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Information technologies and seaport operational efficiency

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Abstract

Purpose – The introduction of information technology (IT) in port operations has been a tremendous contributor to transformation in world trade. This study was carried out to examine the influence of IT on the efficiency of seaport operations.

Design/methodology/approach – The study is quantitative in nature, and it relied on a closed-ended self-administered questionnaire to collect primary data. Structural equation modeling (SEM) was used to test the theoretical model and hypothesis.

Findings – The results indicate that IT has a positive direct effect on port operational efficiency (OE) and an indirect effect on port OE through organizational culture (OC). The mediating role of OC is statistically insignificant.

Originality/value – This is among the first few attempts in Sub-Saharan Africa (SSA) that provides researchers with a contemporary view of IT and seaport operations.

Keywords Information technology, Seaport, Operational efficiency, Organizational culture

Paper type Research paper

Introduction

The need for seaports to ensure efficiency in their operations have been very critical considering the rise in trade volumes (Robinson, 2014; Jeevan *et al.*, 2019, 2021; Ugboma and Oyesiku, 2020). According to Matinez (2011), seaports are sites where there are facilities to berth or anchor ships for cargo management. In furtherance, Roberts (2013) defined ports as the seashore where there are cargo handling facilities available to process cargoes from ships to shore, shore to ships, or ships to ships. Port operations have consistently been expanding. Today, ports are gearing up to face the task of handling mega-vessels capable of carrying 10,000–12,000 twenty-foot equivalent units (TEUs) and beyond while operating with a short period of time when it docks (Baird, 2012). Wang and Cullinane (2006) indicated that there is the need for container ports to deliver reliable and cost-effective services. Hence, in light of this, they have to invest heavily to satisfy the draconian demands to ensure faster service and higher quality. Lately, Shi and Voa (2011) indicated that there is the need to inculcate information technology (IT) in every stage of port operations or management activities. This will improve information flow among port stakeholders.

In furtherance, with much happening within ports across the globe, a lot of port institutions have taken a step ahead to additionally improve on information flow between shippers and destination clearing agents (Haralambides, 2019). According to De Marigny (2016), various ports have taken steps in adding the necessary IT into every form of operation.

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IT is utilized in business operations in the port data processing and communication for the efficiency of many international port organizations (Heilig *et al.*, 2017). The application of IT has led to efficient management of data systems, processing of information and interconnect with management and operational administrators of ports, and efficient transport system. In this vain tracking, devices for containers and cargo at the ports have been prioritized at ports. This phenomenon will improve productivity and satisfaction of customers.

However, the operation of a port is not just about the integration of work processes and IT to provide services related to the management of port and harbor facilities: servicing of vessels (receiving) receipt, storage and delivery of cargo to clients worldwide. The role of human factors is also central to organizational efficiency. This introduces the factor of organizational culture (OC) and its effects or lack thereof on organizational efficiency. Effective OC helps in improving business decisions which in turn translated into organizational efficiency. According to Sathe (1983), culture is described as a combination of values, sets, beliefs, communications and behavioral explanation that serves as a guidance to people.

According to Beaudry and Pinsonnault (2005), the OC encompasses issues such as the capabilities of the staff and their adaptability to IT and the willingness of port users in accepting change. When the human factor (OC) and deployment of IT are successfully coordinated, it brings about organizational efficiency. It is usually the IT which is focused on by management and not taking into consideration the OC and its impact on efficiency. The OC at the port in terms of operability and acceptance of technology has been very challenging. According to Silverstone, Hirsch and Morley (1991), characteristically information and communication only flows down, and not up. This has been an unhealthy culture communication that flows down rather than up and across. Hence, the adoption of technology as a means of transforming the operations at the port has been stiffened with many handicaps which are faced by customers and have not been able to get it across to the top hierarchy of the institution.

The OC at the Tema Port has been an intricate factor posing challenges to the implementation of IT in the operation of the port. This comes as a result of cutting off the middlemen and those cheating the port operations system finding it difficult to do so with the introduction of IT; hence, sabotaging the system. Also, clearing agents who find it difficult to use IT addition to the operations due to low or lack of education also causes a lot of challenge to the smooth operation of the port operations and activities. Congestion and inefficiency in operation; clearing time, lack of understanding by stakeholders in IT inculcation into port operations are among the major factors hindering the processes and improvement of operations at Tema Port in Ghana. The slow shipping time and loss of revenue have been among the major challenges against Tema ports operation. This challenge has brought negative impacts on the performance of the port resulting in revenue loss to government. The loss in revenue can be attributed to diversion of some shipping lines and goods to ports in neighboring countries. This is due to delays in offloading of goods from ships that berth at the port (Van Hassel *et al.*, 2016). This paper has five (5) main parts. The next section chronicles the literature reviewed for the study. This is followed by a description of the data and methodology. The fourth section presents the results and discussions of the study. The last part contains the summary.

