Journal*, *54*(2), 393–420.
Fortino, G., Guerrieri, A., & Russo, W. (2012). Agent-oriented smart objects development. *Proceedings of the 2012 IEEE 16th International Conference on Computer Supported Cooperative Work in Design, CSCWD 2012*, 907–912.
Fox, C., & Miller, H. (1998). Positivism. *International Encyclopedia of Public Policy and Ddministration*, 1718–1723.
Frels, J. K., Shervani, T., & Srivastava, R. K. (2003). The integrated networks model: Explaining resource allocations in network markets. *Journal of Marketing*, *67*(1), 29–45.
G. (1993). Interpreting Information Systems in Organizations. *European Journal of Information Systems*.
Galliers, R. (1992). *Information Systems Research: Issues, Methods and Practical Guidelines.* Blackwell Publishing, Oxford.
Gallivan, M. J., & Benbunan-Fich, R. (2005). A framework for analyzing levels of analysis issues in studies of e-collaboration. *IEEE Transactions on Professional Communication*, *48*(1), 87–104.
Garstone, S. (1995). Electronic data interchange (EDI) in port operations. *Logistics Information Management*, *8*(2), 30–33.
Gaver, W. W. (1991). Technology affordances. *Conference on Human Factors in Computing Systems - Proceedings*, *May*, 79–84.
Gavrilova, T., & Kokoulina, L. (2015). Smart Services Classification Framework. *Position Papers of the 2015 Federated Conference on Computer Science and Information Systems*, *6*(December 2016), 203–207.
Geirbo, H. C. (2017). Smart environments?: Reflections on the role of metaphors in IS. *Scandinavian Journal of Information Systems*, *29*(2), 85–92.
Geum, Y., Jeon, H., & Lee, H. (2016). Developing new smart services using integrated morphological analysis: integration of the market-pull and technology-push approach. *Service Business*, *10*(3), 531–555.
Ghana National Chamber Of Commerce & Industry. (2017). *Situational Analyses Of Tema And Takoradi Seaports And Kotoka* (Issue May, pp. 1–51).
Gibson, J. (1986). *The Ecological Approach to Visual Perception*. Lawrence Erlbaum Associates.
Gibson, J. J. (1977). The theory of affordances. *Hilldale, USA*, *1*(2).
Gibson, J. J. (1979). *The theory of affordances. The ecological approach to visual perception*. Houghton Mifflin Boston, MA.
Giuliano, G., & O'Brien, T. (2007). Reducing port-related truck emissions: The terminal gate appointment system at the Ports of Los Angeles and Long Beach. *Transportation Research Part D: Transport and Environment*, *12*(7), 460–473.
Glaser, B. G., & Strauss, A. L. (1967). The discovery of grounded theory: Strategies for qualitative research. Piscataway. *NJ: Transaction*.
Gobo, G. (2008). Ethnographic interviewing. *Doing Ethnography. London: Sage*, 190–201.
Goccia, M., Bruzzo, M., Scagliola, C., & Dellepiane, S. (2003). Recognition of container code characters through gray-level feature extraction and gradient-based classifier optimization. *Proceedings of the International Conference on Document Analysis and Recognition, ICDAR*, *2003-Janua*(September), 973–977.
Goldkuhl, G. (2012). Pragmatism vs interpretivism in qualitative information systems research. *European Journal of Information Systems*, *21*(2), 135–146.
Gordon, S., & Blake, R. (2013). Case-based research in information systems: Gaps and trends. *Journal of Information Technology Theory and Application*, *14*(2), 47–68.
Goulding, C. (1998). Grounded theory: the missing methodology on the interpretivist agenda.

*Qualitative Market Research: An International Journal*, *1*(1), 50–57.
Green, J., Willis, K., Hughes, E., Small, R., Welch, N., Gibbs, L., & Daly, J. (2007). Generating best evidence from qualitative research: The role of data analysis. *Australian and New Zealand Journal of Public Health*, *31*(6), 545–550.
Greeno, J. G. (1994). Gibson ' s Affordances. *Psychological Review*, *101*(2), 336–342.
Gregg, D. G., Kulkarni, U. R., & Vinze, A. S. (2001). Understanding the Philosophical Underpinnings of Software Engineering Research in Information Systems. *Information Systems Frontiers*, *3*(2), 169–183.
Gregory, R. W. (2010). Design science research and the grounded theory method: Characteristics, differences, and complementary uses. *18th European Conference on Information Systems, ECIS 2010*.
Gretzel, U. (2011). Intelligent systems in tourism. A Social Science Perspective. *Annals of Tourism Research*, *38*(3), 757–779.
Gretzel, U., Werthner, H., Koo, C., & Lamsfus, C. (2015). Conceptual foundations for understanding smart tourism ecosystems. *Computers in Human Behavior*, *50*, 558–563.
Grix, J. (2002). Introducing Students to the Generic Terminology of Social Research. *Politics*, *22*(3), 175–186.
Guba, E G, & Lincoln, Y. S. (1994). *Competing paradigms in qualitative research.*
Guba, Egon G, & Lincoln, Y. S. (1994a). Competing paradigms in qualitative research. *Handbook of Qualitative Research*, *2*(163–194), 105.
Guba, Egon G, & Lincoln, Y. S. (1994b). Competing paradigms in qualitative research. *Handbook of Qualitative Research*, *2*(163–194), 105.
Guba, Egon G, & Lincoln, Y. S. (2001). *Guidelines and checklist for constructivist (aka fourth generation) evaluation*.
Gubbi, J., Buyya, R., Marusic, S., & Palaniswami, M. (2013). Internet of Things (IoT): A vision, architectural elements, and future directions. *Future Generation Computer Systems*, *29*(7), 1645–1660.
Gulati, R. (1998). Alliances and networks. *Strategic Management Journal*, *19*(4), 293–317.
Hafezieh, N., & Eshraghian, F. (2017). Affordance theory in social media research: systematic review and synthesis of the literature. *Twenty-Fifth European Conference on Information Systems (ECIS)*, 3155–3166.
Hakam, M. H., & Solvang, W. D. (2012). RFID Communication in Container Ports. *2012 IEEE 3rd International Conference on Cognitive Infocommunications (CogInfoCom)*, 351–358.
Håkansson, H., & Östberg, C. (1975). Industrial marketing: An organizational problem? *Industrial Marketing Management*, *4*(2–3), 113–123.
Halaweh, M. (2012). Integration of grounded theory and case study: an exemplary application from e-commerce security perception research. *Journal of Information Technology Theory and Application*, *13*(1), 31–50.
Halcom, E. J., & Halcomb, L. (2015). Mixed methods research. *Faculty of Science, Medicine and Health - Papers*, *21*(2), 69–73.
Harvey, L. J., & Myers, M. D. (1995). Scholarship and practice: the contribution of ethnographic research methods to bridging the gap. *Information Technology & People*.
Heaver, T. D. (2002). The evolving roles of shipping lines in international logistics. *International Journal of Maritime Economics*, *4*(3), 210–230.
Heilig, L., Lalla-Ruiz, E., & Voß, S. (2017a). Digital transformation in maritime ports: analysis and a game theoretic framework. *NETNOMICS: Economic Research and Electronic Networking*, *18*(2–3), 227–254.
Heilig, L., Lalla-Ruiz, E., & Voß, S. (2017b). Digital transformation in maritime ports: analysis and a game theoretic framework. *NETNOMICS: Economic Research and Electronic Networking*, *18*(2–3), 227–254.

Heilig, L., Schwarze, S., & Voß, S. (2017a). An analysis of digital transformation in the history and future of modern ports. *International Conference on System Sciences HICSS, (Pp. 1341–1350). Http://Hdl.Handle.Net/10125/41313. In Proceedings of the 50th Hawaii*.

Heilig, L., Schwarze, S., & Voß, S. (2017b). An Analysis of Digital Transformation in the History and Future of Modern Ports. *HICSS 2017 Proceedings*, 1341–1350.

Heilig, L., & Voss, S. (2016). *A holistic framework for security and privacy management in cloud-based smart ports*. *January*.

Heilig, L., & Voß, S. (2017). Information systems in seaports: a categorization and overview. *Information Technology and Management*, *18*(3), 179–201.

Heilig, L., & Voß, S. (2014). A cloud-based SOA for enhancing information exchange and decision support in ITT operations. *International Conference on Computational Logistics*, 112–131.

Hervás-Peralta, M., Poveda-Reyes, S., Molero, G. D., Santarremigia, F. E., & Pastor-Ferrando, J. P. (2019). Improving the performance of dry and maritime ports by increasing knowledge about the most relevant functionalities of the Terminal Operating System (TOS). *Sustainability (Switzerland)*, *11*(6).

Hill, C. A., & Scudder, G. D. (2002). The use of electronic data interchange for supply chain coordination in the food industry. *Journal of Operations Management*, *20*(4), 375–387.

Himmelreich, J. (2013). Good Urban Governance and Smart Technologies: A German City as a Best Practice Case of E-Government. In *Emerging Dimensions of Technology Management* (pp. 55–61).

