Digital Infrastructure for Port Container Handling and Success or Failure of Stakeholders' Goals: A Case Study of Ghana

Completed Research

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Abstract

The purpose of this study is to understand the use of digital infrastructure for port container handling and success or failure of stakeholders' goals. Information Systems (IS) research on digital infrastructure has focused more on health, telecommunication, government, and manufacturing and less on port container handling. IS literature on DI has focused more on e-health, e-government, e-commerce as well as different industries and platforms and less on the use of DI and success or failure of stakeholder goals. To address this gap, we employed affordance theory as an analytical lens and qualitative, interpretive case study as a methodology to investigate the use of digital infrastructure for port container handling in Ghana. The findings show how digital infrastructure conditions success or failure of stakeholder goals. The findings also have implications for research, practice, and policy. This paper contributes to the emerging literature stream on digital infrastructures. The originality of the paper lies in its focus on the use of port container handling systems as a significant IS research phenomenon.

Keywords

Digital infrastructures, port containers, affordance theory, interpretive case study, Ghana.

Introduction

The purpose of this study is to understand the use of digital infrastructure for port container handling and success or failure of stakeholders' goals in Ghana. Digital infrastructure (DI) is an interconnected network of organizations, people and technologies (Bygstad et al. 2017). Information Systems (IS) research on DI has gained prominence in recent times (Henfridsson and Bygstad 2013). Extant literature conceptualized infrastructure as a complex assemblage of different actors and technologies (Henfridsson, 2013; Koutsikouri & Henfridsson, 2017).

This study defines DI as "the collection of technological and human components, networks, systems, and processes that contribute to the functioning of an information system made up of both social and technical elements." (Henfridsson and Bygstad, 2013, p. 908). IS literature on DI has focused more on e-health, e-government, e-commerce as well as different industries and platforms (Blaschke et al. 2016) and less on the use of DI and success or failure of stakeholder goals. Following this research gap, the research question for this study is how the use of digital infrastructure for port container handling in Ghana conditions success or failure of stakeholders' goals.

In addressing the above question, the study employs affordance theory (Burrell and Morgan 1979) as the analytical lens and an interpretive qualitative case study approach (Walsham, 2006, Barrett and Walsham, 2004, Klein and Myers, 1999) as a methodology to investigate how the use of port digital infrastructure enables or constrains stakeholders goals for container handling in Ghana.

We conducted this research at the Tema Port in Ghana. The port authorities had recently implemented a digital infrastructure solution for container handling to minimize the drudgery of cumbersome bureaucracy, human interface, and paper document transactions. One of the main objectives of digitalization is to make port container handling operations more efficient. Furthermore, trade is a significant activity for the Ghanaian economy and ports play an important role in facilitating trade. Trade facilitation helps to reduce transaction costs and result in better prices of goods and services (Milner et. al., 2008). Moreover, the use of digital infrastructure can help address inefficiencies associated with port container handling systems and thus require a need for research to help address inherent challenges.

The remaining part of the paper is structured as follows: The next section reviews the literature on digital infrastructure and port container handling systems. The subsequent two sections present the theoretical foundation and research methodology. The case description follows. The section after presents the case analysis. The discussion follows. The final section presents a conclusion with a contribution to knowledge and recommendation for further research.

Digital infrastructure and port container handling systems

The IS-community has established the competitiveness of the shipping industry enabled by digitalization (Haraldson 2015). The advancement in digital technology (Legner et al. 2017) has enabled online interactions (Blaschke et al. 2018). Generally, these enablers improve connectivity, increased possibilities of digital collaboration, seamless interoperability (Haraldson 2015) between human actors, organizations and processes (Bharadwaj et al. 2013; McKelvey et al. 2015). The enablers are also shifting focus to service ecosystems, new experiences, and new forms of human interactions (Tilson, Lyytinen, & Sørensen, 2010).

These interactions are made possible by new IS artifacts known as digital infrastructure (DI) (Hanseth and Lyytinen 2010; Henfridsson and Bygstad 2013; Tilson et al. 2010). The IS field has focused more on IT governance and system development in well-bounded organizational contexts, impacts on individuals, groups, and markets (Sidorova et al. 2008). Moreover, the complex nature of operations at container terminals require information systems to provide real-time solutions for monitoring and control (Mnale and Park 2017).