Theoretical review

Resource base view theory (RBV)

According to Liu *et al.* (2009), "... the RBV is a strategic theory for understanding why some firms outperform others" (p. 412). This goes to authenticate the phenomenon that in an overly competitive environment, characterized by phenomena such as market globalization, shifting

workforce demographics, changing customer preferences and increasing product-market differentiation; most organizations have put in place measures like IT and strict organization cultures to meet these demands. Organization culture and IT, if managed properly, becomes a source of competitive advantage because their significance to the organization cannot be overlooked (Saa-Perez and Garcia-Falcon, 2002). RBV rest on the premise that organizations are able to develop and sustain competitive advantage by generating value through resources (such as organization culture) in a way that is rare and complicated for other competitors to imitate (Saa-Perez and Garcia-Falcon, 2002; Paauwe, 2004). Grant (2002, p. 133) defined the RBV as "ideas concerning the role of a firm's resources and capabilities as the principal bases for its strategy and primary source of its profitability." The RBV suggests that competitive advantage for businesses, particularly those to be sustained over the long-term, comes from firm resources and capabilities (Barney, 1991; Porter, 1980; Wernerfelt, 1984). Resources are "anything which could be thought of as a strength or weakness of a given firm" (Caves, 1980; Wernerfelt, 1984, p. 172). Therefore, under the RBV, various technological and organizational cultures can be considered resources for acquiring sustained competitive advantage. For instance, OC, managerial skills, backend integration, technology and manufacturing facilities are viewed as manufacturer resources (Dong *et al.*, 2009). IT is regarded as an effective firm resource when it is complemented by other resources or practices (Powell and Dent-Micallef, 1997; Tippins and Sohi, 2003; Nevo and Wade, 2010). In this study, IT is seen as resource that has an influence on port operational efficiency (OE). However, the study argues that the presence of OC may enhance the said relationship. Thus, the study examines the relationship between IT and port OE with OC as the mediator (see Figure 1).

Empirical review and hypothesis development

In reviewing few studies in this field to form some empirical basis for using IT in port operations, there were some scholarly works which were understudied. It is worthy of note that the empirical review of relevant literature has been done with respect to the study objectives which sought to investigate the relationship among IT and OE, IT and OC, and the mediating role of OC on the effect of IT on OE.

Relationship between information technology and operational efficiency (OE). The relationship between IT and OE has been researched by various authors in different fields with varied outcomes. However, it must be emphasized that significant number of the studies have disclosed a positive relationship between IT and OE. Within the work of Olugbode *et al.* (2008), it was discovered that the adoption of new information systems led to different achievements in organizations. The achievement appeared within the company organizational procedures and business processes, which lowered the operating costs of the company and thereby improving the efficiency of organization. In another study by Akande *et al.* (2011), evidence was established to the fact that IT affects the performance of various activities such as examination processing, student registration and assignment

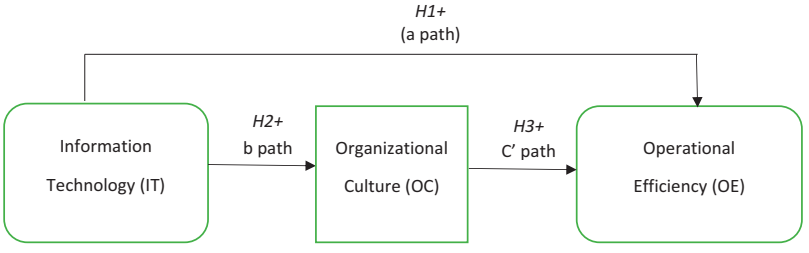

Figure 1.
Conceptual framework

provision, to be carried out on time, thus impacting on the broader organizational efficiency. Further, it is revealed in the work done by Sgouridis and Angelides (2002) that using IT and terminal appointment systems (TAS) as technology-based tools more positively affect overall congestion management. Bardi *et al.* (2004) in support of the argument showed that the capability of a business entity to optimize logistical operations and minimize costs is directly influenced by application of IT. A study conducted on Mombasa port in Kenya by Chen *et al.* (2013) proved that using IT in port operation reduced truck waiting time and averages to about 35% percent less time spent than the traditional way of operations. Hence, implementations of terminal appointment systems could reduce truck turnaround time by 30–35% to enhance operations at the port. It is also obvious that there is clear merit in implementing solutions with IT to manage and evenly distribute traffic flows across the operating hours of the terminal. Majority of all other research discovered similar results (Mithas and Rust, 2016; Carr, 2016; Rusca *et al.*, 2016; Shahriari *et al.*, 2016).