Hirschheim, R. (1992). Information Systems Epistemology: An Historical Perspective. *Information Systems Research: Issues, Methods and Practical Guidelines*, 28–60.

Hlali, A., & Hammami, S. (2017). Seaport Concept and Services Characteristics: Theoretical Test. *The Open Transportation Journal*, *11*(1).

Ho, K. K. W. (2010). *An Exploratory Study on the Impact of Trust on Different E-Payment Gateways : Octopus Card Vs . Credit Card*.

Holden, M. T., & Lynch, P. (2004a). Choosing the Appropriate Methodology: Understanding Research Philosophy. In *The Marketing Review* (Vol. 4, Issue 4, pp. 397–409).

Holden, M. T., & Lynch, P. (2004b). Choosing the Appropriate Methodology: Understanding Research Philosophy. *The Marketing Review*, *4*(4), 397–409.

Hudson, L. A., & Ozanne, J. L. (1988). Alternative ways of seeking knowledge in consumer research. *Journal of Consumer Research*, 508–521.

Hughes, J., & Jones, S. (2003). Reflections on the use of Grounded Theory in Interpretive Information Systems Research. *Ecis*, 833–845.

Hutchby, I. (2001). Technologies, texts and affordances. *Sociology*, *35*(2), 441–456.

Islam, S., Olsen, T., & Daud Ahmed, M. (2013). Reengineering the seaport container truck hauling process: Reducing empty slot trips for transport capacity improvement. In *Business Process Management Journal* (Vol. 19, Issue 5).

Ismagilova, E., Hughes, L., Dwivedi, Y. K., & Raman, K. R. (2019a). Smart cities : Advances in research — An information systems perspective. *International Journal of Information Management*, *47*(January), 88–100.

Ismagilova, E., Hughes, L., Dwivedi, Y. K., & Raman, K. R. (2019b). Smart cities: Advances in research—An information systems perspective. *International Journal of Information Management*, *47*(December 2018), 88–100.

Jain, V. (2003). Analyzing the nature of knowledge in the IS field. *AMCIS 2003 Proceedings*, 374.

Jakobs, K. (2017). Emerging Smart Technologies and the European Standardisation System. *BLED Proceedings*.

Jeffery, K. (1999). *Recent Developments in Information Technology for Container Terminals:*

*A Cargo Systems Report*. Cargo Systems.

Johnson, R. B., & Onwuegbuzie, A. J. (2004). Mixed Methods Research: A Research Paradigm Whose Time Has Come. *Educational Researcher*, *33*(7), 14–26.

Jokonya, O. (2016). The Significance of Mixed Methods Research in Information Systems Research. *Midwest (MWAIS)*.

Jon (Sean) Jasperson, Traci A. Carte, Carol S. Saunders, Brian S. Butler, H. J. P. C. and W. Z. (2002). Review: Power and Information Technology Research: A Metatriangulation Review. *MIS Quarterly*, *26*(4), 397–459.

Jones, M. (2014). A Matter Of Life And Death: Exploring Conceptualizations Of Sociomateriality In The Context Of Critical Care. *MIS Quarterly*, *38*(3), 895–925.

Joshi, G. P., Acharya, S., Kim, C. S., Kim, B. S., & Kim, S. W. (2014). Smart Solutions in Elderly Care Facilities with RFID System and Its Integration with Wireless Sensor Networks. *International Journal of Distributed Sensor Networks*, *2014*.

Jovic, M., Kavran, N., Aksentijevic, S., & Tijan, E. (2019). The transition of Croatian seaports into smart ports. *2019 42nd International Convention on Information and Communication Technology, Electronics and Microelectronics, MIPRO 2019 - Proceedings*, 1386–1390.

Junglas, I., Goel, L., Abraham, C., & Ives, B. (2013). The Social Component of Information Systems-How Sociability Contributes to Technology Acceptance. *Journal of the Association for Information Systems*, *14*(10), 585–616.

Kamolov, A., & Park, S. (2019). An iot-based ship berthing method using a set of ultrasonic sensors. *Sensors (Switzerland)*, *19*(23), 1–20.

Kamolov, A., & Park, S. H. (2018). An IoT Based Smart Berthing ( Parking ) System for Vessels and Ports. In *Lecture Notes in Electrical Engineering* (pp. 129–139). Springer Singapore.

Kaplan, B., & Maxwell, J. A. (2005). Qualitative research methods for evaluating computer information systems. In *Evaluating the organizational impact of healthcare information systems* (pp. 30–55). Springer.

Kaplan, R. M., & Maxwell III, J. T. (1994). *Text-compression technique using frequency-ordered array of word-number mappers*. Google Patents.

Karimi, J., & Walter, Z. (2015). The role of dynamic capabilities in responding to digital disruption: A factor-based study of the newspaper industry. *Journal of Management Information Systems*, *32*(1), 39–81.

Keceli, Y., & Choi, H. R. (2008). Level of information systems in Turkish public ports and direction of improvement. *Int. J. Logistics Systems and Management*, *4*(6), 673–691.

Keceli, Y., Choi, H. R., Cha, Y. S., & Aydogdu, Y. V. (2008). A study on adoption of port community systems according to organization size. *Proceedings - 3rd International Conference on Convergence and Hybrid Information Technology, ICCIT 2008*, *1*, 493–501.

Keller, R., Fridgen, G., Stohr, A., & Rieger, A. (2019). *Affordance-Experimentation-Actualization Theory in Artificial Intelligence Research – A Predictive Maintenance Story*. 1–17.

Kemmerich, H., Ag, A., Brinker, J., & Thomas, O. (2019). Scrutinizing The Design Specifications Of Smart Products : A Practical Evaluation In Yachting. *Twenty-Seventh European Conference on Information Systems (ECIS2019)*, 0–14.

Keutel, M., Michalik, B., & Richter, J. (2014). Towards mindful case study research in IS: A critical analysis of the past ten years. *European Journal of Information Systems*, *23*(3), 256–272.

Khin, E. W. S., Ying, C. W., Meng, W. Y., & Fatt, C. K. (2011). A coherent epistemological theory in management philosophy research. *Australian Journal of Business Management*, *5*(10), 874–880.

Kia, M., Shayan, E., & Ghotb, F. (2000). The importance of information technology in port terminal operations. *International Journal of Physical Distribution and Logistics Management*, *30*(3), 331–344.

Kilani, M. Al, & Kobziev, V. (2016). An Overview of Research Methodology in Information System (IS). *OALib*, *03*(11), 1–9.

Klecun, E., Hibberd, R., & Lichtner, V. (2016). Affordance Theory Perspectives on IT and Healthcare Organization. *ICIS RiP*, *Norman 1999*, 1–11.

Klein, H. K. (1999). Knowledge and methods in IS research: from beginnings to the future. In *New Information Technologies in Organizational Processes* (pp. 13–25). Springer.

Klein, H. K., & Myers, M. (1999a). A set of principles for conducting and evaluating interpretive field studies in information systems. *MIS Quarterly*, *23*(1), 67–94.

Klein, H. K., & Myers, M. D. (1999b). A set of principles for conducting and evaluating interpretive field studies in information systems. *MIS Quarterly: Management Information Systems*, *23*(1), 67–94. https://doi.org/10.2307/249410

Klein, H. K., & Myers, M. D. (1999c). A set of principles for conducting and evaluating interpretive field studies in information systems. *MIS Quarterly: Management Information Systems*, *23*(1), 67–94.

Klein, H. K., & Myers, M. D. (1999d). A Set of Principles for Conducting and Evaluating Interpretive Field Studies in Information Systems. *MIS Quarterly*, *23*(1), 67. https://doi.org/10.2307/249410

Klein, H. K., & Myers, M. D. (1999e). *A Set of Principles for Conducting and Evaluating Interpretive Field Studies in Information Systems*. *23*(1), 67–93.

Klötzer, C., & Pflaum, A. (2015). *Cyber-physical systems (CPS) in supply chain management: a definitional approach*.

Klotzer, C., Weibenborn, J., & Pflaum, A. (2017). The Evolution of Cyber-Physical Systems as a Driving Force behind Digital Transformation. *Proceedings - 2017 IEEE 19th Conference on Business Informatics, CBI 2017*, *2*, 5–14.

Knopf, J. W. (2006). *Doing a Literature Review* (Vol. 39, Issue 1).

Koch, H., & Peters, U. (2017). Shadow Analytics. *Twenty-Third Amercan Conferences on Information Systems*, *2012*, 1–10.

Komninos, N. (2013). Smart Cities and the Future Internet: Innovation ecosystems of embedded spatial intelligence. *International Conference for Entrepreneurship, Innovation and Regional Development*, 1–12.

Koo, C., Shin, S., Gretzel, U., Hunter, W. C., & Chung, N. (2016). Conceptualization of Smart Tourism Destination Competitiveness. *Asia Pacific Journal of Information Systems*, *26*(4), 561–576.