IS scholars have also studied interconnected networks of organizations, people and technologies (Bygstad et al. 2017). DI can, therefore, be referred to as an evolving sociotechnical systems (Vaast and Walsham 2009; Braa et al. 2007; Tilson et al. 2010) use by stakeholders to meet goals (Weinrich et al. 2016). The technical characteristic of DI involves the integration of IPs, artificial intelligence, monitoring devices and data analysis (Slavova 2017). Through unique addressing schemes and standard communication protocols, DI connect a variety of physical devices that can interact with each other (Atzori et al. 2010).

An increasing IS research interest has considered DI's unique properties and effects in understanding digitalization (Tilson et al. 2010, p. 753). Extant literature has assumed the notion of DI concept as a move from single IT infrastructure to networks of digital infrastructures (Ciborra 2000; Tilson et al. 2010) and from a stand-alone, silo or unintegrated systems to interconnected systems (Henfridsson and Bygstad 2013, p. 908).

In relation to seaports, digital infrastructures enable efficient, seamless and secure exchange of information between stakeholders (Srour et al. 2008; Oosterhout, 2008; Carlan et al. 2016). Ports worldwide are using various forms of digital infrastructure technologies to meet current requirements, reduce cost and increase efficiency (Markovitch & Willmott, 2014), support scheduling and equipment control process and provide real-time accurate data for operations within container terminals (Ghoos et al. 2004; Gheith et al. 2013). This improves the operational performance of ports and quality of container handling processes (Conca et. al, 2018). This study seeks to extend existing knowledge on digital infrastructure and port container handling systems.

Theoretical Foundation: Affordance theory

Affordance concepts have been adapted in IS research to understand how humans interact with technology (Hutchby, 2001; Leonardi, 2011; Markus & Silver, 2008b). Affordance is the capabilities of actors in perceiving an object in relation to the actor's goals (Dini et al. 2018). Technology features and organizational contexts are the focus of affordance theory (Herterich et al. 2016). To understand how the use of digital

infrastructure enables or constrains port container handling systems in Ghana, this interpretive case study draws from Affordance Theory (Burrell and Morgan 1979) as the analytical lens. Originally developed in studies by psychologists, affordance theory contends that people directly "pick up" relevant information from objects in their environment (Markus & Silver, 2008).

Affordance can be defined as acts or behaviors enabled or permitted by an object, place, or event (Hammond 2009). Affordances are opportunities or action possibilities such as actor competencies and actualized by users for an action to occur (Strong et al. 2014). Enabling affordances are "the possibilities for goal-oriented action afforded to specified user groups by technical objects" (Markus and Silver, 2008).

The concept of affordances can be used to examine the decisions made by actors to modify either their behavior or technology to achieve goals (Leonardi, 2011). Therefore, the concept offers a rich approach to study digital infrastructure for port container handling systems. It allows us to conceptualize different perceptions and patterns of technology in relation to the goals and capabilities of actors (Markus and Silver, 2008). When port actors engage with digital infrastructure, they alter work practices (Sebastian and Bui 2012) to achieve goals (Leonardi, 2011, p.154).

In IS, affordance is the action possibilities afforded to specified user groups by technical objects (M. Lynne Markus and Silver 2008). Affordance has been argued to equally constrain or hinder the use of technology (Verhulst 2017). Hence, affordance has become a framework that is used to study how people and organizations utilize IS (Majchrzak et. al, 2013). Therefore, the affordance lens can help understand the relationship between technology and actors (Stendal et al. 2016). Affordance can be classified into enabling and constraining affordances (Jan et al. 2013).

The underlying concepts of affordance theory are technical objects, enabling and constraining affordances. Technical objects are the IT artifacts and their component parts, which form a technical system. Technical objects are real objects, material or abstract with properties that may have causal possibilities (Markus and Silver 2008). Enabling affordances are the potentials for goal-oriented actions afford a specified user or groups of users. Constraining affordances are the potentials or possibilities to limit goal-oriented action of a specified user or groups of users. Constraints are also relations between technical objects and users.