Again, it is important to mention that in the study by Kengpol and Tuominen (2006) OE was attributed to the proliferation and advancement of technologies resulting in the flow of information which is a vital logistical resource. Closs and Xu (2000) indicated that the free flow of information in ports operations is valuable in achieving efficiency in logistics management. This is because channels in logistics management are complex and complicated as the operations of the port expands, hence managers will require efficient coordination in information flow to improve the effectiveness in the logistics management. Moreover, business is expanding beyond national boundaries and therefore effective integration of IT becomes important in driving profitability, growth and survival (Bardi *et al.*, 2004).

There has been massive growth witnessed in the application of IT in ports, harbors and logistics organizations leading to an increase in trade and flow of information, as well as minimizing loses and cost of business operation (Chan *et al.*, 2004). Many ports rely on IT within the pretext of enhancing activities with much convenience. This is because customers can conduct activities on a phone anywhere without going to the port.

Bardi *et al.* (2004) revealed that the capacity of an organization in achieving logistics optimization is affected by the IT. The adoption of IT has improved logistical capacities and accuracy in total lead-time in inventory supply (Lai *et al.*, 2005). There have been many researches which have revealed that computerization of business operations has been accepted by many business organizations (Gustin, 1995). IT has become a fundamental aspect of providing support to the logistic functions. This is based on the fact IT improves organizational capabilities and competence (Closs and Xu, 2000). IT application in the last decade is an important tool that enhances quality and efficient management of business operations including logistics management. The most common form of IT applications used by businesses include Microsoft office package, search engines, accounting software, warehouse, and supply chain software and database files (Lai *et al.*, 2008). The introduction of EDI (Electronic Data Interchange) has helped businesses to exchange commercial data and documents including waybill, bill of lading, invoices and payment receipts with the business and customers and regulatory agencies with minimal or no human interference. In this current business environment, companies depend on reliable IT to access accurate and timely information for effective decision (Langley, 1985). Considering the outcome of the reviewed literature above, the researcher hypothesized that:

H1. Information technology has a positive effect on operational efficiency.

Effect of information technology on organizational culture. The relationship between IT and OC has been researched on by various scholars with varied findings in several industries. In spite of the vast studies with different outcomes, significant number of the studies has revealed that IT integration and utilization directly affect the corporate attitude and culture in

organizations. Per the position of Claver *et al.* (2001), the significance of IT systems in an organization permeates all areas of the business such that it creates a shared common vision that shapes the culture of the organization. Weber and Pliskin (1996) also noted in their assertion that IT utilization has direct effect on organizational efficiency, but the degree of the effect varies from industrial and service sectors. In consistent with the positions above, Avison and Myers (1995) explicitly indicated that there is a positive relationship between IT and OC. Beside the studies reviewed above which have revealed a positive link between IT utilization and OC, there seem to be a general consensus in support that IT integration and utilization significantly affect OC in a positive manner (Boland *et al.*, 1994; Daily *et al.*, 1996; Gainey *et al.*, 1999; Melville *et al.*, 2004; Zhang, 2005). Based on the literature reviewed above, the researcher hypothesized that:

H2. Information technology has a positive effect on organizational culture.