Koroleva, K., & Kane, G. C. (2017). Relational affordances of information processing on Facebook. *Information and Management*, *54*(5), 560–572.

Krauss, S. E., & Putra, U. (2005). Research Paradigms and Meaning Making : A Primer. *The Qualitative Report*, *10*(4), 758–770.

Kroeze, J. H. (2011). Interpretivism in IS – a postmodern epistemology? *Americas Conference on Information Systems (AMCIS) SIGPhil Workshop (as Work in Progress)*.

Kuhn, T S. (1970). *The Structure of Scientific Revolutions. Chicago & London: Univ*. Of Chicago Press.

Kuhn, Thomas S. (1970). The structure of scientific revolutions. In *The Philosophical Review* (2nd ed.).

Kuhn, Thomas S. (2012). *The structure of scientific revolutions*. University of Chicago press.

Lairet, G., & RoweWE, F. (2016). Understanding the Undesirable Effects of Using Interorganizational Systems and Integrated Information Systems : Case Studies Among Supply Chain Partners. *Twenty-Fourth European Conference on Information Systems*

*(ECIS)*.
Larson, R. C. (2016). Commentary—Smart Service Systems: Bridging the Silos. *Service Science*, *8*(4), 359–367.
Latour, B. (1987). *Science In Action How to follow*.
Law, J. (1987). Technology and heterogeneous engineering: The case of Portuguese expansion. *The Social Construction of Technological Systems: New Directions in the Sociology and History of Technology*, *1*, 1–134.
Lee-Partridge, J. E., Teo, T. S. H., & Lim, V. K. G. (2000). Information technology management: the case of the Port of Singapore Authority. *The Journal of Strategic Information Systems*, *9*(1), 85–99.
Lee, A. (2004). Thinking about social theory and philosophy for information ystems. In L. Willcocks & J. Mingers (Eds.), *Social theory and philosophy for information systems*, (pp. 1–26). John Wiley & Sons.
Lee, A. S. (1989). A scientific methodology for MIS case studies. *MIS Quarterly: Management Information Systems*, *13*(1), 33–50.
Lee, A. S. (1991). Integrating Positivist and Interpretive Approaches to Organizational Research. *Organization Science*, *2*(4), 342–365.
Lee, A. S., & Baskerville, R. L. (2003). Generalizing generalizability in information systems research. *Information Systems Research*, *14*(3), 221–243.
Lee, H. J. (2012a). A review of value creating motive and business model in smart technology. In *Human centric technology and service in smart space* (pp. 159–163). Springer.
Lee, H. J. (2012b). A Review of Value Creating Motive and Business Model in Smart Technology. In *Human Centric Technology and Service in Smart Space* (pp. 241–247).
Lee, H. J. (2012c). A study on the promotion of the business service for regional retail store using smart technology. *Personal and Ubiquitous Computing*, *17*(7), 1469–1474. https://doi.org/10.1007/s00779-012-0582-6
Leedy, P. D., & Ormrod, J. P. (2005). Practical research–planning and design 8th Edn Pearson. *Upper Saddle River, NJ*.
Lehrig, T., Krancher, O., Dibbern, J., Lehrig, T., & Krancher, O. (2019). Affordance Perceptions under Malleable Information Technology: A Social Cognitive Theory Perspective. *Fortieth International Conference on Information Systems*.
Leijon, E., Svenheden, J., & Svahn, F. (2017). Platform Thinking in Incumbent Firms: From Concept to Capability. *IEEE Computer Society*, 4766–4775.
Leonard, Voß, Stefan, & Lalla-ruizEduardo. (2017). *Digital transformation in maritime ports : analysis and a game theoretic framework. December 2018*. https://doi.org/10.1007/s11066-017-9122-x
Leonardi, P. M. (2013). Theoretical foundations for the study of sociomateriality. *Information and Organization*, *23*(2), 59–76.
Leonardi, P. M., & Barley, S. R. (2010). What's Under Construction Here? Social Action, Materiality, and Power in Constructivist Studies of Technology and Organizing. *The Academy of Management Annals*, *4*(1), 1–51.
Leonardi, P. M. (2011). When Flexible Routines Meet Flexible Technologies: Affordance, Constraint, and the Imbrication of Human and Material Agencies. *MIS Quarterly*, *35*(1), 147–168.
Leonardi, P.M., & Barley, S. . (2008). Materiality and Change: Challenges to Building Better Theory About Technology and Organizing. *Information and Organization*, *18*(3), 159–176.
Leonardi, Paul M. (2011a). When flexible routines meet flexible technologies: Affordance, constraint, and the imbrication of human and material agencies. *MIS Quarterly: Management Information Systems*, *35*(1), 147–167.

Leonardi, Paul M. (2011b). When Flexible Routines Meet Flexible Technologies: Affordance, Constraint, and the Imbrication of Human and Material Agencies. *MIS Quarterly*, *35*(1), 147–167.
Leonardi, Paul M. (2013). Theoretical foundations for the study of sociomateriality. *Information and Organization*, *23*(2), 59–76.
Leonardi, Paul M., & Vaast, E. (2017). Social media and their affordances for organizing: A review and agenda for research. *Academy of Management Annals*, *11*(1), 150–188.
Leonardi, Paul M. (2013). When does technology use enable network change in organizations? A comparative study of feature use and shared affordances. *MIS Quarterly*, 749–775.
Li, X., Yi, W., Chi, H.-L., Wang, X., & Chan, A. P. C. (2018). A critical review of virtual and augmented reality (VR/AR) applications in construction safety. *Automation in Construction*, *86*, 150–162.
Lim, C. H., Maglio, P. P., Kim, K. J., Kim, M. J., & Kim, K. H. (2016). Toward smarter service systems through service-oriented data analytics. *IEEE International Conference on Industrial Informatics (INDIN)*, *0*, 936–941.
Lim, C., Kim, K. J., & Maglio, P. P. (2018). Smart cities with big data: Reference models, challenges, and considerations. *Cities*, *82*(May), 86–99.
Lim, C., & Maglio, P. P. (2018). Data-Driven Understanding of Smart Service Systems Through Text Mining. *Service Science*, *10*(2), 154–180.
Lim, C., & Maglio, P. P. (2019). Clarifying the Concept of Smart Service System. In P. Maglio, C. Kieliszewski, J. Spohrer, Kelly Lia Patrício, & Y. Sawatani (Eds.), *Handbook of Service Science: Vol. II* (pp. 349–376).
Lind, R., Henfrids, O., & Schultze, U. (2004). *Design Principles for Competence Management Systems: A Synthesis of an Action Research Study*. *28*(3), 435–472.
Liu, H., Ning, H., Mu, Q., Zheng, Y., Zeng, J., Yang, L. T., Huang, R., & Ma, J. (2019). A review of the smart world. *Future Generation Computer Systems*, *96*(2019), 678–691.
Løkke, A. K., & Sørensen, P. D. (2014). Theory testing using case studies. *Electronic Journal of Business Research Methods*, *12*(1), 66–74.
Maglio, P., & Lim, C.-H. (2016). Big Data and Smart Service Systems. *Journal of Innovation Management*, *4*(1), 11–21.
Maglio, P. P. (2014). Smart service systems. *Service Science*, *6*(1), i–ii.
Maglio, P. P., Kwan, S. K., & Spohrer, J. (2015). Toward a research agenda for human-centered service system innovation. *Service Science*, *7*(1), 1–10.
Maglio, P. P., & Lim, C.-H. (2016). Innovation and Big Data in Smart Service Systems Letter from Academia. *Journal of Innovation Management*, *4*(1), 1–11.
Maglio, P. P., Vargo, S. L., Caswell, N., & Spohrer, J. (2009). The service system is the basic abstraction of service science. *Information Systems and E-Business Management*, *7*(4 SPEC. ISS.), 395–406.
Mahmoud, M. S., Hamdan, M. M., & Baroudi, U. A. (2019). Modeling and control of Cyber-Physical Systems subject to cyber attacks: A survey of recent advances and challenges. *Neurocomputing*, *338*, 101–115.
Majchrzak, A., & Markus, M. L. (2012). Technology Affordances and Constraints in Management Information Systems (MIS). *Encyclopedia of Management Theory*, 5.
Majchrzak, Ann, Faraj, S., Kane, G. C., & Azad, B. (2013). The contradictory influence of social media affordances on online communal knowledge sharing. *Journal of Computer-Mediated Communication*, *19*(1), 38–55.
Majchrzak, Ann, Markus, M. L., Street, F., Wareham, J., Ramon, E., & Pedralbes, A. De. (2016). Designing for Digital Transformation: Lessons for Information Systems Research from The Study of ICT and Societal Challenges. *MIS Quarterly*, *40*(2), 267–277.
Malaurent, J., & Avison, D. (2017). Reflexivity: A third essential 'R' to enhance interpretive