The principles of Affordance Theory in IS research are: affordance arises from user/artifact relation (Seidel et al. 2013); affordance focus on action, not the state or condition reached after taking the action; affordances are goal-oriented action afforded to specified user groups by technical objects (Turvey 1992) and affordances are meaning-making opportunities relative to actors goals and system capabilities (Verhulst 2017). To sum up, IS affordance literature has provided a useful conceptual foundation to develop an understanding of how digital infrastructure for port container handling system enables or constrains stakeholders from achieving their goals at Tema Port.

Methodology

The study was conducted at Tema Port in Ghana, a developing country. Tema Port was selected because it had recently gone through digitalization. This study's methodology was qualitative, interpretive case study (Myers and Klein 2011; Walsham 1995, 2006). Generally, qualitative research seeks an in-depth understanding of a phenomenon (Creswell, 2013; Miles, Huberman, & Saldana, 2016) involving humans and their social interpretations, experiences and actions (J. W. Creswell 2013).

Based on a qualitative research approach, an interpretive case study in IS attempts to understand interactions between information technologies and their social contexts (Klein & Myers, 1999; Walsham, 1995; 2006). A case study method provides in-depth, flexible and appropriate means to investigate the complex interactions among users of technology (Dubé and Paré, 2003; Myers, 1997).

The underlying research paradigm of the study is based on subjective ontology. This means that the research phenomenon under study and the knowledge output are both socially constructed rather than objectively given (Myers 2013; Orlikowski and Baroudi 1991).

In line with this philosophy, we consider interpretive case study as suitable to understand port systems, actor groups and their interactions as a digital infrastructure phenomenon in Ghana. Data collection occurred over six months, from September 2018 to January 2019. In line with the interpretive case study tradition (Walsham 2006), we gathered qualitative data from multiple sources including interviews,

observations, websites, field notes, and documentary materials (Myers, 1999). Interviews are one of the most important sources of information for the case study and an efficient method to gather rich insights (Yin 2009).

Eleven participants were interviewed. They are involved with the use of the digital port infrastructure in Ghana. The participants were the harbor master (1), information systems professionals (2), customs (3), importers (4) director for operations, and port security manager, selected through purposive sampling (J. Creswell 2013; Patton 2002). A semi-structured interview guide was used (Myers & Newman, 2007) and lasted between 50 minutes and 1 hour.

Some of the interview sessions were audio recorded, subject to the informed consent of the interviewee. We subsequently transcribed the interview sessions for more detailed analysis. The initial data analysis occurred alongside data collection (Myers, 2013; Walsham, 2006) and based on hermeneutics cycle (Myers and Klein, 2011). In step with interpretive tradition, data analysis took place concurrently with the data collection (Walsham, 2006) and aided by affordance theory concepts of technical objects, actors, and their interactions to analyze the case findings.

Case description

Tema Port is located on the eastern coast of Ghana. The port provides container handling facilities via a dedicated container terminal, managed and operated by a private company, Meridian Port Services (MPS). The terminal consists of two berths and a quay length of 575 meters with the following facilities: 3 Ship to shore gantries, 4-yard gantries, 2 Mobile Cranes, Reach Stackers, 272 reefer plug points and a six-lane electronic gate complex.

The port also consists of an inland clearance depot (ICD) known as the Golden Jubilee Terminal (GJT) located on the western end of the port. This facility spans an area of 97,412 square meters and comprises a container freight station (CFS), a state warehouse, car park and an open area for striping/un-stuffing and storage of containers, banking services, and offices for customs.

The 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.

Paper-based systems

Traditionally, container handling processes were largely through silo (i.e. unintegrated) systems and paper-based documents. Container terminals operators, port authorities and shipping lines use different ICT systems for communication at the port. The container handling system was dependent on manual and paper-based systems. For example, the various terminals communication systems were not interconnected. An allocation officer had this to say:

> *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 harbor master's outlet.*

A harbor master supervisor explained:

> *Our harbormasters will look at the availability of berths that is convenient for vessel and schedule it whiles [sic] they go for what we call the berthing meeting. At the meeting, stakeholders confirm, and the process is approved. Then all stakeholders will agree that on this day that vessel will berth.*

The manual system involves physically presenting forms and paper documents for stamps, receipt and moving from one office to another. A senior supervisor indicated that:

> *Even where electronic communications exit, only mails are used. Shipping lines submitted pdf copies of their manifest and discharge list electronically through email.*