The mediating role of organizational culture on the relationship between information technology and operational efficiency. OC is seen to significantly affect the OE and performance of organizations. One school of thought believe that OC is a form of organizational capital without which businesses cannot achieve the level of efficiency they desire (Barney, 1985: cited in Chan *et al.*, 2004). Further to this assertion, Chan *et al.* (2004) also posited that for better or worse, a corporate culture has a major impact on a company's ability to carry out objectives and plans, whether in pursuit of existing or new strategic direction. It must be noted that there is general consensus among researchers that culture is very essential in affecting the efficiency and performance of business as it is difficult to imitate by competitors due to the inherent tacit and complex nature of culture (Barley, 1983; Meek, 1988; Mueller, 1996; Bae and Lawler, 2000). Therefore, an organization which is able to instill good OC in their workers stands a greater chance of achieving greater efficiency in its operations irrespective of the system being used in operations. This is supported by the position of Becker and Gerhart (1996) and Bjorkman and Fan (2002) which described OC as valuable, rare and imperfectly imitable asset with a high potential for creating sustainable advantage of OE and performance. The researcher thus believes that a valuable OC can have an indirect impact on sustaining above-normal OE and proposes a hypothesis that:

H3. Organizational culture has a positive indirect effect on the relationship between IT and OE.

Conceptual framework

Information communication was widely applied in the 1960s and 1970s by businesses to undertake routine administrative functions activities including data processing, bookkeeping to monitor internal and external environment of the business entity (Blili and Raymond, 1993). The cost of the IT in those days was high based on the fact that it was mainly used for basic organizational tasks. This discouraged many businesses from using IT in their operations. Technological innovation and advancement has improved the utilization of IT in business management (Bird and Lehrman, 1993). Currently, IT application has moved from merely recording business transaction to a more competitive weapon used by businesses to gain competitive advantage in the market. Galliers (1994) indicated advancement in technology and IT impact on the changing dynamism in the business environment has encouraged businesses to utilize IT to support them in achieving strategic objectives. This conceptual framework proposed for the study takes into consideration the different IT transformation at the Ghana Ports and Harbours Authority (GPHA), and how it affected the OE of the ports and the role of OC in the deployment of IT systems. The GPHA has deployed a number of IT systems such as Terminal operating systems, Paperless system, Agent check, Business Registration system, Electronic vessel booking system among

others. The core integrations for the conceptual framework are IT, OE and the mediating role of OC.

Operations at Tema port

In Ghana, the Tema port is the biggest in terms of docking activities, and transaction volumes. The seaport development project in Ghana commencement in Ghana dates back before white men brought ships to the beaches of gold coast in the 1950s for trading. The Europeans' trading activities in Gold Coast is evidenced by the number of forts and castles that are found along the coast of Ghana (Oduro, 1999). It must be pointed out that port operations in Ghana started in the early part of the 16th century when breakwater in Accra was constructed (GPHA, 2011). However, over the few years, the Tema Port has witnessed massive implementation of various IT and systems into the flow of operations, with the recent addition of the paperless system. According to Ampah (2015), the facts and data released by the port have seen a tremendous increment in port shipment activities, a reduction in clearance time and rapid improvement in revenue generation for the country. Although some challenges have been reported in terms of network breakdowns, customers are not finding the right way to use the system and port demurrage adjustment system causing few problems.

Data and methodology

Recruitment of participants for the study was based on individuals' familiarity with the GPHA's Information Communication Technology (ICT) system. This group comprises mainly of the staff of the GPHA. All departmental members within the port, qualified to be selected for the study because anecdotal evidence suggest that all the departments are using GHPA's ICT system in their area of work and for other purposes. After distributing 201 questionnaires, 120 questionnaires were received but 8 were contained missing values. Thus, 112 questionnaires were used for analysis. This represents a response rate of 56%. In all, 68 (61%) of the respondents were male and 44 (39%) were female. The majority of the respondents 59 (52.7%) hold a Bachelor's Degree certificate, followed by Higher National Diploma certificate 38(33.9%), 12 (10.7%) Master's degree Holders and 3 (2.7%) indicated other certificates, respectively. Again, 3 (2.7%) indicated they have been working with the company for just below a year, 19 (17%) indicated 1–5 years, 44 (39.3%) indicated 6–10 years, 30 (26.8%) indicated 11–15 years and 16 (14.3%) indicated 16–20 years.

The major concepts in the questionnaire were explained to the participants and all queries were addressed before distributing the questionnaires. The answering of a questionnaire lasted 15 min. A 5-point Likert scale with Strongly Agree (1), Agree (2), Uncertain (3), Disagree (4) and Strongly Disagree (5) was used to measure the constructs. To ensure that the participants have consented to participate in the survey, the first section of the questionnaire required the participants to indicate their willingness to participate or otherwise. The next section of the questionnaire asked information on the demographic characteristics of the respondents. The rest of the questions were structured to ask questions to measure the constructs in the conceptual framework.