field studies. *Information and Management*, *54*(7), 920–933.
Marimon, F., Llach, J., Alonso-almeida, M., & Mas-machuca, M. (2019). CC-Qual : A holistic scale to assess customer perceptions of service quality of collaborative consumption services. *International Journal of Information Management*, *49*(April), 130–141.
Markus, M. L., & Silver, M. (2008a). A Foundation for the Study of IT Effects: A New Look at DeSanctis and Poole's Concepts of Structural Features and Spirit. *Journal of the Association for Information Systems*, *9*(10), 609–632.
Markus, M. L., & Silver, M. S. (2008b). A foundation for the study of IT effects: A new look at DeSanctis and Poole's concepts of structural features and spirit. *Journal of the Association for Information Systems*, *9*(10), 5.
Martin, D., Hirt, R., & Kühl, N. (2019). Service Systems , Smart Service Systems and Cyber-Physical Systems — What ' s the difference ? Towards a Unified Terminology. *14th International Conference on Wirtschaftsinformatik*, 17–31.
Martin, P. Y., & Turner, B. A. (1986). Grounded Theory and Organizational Research. *The Journal of Applied Behavioral Science*, *22*(2), 141–157.
Mason, J. (2017). *Qualitative researching*. Sage.
Massink, M., Harrison, M., & Latella, D. (2010). Scalable analysis of collective behaviour in smart service systems. *Proceedings of the ACM Symposium on Applied Computing*, 1173–1180.
Matavire, R., & Brown, I. (2013). Profiling grounded theory approaches in information systems research. *European Journal of Information Systems*, *22*(1), 119–129.
Matt, C., Hess, T., & Benlian, A. (2015). Digital Transformation Strategies. *Business and Information Systems Engineering*, *57*(5), 339–343.
Mattila, M., & Aaltio, I. (2006). From Tools to Social Construction of Organizational Reality : Studying Value Dissemination in three Case Companies. *Electronic Journal of Business Ethics and Organizational Studies*, *11*(2), 15–23.
Maurya, K., Singh, M., & Jain, N. (2012). Real Time Vehicle Tracking System using GSM and GPS Technology-An Anti-theft Tracking System. *International Journal of Electronics and Computer Science Engineering*, *2*(3), 1103–1107.
Maxwell, J. a. (2004). Causal Explanation, Qualitative Research, and Scientific Inquiry in Education. *The Sciences*, *ll*(March), 3–11.
McCardle, J. R. (2002). The challenge of integrating AI & smart technology in design education. *International Journal of Technology and Design Education*, *12*(1), 59–76.
Medina-Borja, A. (2015a). Editorial Column - Smart things as service providers: A call for convergence of disciplines to build a research agenda for the service systems of the future. *Service Science*, *7*(1), ii–v.
Medina-Borja, A. (2015b). Smart things as service providers: A call for convergence of disciplines to build a research agenda for the service systems of the future. *Service Science*, *7*(1), ii–v.
Mele, C., & Polese, F. (2010). Key dimension of service systems: Interaction in social & technological networks to foster value co-creation. *The Science of Service System, New York, NY: Springer*.
Merriam, S. B. (2009). Qualitative case study research. *Qualitative Research: A Guide to Design and Implementation*, 39–54.
Mesgari, M., & Faraj, S. (2012). Technology Affordances : The Case of Wikipedia Technology Affordances : The Case of Wikipedia. *AMCIS (Americas Conference on Information Systems)*.
Mettler, T., & Wulf, J. (2018). Physiolytics at the workplace: Affordances and constraints of wearables use from an employee's perspective. *Information Systems Journal*, *29*(1), 245–273.

Mikalef, P. (2014). Developing IT-Enabled Dynamic Capabilities : A Service Science Approach Developing IT-Enabled Dynamic Capabilities : A Service Science Approach. *In International Conference on Business Informatics Research*, *September*, 87–100.

Miller, D. (1995). Citizenship and Pluralism. *Political Studies*, *43*(3), 432–450.

MILLER1, K. D., & TSANG, E. W. K. (2010). Testing Management Theories: Critical Realist Philosophy and Research Methods. *Business*, *158*(February 2009), 1–43.

Mingers, J., & Willcocks, L. (2004). *Social Theory and Philosophy of Information Systems*.

Misangyi, V. F., Greckhamer, T., Furnari, S., Fiss, P. C., Crilly, D., & Aguilera, R. (2017). Embracing causal complexity: The emergence of a neo-configurational perspective. *Journal of Management*, *43*(1), 255–282.

Mori, S., Suen, C. Y., & Yamamoto, K. (1992). Historical review of OCR research and development. *Proceedings of the IEEE*, *80*(7), 1029–1058.

Mouton, J. (2001). *How to succeed in your master's and doctoral studies: A South African guide and resource book*. Van Schaik.

Mühlhäuser, M. (2007). Smart Products: An Introduction, Constructing Ambient Intelligence. *CCIS*, *11*, 158–164.

Mumford, E. (2006). The story of socio-technical design: Reflections on its successes, failures and potential. *Information Systems Journal*, *16*(4), 317–342.

Mutch, C. (2013). *Doing educational research*. Nzcer Press.

Myers, G. (2011). *African cities: Alternative visions of urban theory and practice*. Zed Books Ltd.

Myers, M. (2009). *Qualitative research in business and management*. Sage.

Myers, M. D. (1997). Critical Ethnography in Information Systems. In A. S. L. et Al. (Ed.), *Information System and Qualitative Research* (Vol. 52, Issue 4, pp. 55–57).

Myers, M.D. (1997). Qualitative Research in Information Systems. *MIS Quarterly*, *22*(2), 241–24.

Myers, M.D. (1999). *A Set Of Principles For Conducting And Evaluating Interpretive Field Studies In Information Systems*. *23*(1), 67–93.

Myers, M.D. (2013). *Qualitative Research in Business and Management*. Sage.

Myers, Michael. (2013). *Qualitative Research in Business & Management* (N. S. Kirsty Smy (ed.); 2nd ed.). Sage Publications.

Myers, Michael D. (2004). Qualitative Research in Information Systems. *MIS Quarterly*, *28*(1), 75–105.

Myers, Michael D. (2013). *Qualitative research in business and management*. Sage.

Myers, Michael D, & Avison, D. (2002a). *An introduction to qualitative research in information systems*.

Myers, Michael D, & Avison, D. (2002b). *Qualitative research in information systems: a reader*. Sage.

Nambisan, S., Lyytinen, K., Majchrzak, A., & Song, M. (2017). Digital Innovation Management: Reinventing Innovation Management Research in a Digital World. *MIS Quarterly*. *Special Issue on IT and Innovation*, *41*(1), 223–238.

Neo, B. S. (1994). Managing new information technologies: Lessons from Singapore's experience with EDI. *Information and Management*, *26*(6), 317–326.

Neuhofer, B., Buhalis, D., & Ladkin, A. (2015). Smart technologies for personalized experiences : a case study in the hospitality domain. *Electronic Markets*.

Neuman, W. L. (2007). *The Basics of Social Research: Qualitative and Quantitative Approaches 2nd ed. Boston, Massachusetts: Pearson Education*. Inc.

Ng, C. S. P., & Gable, G. G. (2010). Maintaining ERP packaged software - A revelatory case study. *Journal of Information Technology*, *25*(1), 65–90.

Niemimaa, M. (2014). Sociomaterial Ethnography: Taking the Matter Seriously. *Proceedings* *of the 8th Mediterranean Conference on Information Systems*.

Ning, X., & Khuntia, J. (2019). Citizen-Government Ecosystem for Smart Technology Enabled City Performance. *Twenty-Fifth Americas Conference on Information Systems*, 1–9.

Notteboom, T. E., & Winkelmans, W. (2001). Structural changes in logistics: How will port authorities face the challenge? *Maritime Policy and Management*, *28*(1), 71–89.

Orlikowski, W. (2000). Using Technology and Constituting Structures: A Practice Lens for Studying Technology in Organizations. *Organization Science*, *11*(4), 404–428.

Orlikowski, W.J. (2010). The Sociomateriality of Organisational Life: Considering Technology in Management Research. *Cambridge Journal of Economics*, *34*(1), 125–141.

Orlikowski, W.J., & Baroudi, J. J. (1991). Studying Information Technology in Organizations: Research Approaches and Assumptions. In *Information systems research (2:1)* (pp. 1–28).

Orlikowski, W J, & Baroudi, J. J. (1991). Studying Information Tech- nology in Organizations: Research Approaches and Assump- tions. *Information Systems Research*, *2*, 1–28.

Orlikowski, Wanda J., & Baroudi, J. J. (1991). Studying Information Technology in Organziations: Research Approaches and Assumptions. *Information Systems Research*, *2*(1), 1–28.

Orlikowski, Wanda J. (1992). The duality of technology: Rethinking the concept of technology in organizations. *Organization Science*, *3*(3), 398–427.

Orlikowski, Wanda J, & Baroudi, J. J. (1991). Studying information technology in organizations: Research approaches and assumptions. *Information Systems Research*, *2*(1), 1–28.