The container handling system in the pre-digitalization era was characterized by manual and paper documents. This caused delays and inefficiencies and possible collusion of terminal operators and importers. The terminal operation manager explained:

> *The officers go through the manifest list one by one to pick the consignee's address to determine whether the cargo is meant for transit or bound for other countries.*

This is followed by checking the description of goods. The shipping lines indicated containers to their designated inland cargo depot (ICD) terminals. However, the allocation office has the final discretion to re-allocate containers based on the standard operation procedures (SOP). Terminal one manager shared his thoughts:

> *Though the shipping line also has the SOP, there are times where the lines misallocate containers. After making the necessary corrections, the allocation office sent an email to the shipping line and control room for unloading of the containers unto truck.*

Digital port infrastructure

In April 2014, port authorities implemented an integrated online system to facilitate international trade. The goal was to reduce people-to-people contact to expedite container handling. The migration to the digital platform became contentious. Some of the existing parties fiercely resisted. This is because it enabled freight forwarders to charge premiums, using the lack of data transparency to cover up. The principal use of ICT in ports is a digital terminal operating system (DTOS). An IT manager observed:

> *The terminal operating system is a port container handling software that enables faster decision making, maximizes operational efficiency and improves competitiveness. DTOS is a stable and comprehensive and forms the core of the port's information system.*

Shipping lines their track containers during the delivery process from these terminals. It also facilitates submission of soft copies of shipping line delivery orders and customs release for confirmation. An importer stated that:

> *Cargo expected at the terminal, containerized and non-containerized cargo. The system is used to planned vessel arrivals and departure. Truckers use digital truck appointment system functionality to pre-register their visit to the terminal and speed up the actual gate procedures.*

A yard visualization and planning module ensure containers received at the terminals are automatically scheduled to a yard location, based on configurable rules. Furthermore, the exact yard situation can be visualized both in a 2D and 3D graphical overview. Execution of planned moves is taken care of by an integrated equipment control module, sending instructions to equipment operators. The system supports cargo handling equipment and terminal layouts. An IT officer said:

> *Terminal automation technologies which involve a collaboration platform or solution that facilitates dynamic interaction between the systems of port authorities, shipping agents, freight and logistics businesses.*

A stowage planning module allows terminals to plan loading container vessels, based on incoming stowage plan and position of cargo. A resulting load plan issues move instructions to equipment operators.

Tema Port is designed to run automated and semi-automated processes using the latest generation of digital technologies at various stages of terminal operations. An operations manager had this to say:

> *Truck Appointment System (TAS), an online portal is open 24 hours a day, seven days a week to avoid delays compared to the manual process. The TAS will communicate in real-time with a centralized and high-available Terminal Operating System (TOS) to retrieve and validate all data. Once an appointment is confirmed, a registered truck driver is welcomed at the terminal and allowed to enter based upon biometric fingerprint validation process.*

Using such advanced technology allows granting access to truck drivers already registered. This ensures that cargoes are safe and compliant with the International Ship and Port Facility Security (ISPS) code. The head of security averred:

> *As soon as a truck enters the port premises, an automated workflow is initiated at the background. Upon arrival at our gates, an automated License Plate Recognition (LPR) picks the truck license plate. In addition to the LPR, each truck will be identified through a unique and tamper-proof identification sticker based upon RFID technology.*

Every data is captured and verified in real time as the truck drives through automated gates. By the time the truck reaches the terminal gates, all captured data has been processed, and the weight taken through automated weighbridges. The truck is automatically identified by RFID and proceeds to its destination at the container yard. The yard eRTG operator will be automatically informed through the Terminal Operating System. Upon arrival, the visiting truck will be served by operators immediately. 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.

Case Analysis

This section draws on affordance theory concepts for the case analysis. From the case description, the port container handling system (PCHS) is conceptualized as a digital infrastructure enabling distribution of e-documents on containers before ships berthing. The stakeholder groups are shipping lines, port authorities, importers and truck drivers.

The concepts of affordance were used to explain the container handling processes. The key principles of affordance theory are enabling and constraining affordance. The concepts of affordance are technical objects (digital technologies), stakeholder groups, and their goals were used to analyze the case findings.