The instruments were adapted from literature (IT, OC and OE). OC instruments were adapted from Baptista and Oliviera (2015) and Jackson (2011). The questions requested respondents to rate their response on the existing OC at the port. Using Cronbach's alpha, the construct recorded a reliability value of 0.772. With regards to IT, the constructs were adapted from Prajogo and Olhager (2012), Paulraj and Chen (2007) and Fei and Grewal (2004). Using Cronbach's alpha, the construct recorded a reliability value of 0.742. OE was measured with eight (8) items. OE questions capture issues on speed at the port, turn-around time and general efficiency at the port. The items used were adapted from Somjai and Jermsittiparsert (2019) and Lee *et al.* (2012). The overall reliability (Cronbach's alpha) is 0.822.

Results and discussion

Technologies used at the port

At the GPHA, there are various software that are used in performing various duties. Table 1 below depicts the software that are being used at the GPHA. The software include ERP, EVD. GCNET. HMS, Jade Combis, Jade master terminal, MS-Dynamics, Outlook/GPHA prestart, PMCD, port statistics and TOS. From the study, it was obvious that TOS is highly used in the port followed by ERP and HMS.

Descriptive statistics

Descriptive statistics were computed and presented on Table 2. The tables show a mean ranging from 3.1955 to 3.8417. The standard deviation ranged from 0.37020 to 1.15506. Specifically, OE scored a mean and standard deviation (M = 3.8596: SD = 0.33621), INFO_TECH scored a mean and standard deviation (M = 3.2410: SD = 1.28811) and ORGAN_CULTURE scored a mean and standard deviation (M = 3.3584: SD = 1.51778).

Reliability and validity test

The reliability and validity of the data were tested. The researcher verified the suitability of the data set with (principal component) factor analysis. An inspection of the correlation matrix (Appendix) revealed that many of the correlation coefficients were above 0.3 (Pallant, 2016). The researcher, however, found the Kaiser–Meyer–Olkin Measure of Sampling adequacy (KMO) to be 0.075 above the threshold of 0.6 (Kaiser, 1970, 1974) and the Bartlett's Test of Sphericity value reached statistically significant at (p = 0.000) indicating factor analysis is appropriate (Bartlett, 1954), thereby supporting the factorization of the correlation matrix.

The data were deemed reliable after all the factors recorded factor loading >0.5 (Hair *et al.*, 2010). An online calculator was employed for the estimation of the composite reliability (CR) (Colwell, 2016) and the acceptable threshold values 0.70 CR and Cronbach's alpha was set

Technologies	Frequency	Percent
ERP	34	30.4
EVB	9	8.0
GCNET	1	0.9
HMS	14	12.5
Jade Conbis/Outlook	8	7.1
Jade master terminal	2	1.8
MS-dynamics	4	3.6
Outlook/GPHA Potstat	1	0.9
PMCD	1	0.9
Port statistics	2	1.8
TOS	36	32.1
Total	112	100.0

Table 1. Technologies used at the port

Constructs	Minimum	Maximum	Mean	Std. deviation
OE	2.00	4.63	3.8417	0.37020
INFO_TECH	1.75	13.50	3.1955	1.15506
ORGAN_CULTURE	2.00	16.25	3.3153	1.34321

Table 2. Descriptive statistics

based on empirical review (Hair *et al.*, 2011; Henseler *et al.*, 2009). Table 3 displayed below indicate that all the factors recorded values that are above the accepted threshold value, hence the data were deemed reliable. Hair *et al.* (2011) pointed out that the average variance extracted (AVE) value should be more than 0.5 to meet the standard of valid data. Table 3 below also pointed out that each construct was above the threshold values except OE which recorded AVE of 0.489. This shows that the data also met the convergent validity test.

Principal component analysis supported the presence of the three factor components with eigenvalues exceeding 1 explaining 29.081, 17.333 and 9.463% of the variance, respectively. However, all the three components explained a total of 55.877% of the variance. An inspection of the screen plot revealed a clear break after the third component supporting the three factor components of the data as shown in the screen plot below (Figure 2).

The researcher finally computed an online parallel analysis using Monte Carlo principal component analysis (PCA) for parallel analysis (computer software) to compare the eigenvalues of the PCA and the criterion values from the parallel analysis. It was evident that all the actual eigenvalues of the PCA were greater than the criterion values from the parallel analysis. Therefore, it was decided to retain the three components for further investigations. The comparison of eigenvalues from PCA and criterion values from parallel analysis is presented in Table 4.