Packer, M. (1999). *Interpretive research*.

Pal, A., Herath, T., De, R., & Rao, H. R. (2018). An Investigation of Affordances and Constraints for Continued Usage of Mobile Payment Technology. *Proceedings Annual Workshop of the AIS Special Interest Group for ICT in Global Development*.

Papagiannidis, S., & Marikyan, D. (2019). Smart offices : A productivity and well-being perspective. *International Journal of Information Management*, *October*, 1–11.

Paré, G. (2001). *Using a positivist case study methodology to build and test theories in information systems: Illustrations from four exemplary studies*.

Paré, G. (2004). Investigating Information Systems with Positivist Case Research. *Communications of the Association for Information Systems Volume*, *13*.

Parikh, P. P., Kanabar, M. G., & Sidhu, T. S. (2010). Opportunities and challenges of wireless communication technologies for smart grid applications. *IEEE PES General Meeting, PES 2010*, *Cc*, 1–7.

Patsadu, O., Nukoolkit, C., & Watanapa, B. (2012). Survey of Smart Technologies for Fall Motion Detection: Techniques, Algorithms and Tools. *Communications in Computer and Information Science*, *344*, 137–147.

Patton, M. Q. (2002). *Qualitative Research and Evaluation Methods*. SAGE Publications.

Paukstadt, U., Eicker, S., & Eicker, S. (2019). Understanding Services in the Era of the Internet of Things : A Smart. *27th European Conference on Information Systems*, June 8-14, 2019.

Paulo, S., Carlos, S., Christ, M., & Christ, M. (2012). Revealing the Sociotechnical Complexity of Business Process Modeling – An Actor-Network Theory. *Eighteenth Americas Conference on Information Systems, Seattle, Washington, August 9-12*.

Pelletier, M. P., Trépanier, M., & Morency, C. (2011). Smart card data use in public transit: A literature review. *Transportation Research Part C: Emerging Technologies*, *19*(4), 557–568.

Perren, L., & Ram, M. (2004). Case study method in small business and entrepreneurial research: Mapping boundaries and perspectives. *International Small Business Journal*, *22*(1), 83–101.

Polese, F., Tommasett, A., Vesc, M., Carrubbo, L., & Trois, O. (2016). Decision-Making in Smart Service Systems: A Viable Systems Approach Contribution to Service Science Advances. *Lecture Notes in Business Information Processing*, *247*, 3–14.

Ponelis, S. R. (2015). Using interpretive qualitative case studies for exploratory research in doctoral studies: A case of information systems research in small and medium enterprises. *International Journal of Doctoral Studies*, *10*(December), 535–550.

Ponterotto, J. G. (2005). Qualitative research in counseling psychology: A primer on research paradigms and philosophy of science. *Journal of Counseling Psychology*, *52*(2), 126.

Porter, J. D., Billo, R. E., & Mickle, M. H. (2004). A Standard Test Protocol for Evaluation of Radio Frequency Identification Systems for Supply Chain Applications. *Journal of Manufacturing Systems*, *23*(1).

Porter, M. E., & Heppelmann, J. E. (2014). How smart, connected products are transforming competition. *Harvard Business Review*, *92*(11), 64–88.

Porter, M. E., & Heppelmann, J. E. (2015). How smart, connected products are transforming companies. *Harvard Business Review*, *2015*(October).

Pozzi, G., Pigni, F., & Vitari, C. (2014). Affordance Theory in the IS Discipline: a Review and Synthesis of the Literature. *Twentieth Americas Conference on Information Systems, Savannah, 2014*, *13*, 1–12.

Pramanik, M. I., Lau, R. Y. K., Demirkan, H., & Azad, M. A. K. (2017). Smart health: Big data enabled health paradigm within smart cities. *Expert Systems with Applications*, *87*(2017), 370–383.

Presthus, W., & Munkvold, B. E. (2016). How to frame your contribution to knowledge? A guide for junior researchers in informaton systems. *Nov. NOKOBIT Bibsys Open Journal Systems*, *24*(1), 28–30.

Rapoport, R. N. (1970). Three Dilemmas in Action Research:With Special Reference to the Tavistock Experience. *Human Relations*, *23*(6), 499–513.

Reiter, S., Stewart, G., & Bruce, C. (2010). Integrating qualitative and quantitative approaches in cross-cultural research. *16th Americas Conference on Information Systems 2010, AMCIS 2010*, *6*, 4172–4180.

Reporter, G. T. (2020). *Ghana : ' ICUMS Rakes in Over Gh ₵ 177 Million At Tema Port in a Week '*.

Reynolds, J., Denaro, R., & Kalafus, R. (1990). GPS-based vessel position monitoring and display system. In: Proceedings of the position location and navigation symposium (PLANS). *IEEE Aerospace and Electronic Systems Magazine*, *5*(7), 16–22.

Rico, J., & Xia, W. (2018). Incorporating culture into the theory of IT affordances. *Americas Conference on Information Systems 2018: Digital Disruption, AMCIS 2018*, *Schein 1984*, 1–5.

Rieback, M. R., Crispo, B., & Tanenbaum, A. (2006). The Evolution of Policy Analysis. *IEEE Pervasive Comput Ing*, *5*(1), 62–69.

Robey, D., Anderson, C., & Raymond, B. (2013). Information technology, materiality, and organizational change: A professional odyssey. *Journal of the Association for Information Systems*, *14*(7), 1.

Roer-strier, D., & Kurman, J. (2010). Combining Qualitative and Quantitative Methods to Study. *Journal of Cross-Cultural Psychology*, *40*(6), 988–995.

Rogerson, J. M., & Sims, S. R. (2012). The Greening of Urban Hotels in South Africa: Evidence from Gauteng. *Urban Forum*, *23*(3), 391–407.

Rubin, H. J., & Rubin, I. S. (2011). *Qualitative interviewing: The art of hearing data*. Sage Publications.

Ryder, M., & Wilson, B. (1996). *Affordances and Constraints of the Internet for Learning and Instruction*.

Sadiku, M. N. O., Wang, Y., Cui, S., & Musa, S. M. (2017). Cyber-Physical Systems : A Literature Review. *European Scientific Journal*, *13*(36), 52–58.

Salhi, A., Alsoufi, G., & Yang, X. (2019). An evolutionary approach to a combined mixed integer programming model of seaside operations as arise in container ports. *Annals of Operations Research*, *272*(1–2), 69–98.

Sanday, P. R. (2016). *The Ethnographic Paradigm ( s ) Author ( s ): Peggy Reeves Sanday Source : Administrative Science Quarterly , Vol . 24 , No . 4 , Qualitative Methodology ( Dec ., Published by : Sage Publications , Inc . on behalf of the Johnson Graduate School of Managem*. *24*(4), 527–538.

Sari, P. A. T., Garcia, C. D. P., Mendia, A. S. G., Piedra, D. F. M., Zaruma, E. F. P., & Orellana, I. P. C. (2017). Smart Irrigation System for Smart Farming. *Isd*.

Saunders, M, Lewis, P., & Thornhill, A. (2009). Research Methods for Business Students. In *Research methods for business students*.

Saunders, Mark, Lewis, P., & Thornhill, A. (2011). *Research methods for business students, 5/e*. Pearson Education India.

Savoli, A., & Barki, H. (2013). Functional Affordance Archetypes : a New Perspective for Examining the Impact of IT Use on Desirable Outcomes. *Icis-Rp*, 1–10.

Savoli, A., & Barki, H. (2016). A Multilevel Perspective on IT Affordances. *Twenty-Fourth European Conference on Information Systems (ECIS)*. elibrary@aisnet.org.

Savoli, A., & Barki, H. (2019). Affordance networks: An approach for linking IT features-in-use to their effects. *40th International Conference on Information Systems, ICIS 2019*.

Schultze, U. (2000). A confessional account of an ethnography about knowledge work. *MIS Quarterly: Management Information Systems*, *24*(1), 3–40.

Schwartz-shea, P., & Yanow, D. (2013). *Interpretive research design: Concepts and processes*. Routledge.

Sebastian, I. M., & Bui, T. (2012). The Influence of Is Affordances on Work Practices in Health Care : A Relational Coordination approach. *Icis 2012*, 1–11.

Seidel, S., Recker, J., & Vom Brocke, J. (2013). Sensemaking and sustainable practicing: Functional affordances of information systems in green transformations. *MIS Quarterly: Management Information Systems*, *37*(4), 1275–1299.

Sein, M. K., Thapa, D., Hatakka, M., & Sæbø, Ø. (2019). A holistic perspective on the theoretical foundations for ICT4D research. *Information Technology for Development*, *25*(1), 7–25.

Selander, L., & Jarvenpaa, S. L. (2016). *D a r t*. *40*(2), 331–352.

Shaw, R. E., Turvey, M. T., & Mace, W. M. (1982). *Ecological psychology: The consequence of a commitment to realism. InW. Weimer & D. Palermo (Eds.), Cognition and the symbolic processes (Vol. 2, pp. 159-226)*. Hillsdale: Erlbaum.