Enabling Affordance of Digital Container Handling Systems

Stakeholder groups	Digital technology	Enabling affordance
shipping lines, port authorities, importers, *Goal: Cost reduction, Efficiency*	digital port operating system	online transaction
shipping lines; importers *Goals: to track the location of containers, transparency*	digital container tracking system	online container tracking
truck drivers *Goals: reduce congestion*	digital truck appointment system	online booking
port authorities *Goal: port security*	electronic gating (E-Gate) system	online container verification

Table 1: Enabling Affordance of Digital Container Handling Systems

From the case description, the digital container handling system enables port stakeholders to achieve intended goals. Table 1 shows a summary of the enabling affordance of digital port container handling system. The next sections detail how the digital container handling system enables achievement goals of shipping lines, terminal operators, port authorities, importers, stevedore, crane operators, and truck drivers' goals. Shipping lines, port authorities, and importers successfully achieve goals of efficiency and cost reduction through online interactions. Shipping lines and importers can track their container locations online via the digital container tracking portal. While the goal of shipping lines is for vessels to be served immediately, track containers location to ensure transparency.

Terminal operators and stevedore can schedule container handling operations online. This enables efficiency and quick decision making. The goal of stevedore and crane operators is to load and off-load containers on off trucks efficiently - online transmission of information to load/offload containers on trucks through an onboard transmission system.

Port container handling process efficiency has significantly improved compared to the pre-digitalization regime. Truck drivers use the digital truck appointment system to book the arrival and departure of trucks online to reduce congestion and long waiting time. Port authorities' goal is suppressing potential security risks by using the electronic gating (E-Gate) system and online container verification.

Constraining Affordance of Port Container Handling Systems

Actor groups & their goals	**Digital technology**	**Constrain affordance**
importers *Goal: smuggle*	3 D container scanner	smuggling
infiltrators *Goals: bypass security*	electronic gating (E-Gate) system	non-authorized entry

Table 2: Constraining affordance of Port Container Handling Systems

The constraining affordances are smuggling and security. Containers are scanned by 3D scanners to detect and stop importers smuggling illegal cargo. The absence of face to face interactions constrains the possibility of discretion and extortion of money. Table 2 is a summary of the constraints of the digital port container handling systems.

3 D scanners constrain smuggling by importers who may want to outwit port authorities from detecting such goods. The goal of infiltrators is to have unauthorized access, however, the electronic gating (E-Gate) systems allow only biometrically verified persons into the port space.

Discussion of findings

This section discusses how the research question is answered using affordance as the theoretical lens. In line with the research question: how digital infrastructure for port container handling in Ghana conditions success or failure of stakeholders' goals as shown in Table 1 and Table 2 above. The study sought to achieve this by examining how digital infrastructure for port container handling in Ghana's seaport reduce cost and increase efficiency (Markovitch and Willmott 2014). It is important to state that the digital port container handling system is a technical object with component parts (Glowalla et al. 2014).

From the case study, the digital port container handling system is an infrastructure which enables online interactions between stakeholders to achieve their goals (Leonardi 2013) while restricting other stakeholders achieving their goals (Majchrzak and Markus 2012; Dini et al. 2016). The interactions between the actors and the digital port handling system identified in the case study raise interesting issues for discussion, however, based on the research questions and affordance theory the success and failure of stakeholder goals and the digital container handling systems in Ghana are discussed.

This study has sought to achieve this by explaining affordance and constrains resulting from the digital port container handling systems and its stakeholders. The research findings show how stakeholders in Ghana use a digital port container handling system for online transactions, container tracking, information exchange, booking, and verification.

Conclusion

The purpose of this study was to understand the use of digital infrastructure for port container handling systems and success or failure of stakeholders' goals. The paper's originality lies in its focus on the use of digital infrastructure for port container handling systems as a significant IS research phenomena.

The findings show how the use of digital infrastructure conditions success or failure of stakeholders' goals. The findings have implications for research, practice, and policy. For research, affordance theory is considered useful for studying digital infrastructure phenomena involving heterogeneous actor groups. For practice, digital infrastructure can significantly help improve streamline port container handling systems. For policy, digital infrastructure can help improve efficiency and reduce cost.

The study is limited to a single case study in Ghana. However, from an interpretive perspective, the findings apply to other ports with similar settings. Future research can focus on digital infrastructure for port security systems.