Again, the discriminant validity test was carried out. Fornell and Larcker (1981) noted that effective discriminant validity test is carried out through the application of AVE. For effective discriminant validity test, the AVE should be more than the variance (Chin, 1998). Table 5 below indicates that the discriminant validity test was sufficiently met by the study.

Structural model evaluation

The study also employed the structural model to display the relationship between the exogenous latent variables and the endogenous latent variables based on variance recorded (Hulland, 1999). The efficiency of the model is based on two factors: squared multiple correlations (R^2) and path coefficient (β). According to the assertion of Chin (1998), an R^2 of 0.26 explained in an endogenous variable is considered as substantial, 0.13 as moderate and 0.02 as weak. The R^2 values for the endogenous variables (OP_EFFI and ORG_CUL) of

Table 3.
Factor loadings, reliability and validity of the measurement

Construct	Items	Factor loadings (pattern)	Average variance extracted (AVE)	Reliability composite (CR)	Cronbach's alpha (CA)
Information technology	IT1	0.670	0.559718	0.853	0.742
	IT2	0.798			
	IT3	0.574			
	IT4	0.419			
	IT5	0.574			
Organizational culture	OC1	0.658	0.62872125	0.926	0.772
	OC2	0.873			
	OC3	0.804			
	OC4	0.503			
Operational efficiency	OE1	0.709	0.4899025	0.745	0.822
	OE2	0.746			
	OE3	0.791			
	OE4	0.654			
	OE5	0.712			
	OE6	0.763			
	OE7	0.775			
	OE8	0.555			

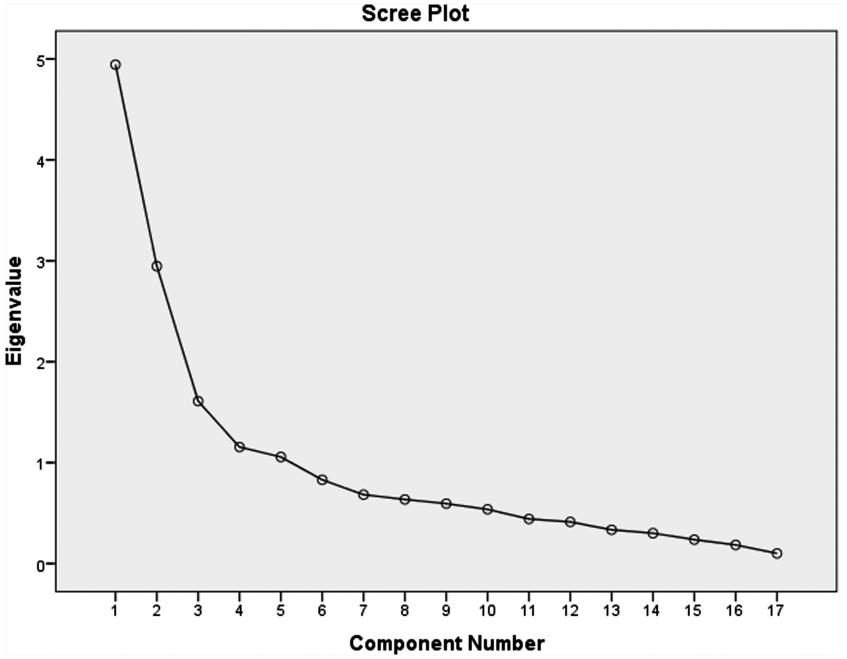

Figure 2.
Screen plot

Component number	Actual eigenvalues (PCA)	Criterion values (parallel analysis)	Decision
1	4.944	1.756	Accept
2	2.947	1.587	Accept
3	1.609	1.463	Accept
4	1.155	1.6325	Reject

Table 4.
Comparison of eigenvalues from PCA and criterion values from parallel analysis

Construct	INFO TECH	ORG CUL	OPP EFFIC
INFO TECH	0.939		
ORG CUL	0.086	1.006	
OPP EFFIC	0.175	0.340	0.927

Table 5.
Discriminant validity

the structural model are 0.11 and 0.57, respectively, indicating that IT and OC explain 0.11 (11%) of the variance in OE of the port, while IT at the same time alone explains about 0.57 (57%) variance in OC. Therefore, an R^2 value of 0.11 indicates that the model has the power to explain the impact of the constructs on OE though the power is moderate. The result points out that the data are adequately fit for the hypothesized model. This implies the model is accurate to examine the causal effect between the constructs.