Sheer, V. C., & Rice, R. E. (2017). Mobile instant messaging use and social capital: Direct and indirect associations with employee outcomes. *Information and Management*, *54*(1), 90–102.

Shenton, A. K., Hayter, S., Kondowe, C., Johl, S. K., Renganathan, S., & Walsham, G. (2006). Doing interpretive research. *European Journal of Information Systems*, *15*(3), 320–330.

Shi, X., Tao, D., & Voß, S. (2011). RFID technology and its application to port-based container logistics. *Journal of Organizational Computing and Electronic Commerce*, *21*(4), 332–347.

Shim, J. P., Avital, M., Dennis, A. R., Rossi, M., & Sørensen, C. (2019). The Transformative Effect of the Internet of Things on Business and Society. *Communications of the Association for Information Systems*, *44*(1).

Siggelkow, N. (2001). Change in the presence of fit: The rise, the fall, and the renaissance of Liz Claiborne. *Academy of Management Journal*, *44*(4), 838–857.

Singh, P., Dwivedi, Y. K., Kahlon, K. S., Sawhney, R. S., Alalwan, A. A., & Rana, N. P. (2020). Smart Monitoring and Controlling of Government Policies Using Social Media and Cloud Computing. *Information Systems Frontiers*, *22*, 315–337.

Snow, D. A. (2004). Thoughts on alternative pathways to theoretical development: Theory generation, extension, and refinement. In C. Ragin, J. Nagel, & P. White (Eds.), *Workshop on scientific foundations of qualitative research* (pp. 133–136). National Science Foundation.

Spagnoletti, P., Resca, A., & Lee, G. (2015). A design theory for digital platforms supporting online communities: A multiple case study. *Journal of Information Technology*, *30*(4), 364–380.

Spohrer, J., Maglio, P. P., Bailey, J., & Gruhl, D. (2007). Steps toward a science of service systems. *Computer*, *40*(1), 71–77.

Spohrer, J., Siddike, M. A. K., & Kohda, Y. (2017). Rebuilding Evolution: A Service Science Perspective. *Proceedings of the 50th Hawaii International Conference on System Sciences (2017)*, 1663–1672.

Stake, R. E. (2005). *Qualitative case studies.*

Star, S. L. (2010). This is not a boundary object: Reflections on the origin of a concept. *Science Technology and Human Values*, *35*(5), 601–617.

Star, S. L., & Griesemer, J. R. (1989). Institutional ecology,translations' and boundary objects: Amateurs and professionals in Berkeley's Museum of Vertebrate Zoology, 1907-39. *Social Studies of Science*, *19*(3), 387–420.

Steenken, D., Voß, S., & Stahlbock, R. (2004). Container terminal operation and operations research - A classification and literature review. *OR Spectrum*, *26*(1), 3–49.

Stendal, K., Thapa, D., & Lanamaki, A. (2016). Analyzing the concept of affordances in information systems. *Proceedings of the Annual Hawaii International Conference on System Sciences*, *2016-March*(January), 5270–5277.

Stranges, M. K. W., Ul Haq, S., & Dunn, D. G. (2014). Doing a Thematic Analysis: A Practical, Step-by-Step Guide for Learning and Teaching Scholars. *IEEE Transactions on Industry Applications*, *50*(5), 3135–3140.

Strong, D. M., Johnson, S. a, Tulu, B., Trudel, J., Group, R. M., Volkoff, O., Pelletier, L. R., Bar-on, I., & Garber, L. (2014). A Theory of Organization-EHR Affordance Actualization. *Journal of the Association for Information Systems*, *15*(2), 53–85.

Sullivan, P. S. O., & Irby, D. M. (2014). *Promoting Scholarship in Faculty Development : Relevant Research Paradigms and Methodologies*. 375–398.

Susman, G., & Evered, R. D. (1978). An Assessment of the Scientific Merits of Action Research. *Administrative Science Quarterly*, *23*(4), 582–603.

Tajima, M. (2007). Strategic value of RFID in supply chain management. *Journal of Purchasing and Supply Management*, *13*(4), 261–273.

Technikwissenschaften, acatech—Deutsche A. der. (2011). *Cyber-Physical Systems: Innovationsmotor für Mobilität, Gesundheit, Energie und Produktion*. Springer Berlin Heidelberg.

Teo, H., Tan, B. C. Y., & Wei, K. (1997). Organizational Transformation Using Electronic Data Interchange: The Case of TradeNet in Singapore. *Journal of Management Information Systems*, *13*(4), 139–165.

Thapa, D., & Sein, M. K. (2018). Trajectory of Affordances: Insights from a case of telemedicine in Nepal. *Information Systems Journal*, *28*(5), 796–817.

Tijan, E. (2012). ICT enablement of administrative processes in Croatian seaports. *25th Bled EConference: Graduate Student Consortium*, 55–60.

Tijan, E. (2018). Integrating Maritime National Single Window with Port Community System – Case Study Croatia. *BLED*.

Tijan, E., Agatić, A., & Hlača, B. (2012). The necessity of port community system implementation in the Crozatian seaports. *PROMET-Traffic&Transportation*, *24*(4), 305–315.

Tim, Y., Pan, S. L., Bahri, S., & Fauzi, A. (2018). Digitally enabled affordances for community-driven environmental movement in rural Malaysia. *Information Systems Journal*, *28*(1), 48–75.

Tongzon, J., & Heng, W. (2005). Port privatization, efficiency and competitiveness: Some empirical evidence from container ports (terminals). *Transportation Research Part A: Policy and Practice*, *39*(5), 405–424.

Treem, J. W., & Leonardi, P. M. (2013). Social media use in organizations: Exploring the affordances of visibility, editability, persistence, and association. *Annals of the International Communication Association*, *36*(1), 143–189.

Trier, M., & Richter, A. (2015). The deep structure of organizational online networking - an actor-oriented case study. *Information Systems Journal*, *25*(5), 465–488.

Turyasingura, W. (2011). *Interdependency of knowledge management and learning: the case of higher education institutions in Uganda*.

Ulin, P. R., Robinson, E. T., & Tolley, E. E. (2005). Qualitative methods in public health: a field guide for applied research. *Medicine & Science in Sports & Exercise*, *37*(7), 1249.

Université, A., & Sébastien, B. (2020). The Affordance-Actualization Process in a Predictive Policing Context: Insights from the French Military Police. *Twenty-Eighth European Conference on Information Systems (ECIS2020)*.

Urquhart, C. (2001). An encounter with grounded theory: Tackling the practical and philosophical issues. In *Qualitative research in IS: Issues and trends* (pp. 104–140). IGI Global.

Vaast, E., Safadi, H., Lapointe, L., & Negoita, B. (2017). Social Media Affordances for Connective Action: An Examination of Microblogging Use During the Gulf of Mexico Oil Spill. *MIS Quarterly*, *41*(4).

Van Maanen, J. (2011). *Tales of the field: On writing ethnography*. University of Chicago Press.

Vargo, S. L., & Lusch, R. F. (2004). Evolving to a New Dominant Logic for Marketing. *Journal of Marketing*, *68*(1), 1–17.

Vargo, S. L., & Lusch, R. F. (2008a). From goods to service(s): Divergences and convergences of logics. *Industrial Marketing Management*, *37*(3), 254–259.

Vargo, S. L., & Lusch, R. F. (2008b). Why “service”? *Journal of the Academy of Marketing Science*, *36*(1), 25–38.

Venkatesh, V., Chan, F. K. Y., Brown, S. a, Hu, P. J., Tam, K. Y., & Thong, J. (2010). Modeling Citizen Satisfaction with Mandatory Adoption of an E-Government Technology. *Journal of the Association for Information*, *11*(10), 519–549.

Verhulst, M. J. (2017). *Catch Me If You Can : Technological Constraints / Affordances and Mindfulness during Collaborative Police Emergency Response*. 771–780.

Vis, I. F. A., & De Koster, R. (2003). Transshipment of containers at a container terminal: An overview. *European Journal of Operational Research*, *147*(1), 1–16.

Volkoff, O., & Stron, D. M. (2013). Critical Realism and Affordances: Theorizing It-Associated Organizational Change Processes. *MIS Quarterly*, *37*(3), 819–834.

Volkoff, O., & Strong, D. (2018). Affordance theory and how to use it in IS research. *The Routledge Companion to Management Information Systems*, 514.

Volkoff, O., & Strong, D. M. (2013). Critical realism and affordances: Theorizing IT-associated organizational change processes. *Mis Quarterly*, 819–834.

Vom Brocke, J., Watson, R. T., Dwyer, C., Elliot, S., & Melville, N. (2013). Green information systems: Directives for the IS discipline. *Communications of the Association for*

*Information Systems*, *33*(1), 509–520.

Vowels, S. A. (2016). Information Systems Implementation Consequences : Ethical Treatment of End Users. *Proceedings of the Southern Association for Information Systems Conference*.