REFERENCE

Atzori, L., Iera, A., and Morabito, G. 2010. "The internet of things: A survey", *Computer networks* (54:15), Elsevier, pp 2787–2805.

Blaschke, M., Aier, S., and Winter, R. 2018. "Capabilities for Digital Platform Survival : Insights from a Business-to-Business Digital Platform", in *Thirty Ninth International Conference on InformationSystems,* pp 1–17.

Blaschke, M., Winter, R., and Aier, S. 2016. "Digital Infrastructure : A Service-dominant Logic Perspective", *Thirty-Seventh International Conference on Information Systems*, pp 1–11.

Braa, J., Hanseth, O., Heywood, A., Mohammed, W., and Shaw, V. 2007. "Developing health information systems in developing countries: the flexible standards strategy", *Mis Quarterly*, JSTOR, pp 381–402.

Burrell, G., and Morgan, G. 1979. "Two dimensions: Four paradigms", *Sociological paradigms and organizational analysis*, pp 21–37.

Bygstad, B., Hanseth, O., Siebenherz, A., and Ovrelid, E. 2017. "Process innovation meets digital infrastructure in a high-tech hospital", *Proceedings of the European Conference on Information Systems* (2017), pp 1–14.

Carlan, V., Sys, C., and Vanelslander, T. 2016. "How port community systems can contribute to port competitiveness: Developing a cost-benefit framework", *Research in Transportation Business and Management* (19), Elsevier Ltd, pp 51–64.

Ciborra, C. 2000. "From alignment to loose coupling: from MedNet to www. roche. com", *From control to drift: The dynamics of corporate information infrastructures*, pp 193–212.

Conca, A., Febbraro, A. Di, Giglio, D., and Rebora, F. 2018. "Automation in freight port call process: Real time data sharing to improve the stowage planning", *Transportation Research Procedia* (30), Elsevier B.V., pp 70–79.

Creswell, J. 2013. "Qualitative, quantitative, and mixed methods approaches", *Research design*, London: SAGE Publications.

Creswell, J. W. 2013. *Steps in conducting a scholarly mixed methods study*.

Dini, A. A., Sæbo, Ø., and Wahid, F. 2018. "Affordances and effects of introducing social media within eParticipation—Findings from government-initiated Indonesian project", *Electronic Journal of Information Systems in Developing Countries* (84:4), pp 1–14.

Dini, A. A., Wahid, F., and Sæbo, Ø. 2016. *Affordances and constraints of social media use in eParticipation: perspectives from Indonesian politicians*.

Gheith, M. S., El-Tawil, A. B., and Harraz, N. A. 2013. "A proposed heuristic for solving the container pre-marshalling problem", in *The 19th International Conference on Industrial Engineering and Engineering Management*, Springer, pp 955–964.

Ghoos, H., Korsgaard, J., Runge-Schmidt, L., and Agerschou, H. 2004. *Berth and Terminal Design in General. Storage Facilities and Cargo-Handling Systems*.

Glowalla, P., Rosenkranz, C., and Sunyaev, A. 2014. "Evolution of IT Use: A Case of Business Intelligence System Transition", *Icis*, pp 1–19.

Hammond, M. 2009. "What is an affordance and can it help us understand the use of ICT in education?", *Education and Information Technologies* (15:3), pp 205–217.

Haraldson, S. 2015. "Digitalization of Sea Transports – Enabling Sustainable Multi-Modal Transports", in *AMCIS 2015 Proceedings*, pp 1–9.

Henfridsson, O., and Bygstad, B. 2013. "The Generative Mechanisms Of Digital Infrastructure Evolution", *MIS Quarterly* (37:3), pp 907–931.

Herterich, M. M., Eck, A., and Uebernickel, F. 2016. "Exploring How Digitized Products Enable Industrial Service Innovation – An Affordance Perspective", in *Proceedings of the 24th European Conference on Information Systems (ECIS)*, pp 1–17.

Hutchby, I. 2001. "Technologies, texts and affordances", *Sociology* (35:2), Cambridge University Press, pp 441–456.

Jan, C., Bernhard, E., Recker, J., and Burton-jones, A. 2013. "*Understanding The Actualization Of A Affordances : A Study In The Process Modeling Context*".

Koutsikouri, D., and Henfridsson, O. 2017. "Building Digital Infrastructures : Towards an Evolutionary Theory of Contextual Triggers", in *Hawaii International Conference on System Sciences*, pp 4716–4725.

Legner, C., Eymann, T., Hess, T., Matt, C., Böhmann, T., Drews, P., Mädche, A., Urbach, N., and Ahlemann, F. 2017. "Digitalization: Opportunity and Challenge for the Business and Information Systems Engineering Community", *Business & Information Systems Engineering* (59:4), pp 301–308.

Leonardi. 2011. "When Flexible Routines Meet Flexible Technologies: Affordance, Constraint, and the Imbrication of Human and Material Agencies", *MIS Quarterly* (35:1), p 147.

Leonardi, P. M. 2013. "When does technology use enable network change in organizations? A comparative study of feature use and shared affordances", *MIS quarterly*, JSTOR, pp 749–775.

Majchrzak, A., Faraj, S., Kane, G. C., and Azad, B. 2013. "The contradictory influence of social media affordances on online communal knowledge sharing", *Journal of Computer-Mediated Communication* (19:1), Oxford University Press Oxford, UK, pp 38–55.

Majchrzak, A., and Markus, M. L. 2012. "Technology Affordances and Constraints in Management Information Systems (Mis)", *Encyclopedia of Management Theory*, p 5.

Markovitch, S., and Willmott, P. 2014. "Accelerating the digitization of business processes", *McKinsey & Company*.

Markus, M. Lynne, and Silver, M. 2008. "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), pp 609–632.

Markus, M Lynne, and Silver, M. S. 2008. "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), p 5.

Milner, Chris; Morrissey, Oliver; Zgovu, E. 2008. "Trade facilitation in developing countries".

Mnale, F., and Park, J. 2017. *MobDesctop : A Mobile Decision Support Application for Monitoring Real-time Container Terminals Operations MobDesctop : A Mobile Decision Support Application for Monitoring Real-time Container Terminals Operations*.

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

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

Myers, M. ., and Klein, H. K. 2011. "A Set of Principles for Conducting Critical Research in Information Systems", *MIS Quarterly* (35:1), pp 17–36.

Myers, M. ., and Newman, M. 2007. *The qualitative interview in IS research : Examining the craft*, (17), pp 2–26.

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

Patton, M. Q. 2002. *Qualitative Research and Evaluation Methods*, Thousand Oaks: SAGE Publications.

Sebastian, I. M., and Bui, T. 2012. "the Influence of IS Affordances on Work Practices in Health Care : a Relational Coordination approach", *Icis 2012*, pp 1–11.

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

Sidorova, A., Evangelopoulos, N., and Valacich, J. S. 2008. "Uncovering The Intellectual Core Of The Information Systems Discipline", *MIS Quarterly* (32:3), pp 467–482.

Slavova, M. 2017. "Digital Infrastructures As Platforms : The Case Of Smart Electricity Grids", *European Conference on Information Systems (ECIS)* (2017), pp 1217–1231.

Srour, F. J., van Oosterhout, M., van Baalen, P., and Zuidwijk, R. 2008. "Port Community System Implementation : Lessons Learned from an International Scan", *Transportation Research Board 87th Annual Meeting* (August), pp 1–16.

Stendal, K., Thapa, D., and Lanamaki, A. 2016. "Analyzing the Concept of Affordances in Information Systems", in *49th Hawaii International Conference on System Sciences Analyzing* (Vol 2016-March), pp 5270–5277.

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

Tilson, D., Lyytinen, K., and Sørensen, C. 2010. "Research commentary—Digital infrastructures: The missing IS research agenda", *Information systems research* (21:4), Informs, pp 748–759.

Turvey, M. T. 1992. "Affordances and prospective control: An outline of the ontology", *Ecological psychology* (4:3), Taylor & Francis, pp 173–187.

Vaast, E., and Walsham, G. 2009. "Trans-situated learning: supporting a network of practice with an information infrastructure", *Information Systems Research* (20:4), INFORMS, pp 547–564.

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

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

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

Weinrich, T., Muntermann, J., and Gregory, R. W. 2016. "Exploring Principles for corporate digital Infrastructure Design in the Financial Service Industry", *Pacis*.

Yin, R. K. 2009. "Case study research: Design and methods. Sage publications", *Thousand oaks*.