Wallace, L., Warkentin, M., & Benbasat, I. (2018). How Do You Handle It? An Investigation of Facebook Affordances and Envy. *Proceedings of the 51st Hawaii International Conference on System Sciences*, *9*, 5254–5263.

Walsham. (1995). Interpretive case studies in IS research: nature and method. *European Journal of Information Systems*, *4*(2), 74–81.

Walsham, G. (1995). Interpretive case studies in IS research: nature and method. *European Journal of Information Systems*, *4*(2), 74–81.

Walsham, G. (2006). Doing interpretive research. *European Journal of Information Systems*, *15*(3), 320–330.

Walsham, Geoff. (1993). *Interpreting information systems in organizations*. John Wiley & Sons, Inc.

Walsham, Geoff. (1995a). Interpretive case studies in IS research: nature and method. *European Journal of Information Systems*, *4*(2), 74–81.

Walsham, Geoff. (1995b). The emergence of interpretivism in IS research. *Information Systems Research*, *6*(4), 376–394.

Walsham, Geoff. (2006a). Doing interpretive research. *European Journal of Information Systems*, *15*(3), 320–330.

Walsham, Geoff. (2006b). Doing interpretive research. *European Journal of Information Systems*, *15*, 320–330.

Walsham, Geoff. (2006c). Doing interpretive research. *European Journal of Information Systems*, *15*(3), 320–330.

Walsham, Geoff, & Barrett, M. (2004). Making Contributions From Interpretive Case Studies: Examining Processes of Construction and Use. In *Information Systems Research* (pp. 293–312). Kluwer Academic Publishers.

Wang, H., Wang, J., & Tang, Q. (2018). A Review of Application of Affordance Theory in Information Systems. *Journal of Service Science and Management*, *11*, 56–70.

Wang, & Nandhakumar, J. (2016). Affordance-Based Conceptualization of Adaptive Use of Enterprise Systems. *Ecis*.

Watanabe, K., & Mochimaru, M. (2017). Expanding impacts of technology-assisted service systems through generalization: case study of the Japanese service engineering research project. *Service Science*, *9*(3), 250–262.

Weber, R. (2004). The rhetoric of positivism versus interpretivism. *MIS Quarterly*, *28*(1), iii–xii.

Weber, S. (2010). Design Science Research : Paradigm or Approach? *Proceedings of the 16th Americas Conference on Information Systems*, Paper 214.

Wessel, L., Davidson, E., Barquet, A. P., Rothe, H., Peters, O., & Megges, H. (2019). Configuration in smart service systems: A practice-based inquiry. *Information Systems Journal*, *29*(6), 1256–1292.

Wessel, L., Rothe, H., Davidson, E., Paula, A., Peters, O., & Megges, H. (2019). Configuration in smart service systems : A practice- based inquiry. *Information Systems Journal*, *June*, 1–37.

Wiesche, M., Jurisch, M. C., Yetton, P. W., & Krcmar, H. (2017). *Grounded theory methodology in information systems research*. *41*(3), 685–701.

Williams, P., Basker, S., & Ward, N. (2008). e-Navigation and the case for eLoran. *Journal of Navigation*, *61*(3), 473–484.

Winkler, D. A., Beltran, A., Esfahani, N. P., Maglio, P. P., & Cerpa, A. E. (2016). FORCES:

Feedback and control for occupants to refine comfort and energy savings. *UbiComp 2016 - Proceedings of the 2016 ACM International Joint Conference on Pervasive and Ubiquitous Computing*, 1188–1199.

Woo, S., Jeong, S., Mok, E., Xia, L., Choi, C., Pyeon, M., & Heo, J. (2011). Application of WiFi-based indoor positioning system for labor tracking at construction sites: A case study in Guangzhou MTR. *Automation in Construction*, *20*(1), 3–13.

Wrigley, C. D., Wagenaar, R. W., & Clarke, R. A. (1994). Electronic data interchange in international trade: frameworks for the strategic analysis of ocean port communities. *Journal of Strategic Information Systems*, *3*(3), 211–234.

Wünderlich, N. V., Wangenheim, F. V., & Bitner, M. J. (2013). High Tech and High Touch: A Framework for Understanding User Attitudes and Behaviors Related to Smart Interactive Services. *Journal of Service Research*, *16*(1), 3–20.

Wynn, D., & Williams, C. K. (2012). Principles For Conducting Critical Realist Case Study Research In Information Systems. *MIS Quarterly*, *36*(3), 787–810.

Yan, H., Huo, H., Xu, Y., & Gidlund, M. (2010). Wireless sensor network based E-health system - Implementation and experimental results. *IEEE Transactions on Consumer Electronics*, *56*(4), 2288–2295.

Yang, J., Wang, H., Wang, J., Tan, C., & Yu, D. (2011). Provable Data Possession of Resource-constrained Mobile Devices in Cloud Computing. *Journal of Networks*, *6*(7), 1033–1040.

Yang, Y., Zhong, M., Yao, H., Yu, F., Fu, X., & Postolache, O. (2018). Internet of Things for Smart Ports : Technologies and Challeges. *IEEE Instrumentation & Measurement Magazine*, *February*.

Yin, R K. (2009). Case Study Research: Design and Methods, Essential guide to qualitative methods in organizational research. *Applied Social Research Methods Series*, *219*.

Yin, Robert K. (1994). Discovering the Future of the Case Study Method in Evaluation Research. *Evaluation Practice*, *15*(3), 283–290.

Yin, Robert K. (2003). Case study research: design and methods, Applied social research methods series. *Thousand Oaks, CA: Sage Publications, Inc. Afacan, Y., & Erbug, C.(2009). An Interdisciplinary Heuristic Evaluation Method for Universal Building Design. Journal of Applied Ergonomics*, *40*, 731–744.

Yin, Robert K. (2009). Case study research: Design and methods. Sage publications. *Thousand Oaks*.

Yin, Robert K. (2013). *Case Study Research Design and Methods, 5th Revise*. Sage Publications Inc.

Yin, Robert K. (2017). *Case study research and applications: Design and methods*. Sage publications.

Zach, F., Gretzel, U., & Xiang, Z. (2010). Innovation in the Web Marketing Programs of American Convention and Visitor Bureaus. *Information Technology & Tourism*, *12*(1), 47–63.

Zammuto, R. F., Griffith, T. L., Majchrzak, A., Dougherty, D. J., & Faraj, S. (2007). Information technology and the changing fabric of organization. *Organization Science*, *18*(5), 749–762.

Zhao, Wanying, & White, G. (2017). An Evolution Roadmap for Community Cyber Security Information Sharing Maturity Model. *Proceedings of the 50th Hawaii International Conference on System Sciences (2017)*, 2369–2378.

Zhao, Wenjuan, & Goodchild, A. V. (2010). The impact of truck arrival information on container terminal rehandling. *Transportation Research Part E: Logistics and Transportation Review*, *46*(3), 327–343.

Zhou, K., Liu, T., & Zhou, L. (2015). Industry 4.0: Towards future industrial opportunities and challenges. *2015 12th International Conference on Fuzzy Systems and Knowledge*

*Discovery (FSKD)*, 2147–2152.

# APPENDICES

## Appendix A - Publications from the Study

**Journal Paper:**

Effah, J., **Amankwah-Sarfo, F**., & Boateng, R. (2020). *Affordances and constraints processes of smart service systems: Insights from the case of seaport security in Ghana.* International Journal of Information Management. Published online https://www.sciencedirect.com/science/article/abs/pii/S0268401219317025

**Conference Papers:**

**Amankwah-Sarfo, F.,** Effah, J., & Boateng, R. (2019). *Digital Infrastructure for Port Container Handling and Success or Failure of Stakeholders' Goals*: A Case Study of Ghana. Twenty-Fifth Americas Conference on Information Systems, Cancun, 2019, 1–10.

**Amankwah-Sarfo, F.** (2019). *Use of Digital-Physical Security System in a Developing Country's Port: A Case Study of Ghana*. In Y. Dwivedi (Ed.), ICT Unbounded, Social Impact of Bright ICT Adoption (pp. 1–11). Springer Nature Switzerland AG 2019.

**Amankwah-Sarfo, F.,** Effah, J., & Boateng, R. (2018). *Import Clearance Digitalization and Socioeconomic Development: The Case of Ghana*. Twenty-Fourth Americas Conference on Information Systems, New Orleans, 2018, 1–10.

## Appendix B - Summary of Research Questions and Findings

| **Research questions** | **Findings** |
|---|---|
| Why would a developing country seaport deploy smart service systems? | Developing countries seaport perceived that the deployment of the smart service systems could enable (1) autonomous access control, (2) autonomous digital data capturing, (3) data analytic and dashboard reporting, (4) online submission documentation, (5) increased efficiency and transparency |
| How can smart service systems improve seaport services in a developing country and how can smart service systems be constrained? | smart service systems can improve seaport service by replacing physical access control with autonomous access control, paper-based data capturing and analysis with digital data capturing, data analytic and dashboard reporting. |
| How can smart service systems be constrained? | Smart service systems can be constrained by electricity and internet downtimes, limited digital data storage capacity and fatigue of screen monitoring personnel. |
| What are the effects of using smart service systems in developing country seaport?<br><br>What happened after the deployment of the smart service systems? | The effects of using smart service system are: convenience through online submission of trade-related documentation, increased revenue, improved efficiency, speed and integration with back-end systems, transparency and online tracking of your documentation. Increasing port capacity and port efficiency. |

## Appendix C - Summary of Contributions to Knowledge

### C.1 Matrix for Contribution to Theory

| The Literature (What we know) | Gap (What we don't know) | What and why we need to know | Contribution (What we now know) |
|---|---|---|---|
| In affordance conception, affordances are action possibilities that emerge from interactions between technologies and goal-oriented actor(s) or user (s) while constraints are hindrances that prevent actors from using the technology to achieve intended goals (Markus & Silver, 2008b; Thapa & Sein, 2018).<br><br>The attention of IS researchers in studying affordances effects is mostly on how and why outcomes occur (Volkoff and Strong 2013; Strong et al. 2014) and on what barriers an actor might face in trying to achieve those outcomes (Leonardi 2013), | There is a lack of research attention on the constraint process apply to technology affordances and constraints theory.<br><br>IS literature has focused on conceptual (e.g. Geirbo, 2017; Lim & Maglio, 2018, 2019) and literature reviews of papers largely from other disciplines (e.g. Heilig & Voß, 2017).<br><br>IS research on smart service systems has largely been conceptual and literature review without a theoretical foundation. A research gap, therefore, exists in in-depth and theory-driven studies to investigate smart service systems' use and effects in an organisational context. This study addresses this limitation by conducting an in-depth and theory-driven study using technology affordances and constraints theory (TACT) (Majchrzak & Markus, 2013) in a seaport environment. | a) smart service systems comprise smart technology, people, information working together. TACT considers human actors as affording or constraining.<br><br>b) smart technology affordance helps us to understand that smart technology is an active participant n the affordance process and must be treated as human technology affordance as well as. | smart technology affordance as distinguished from human technology affordance as well as the affordance-constraint process as a complement to the affordance-actualisation process. |

**C.2 Matrix for Contribution to Research**

| The Literature (What we know) | Gap (What we don't know) | What and why we need to know | Contribution (What we now know) |
|---|---|---|---|
| IS studies on smart service systems have focused on conceptual (e.g. Geirbo, 2017; Lim & Maglio, 2018, 2019) and literature reviews of papers largely from other disciplines (e.g. Heilig & Voß, 2017). | IS research on smart service systems has largely been conceptual and literature review without a theoretical foundation. A research gap, therefore, exists for in-depth and theory-driven studies to investigate smart service systems' use and effects in an organisational context. | Research on the seaport smart service systems will improve the understanding of smart service systems. | This study contributes to knowledge in smart service systems using an interpretive case study methodology (Klein & Myers, 1999; Walsham, 2006; Barrett & Walsham, 2004; Crowe et al., 2011; Myers, 2013) |
| Lack of empirical research on smart service systems | Extant IS literature has focused on application areas such as smart health, smart building, smart government, smart grid, smart transportation, smart environment, smart home, and smart lifestyle (Caragliu et al., 2011; Pramanik, Lau, Demirkan, & Azad, 2017).<br><br>On seaport smart container handling and smart security systems as a significant study is yet to receive IS research attention. | Research on other location facilities systems will improve understanding of smart service systems by explaining the affordance, constraints, and effects of smart service systems. | This study has extended the literature from a limited focus on conceptual and literature reviews to empirical studies on seaport security and container systems. The study enriches our understanding of smart service systems.<br><br>The study contributes to research attention focus on what outcomes occur and what goals are achieved due to the actualisation process. |

### 5.1.1 C. 3 Matrix of Contribution to Practice

| Findings | Implications for Practice |
|---|---|
| Developing countries' seaports deploy smart service systems enable (1) autonomous access control, (2) autonomous digital data capturing, (3) data analytic and dashboard reporting, (4) online submission documentation, (5) increased efficiency and transparency | The use of smart service systems improves seaport services through autonomous access control where smart technologies replace personnel to do what humans do.<br><br>Smart technologies such as smart cameras and RFID devices take over security patrolling of the port.<br><br>Smart service systems can provide better surveillance of the port but also generate readily information for analysis and decision making.<br><br>Smart service systems can be used to replace humans in various domains in order to address problems of inefficiencies, corruption. |
| Smart service systems can improve seaport services in a developing country and smart service systems be constrained | In a developing country, smart service can improve seaport service by replacing physical access control with autonomous access control, paper-based data capturing and analysis with digital data capturing, data analytic and dashboard reporting. |
| Smart service systems can be constrained by electricity and internet downtimes, limited digital data storage capacity, and fatigue of screen monitoring personnel. | In developing countries, the internet and electricity availability are not guaranteed always. This can constraint the effectiveness of smart service systems. An alternative source of power is required. |
| There are consequences of the deployment of the smart service systems | The consequences of using smart service systems are: convenience through online submission of trade-related documentation, improved efficiency, transparency and online tracking of documentation and increasing port capacity and efficiency. |

## Appendix D - Approval Letters

### D. 1 Approval Letter from Research Organization

GHANA PORTS AND HARBOURS AUTHORITY

PORT OF TEMA

P. O. BOX CO 488
Tema, Ghana
**Telephone:**(233) 0303-202631-8 / (233) 0303-204385-8
**Fax:**(233) 0303 - 204136
**Website:** www.ghanaports.gov.gh
**Email:** tema@ghanaports.net

OUR REF.: DP.TM/T9D/Vol.3/3493

SEPTEMBER 28, 2017

UNIVERSITY OF GHANA BUSINESS SCH.
DEPT. OF OPERATIONS & MGMT
INFORMATION SYSTEMS
ACCRA

**ATTN: DR. JOHN EFFAH**

Dear Sir,

**RE: DOCTORAL RESEARCH: REQUEST FOR INTERVIEW ACCESS ON GHANA'S PAPERLESS PORT DIGITALISATION PROCESSES**

Your letter No. OMIS0917003 dated September 19, 2017 on the above subject refers.

We wish to inform you that approval has been given for your students, **Fred Amakwah-Sarfo** and **Prince Kwame Senyo** to collect information for their project work on the topic **"Ghana's Paperless Port Digitalisation Processes."** from our organization.

They are kindly required to furnish us with copies of their completed research work for our study.

By copy of this letter, the Terminal Manager - GJT, the Marketing & Public Affairs Manager and the Financial Manager are kindly requested to give them the necessary assistance.

In addition, the Port Security Manager is requested to allow them entry into the Port from 28th September, 2017 to 31st July, 2018 to conduct their research work.

**This supersedes letter No. DP.TM/T9D/Vol.3/3367 dated September 25, 2017 on the above subject.**

Yours faithfully,
**FOR: GHANA PORTS & HARBOURS AUTHORITY**

**FLORENCE ESSEL**
PERS./ADMIN. MANAGER
FOR: DIRECTOR OF PORT, TEMA

cc: *Terminal Manager, GJT*
*Financial Manager, Tema*
*Marketing & Public Affairs Manager, Tema*
*Port Security Manager, Tema*
*P/Copies*

PORT SECURITY MANAGER
GHANA PORTS & HARBOURS AUTH.
TEMA

## D. 2 Ethical Clearance

**UNIVERSITY OF GHANA**
ETHICS COMMITTEE FOR THE HUMANITIES (ECH)
*P. O. Box LG 74, Legon, Accra, Ghana*

My Ref. No… **ECH 166/19-20** ……………

June 8, 2020

Mr. Fred Amankwah-Sarfo
Department of Operations and Management Information
University of Ghana
Legon

Dear Mr. Amankwah-Sarfo,

**ECH 166/19-20: Affordance and Constraints of Seaport Smart Service Systems in a Developing Country: A Case Study from Ghana**

This is to inform you that your request for review of your protocol for ethical clearance by the Ethics Committee for the Humanities has been completed. The study has adequately addressed the informed consent. The committee has approved your protocol subject to the following changes:

***Study design***

- The Methodology needs to be better elaborated.
- The sample size should be indicted.

***Benefits and risks***

- There are no direct benefits to participants in the study and this must be made clear to them.

***Selection of participants***

- The two case studies should be specified, in addition to the inclusion and exclusion criteria which must be clearly started.

***Other comments***

- The date of commencement should be revised.

**Please respond to the points raised and highlight the corrections/changes (for ease of reference) and submit a soft copy of the revised documents to the ECH Administrator to the email - *ech@ug.edu.gh* by Tuesday 14th July 2020. The hard copy can be delivered to the ECH office during the opening hours.**

Yours sincerely,

Mrs. Afia Attrams
**ECH Administrator**

Tel: +233-303933866 Email: ech@ug.edu.gh