The fit statistics for the hypothesized model were goodness of fit (GFI) = 0.886, adjusted goodness of fit index (AGFI) = 0.838, incremental fit index (IFI) = 0.967 and comparative fit index (CFI) = 0.966 representing a reasonable model data fit while the root mean square

error of approximation (RMSEA) = 0.047. This indicates a model fit and satisfactory (MacCallum, 1986; Bentley, 1992, 1995; Brown and Cudeck, 1993). The chi-square of the model is 134.402 with degrees of freedom of 108, at a probability level of 0.043 implying a good fit (Bollen, 1989). The figure below displays the path diagram resulting from the structural equation modeling (SEM) using Amos v.26. The result shows that the direct effect of INF_TECH on OP_EFF yielded a beta of 0.13, INF_TECH on ORG_CUL is 0.89 and ORG_CUL on OP_EFF is 0.08. The entire model shows a positive relationship (Figure 3).

Hypothesis testing

The result of the SEM analysis is presented in Table 6, indicating support for all hypotheses. Specifically, the data showed that IT in the organization positively affects OE (b = 0.134; p < 0.005) supporting hypothesis 1 (H1) that, IT positively affects OE. This result indicates that for every unit increase in IT there will be a corresponding increase of 13.4% in OE. As revealed in the work done by Sgouridis and Angelides (2002), that using IT and TAS as technology-based tools more positively affect overall congestion management. Bardi *et al.* (2004) in support of the argument showed that the capability of a business entity to optimize logistical operations and minimize costs is directly influenced by application of IT. The result

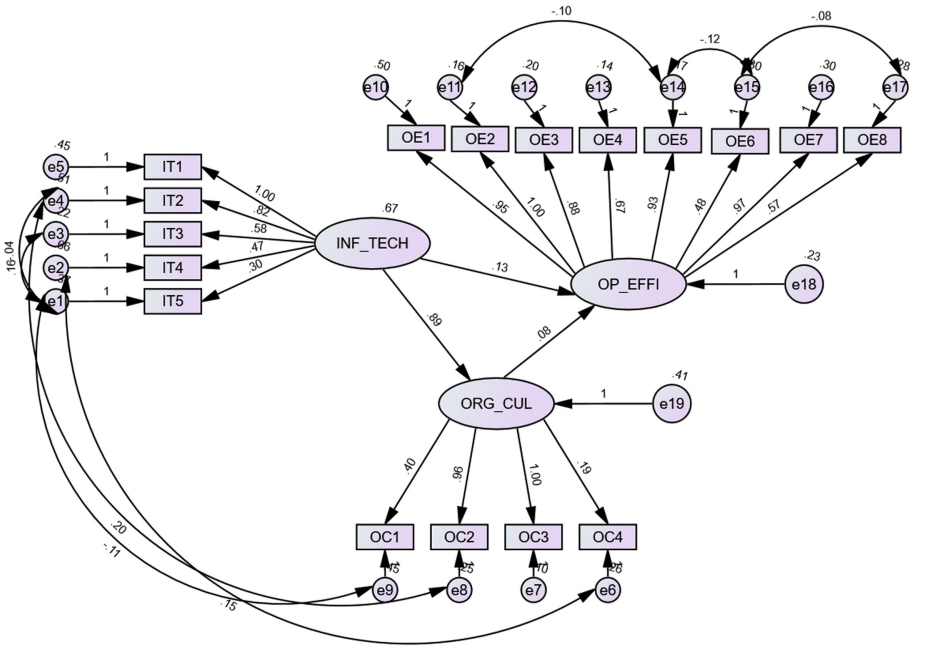

Figure 3.
Path diagram

Hypotheses	Path	Standardized path coefficient	*T* statistics	*P* values	Decision
H_1	IT → OE	0.134	20.821	0.000	Supported
H_2	IT → OC	0.894	5.776	0.000	Supported
H_3	OC → OE	0.077	2.833	0.003	Supported

Note(s): GFI = 0.886, AGFI = 0.838, IFI = 0.967, CFI = 0.966, RMSEA = 0.047

Table 6.
Result for structural equation model

show also that IT affects OC positively ($b = 0.894$; $p < 0.005$) supporting the second hypothesis (H2) from the model that IT will positively affect the OC of the firms. Thus, implementation of IT in organizations can have a button line effect on OC in the long run.

It was also clear that OC positively affects OE ($b = 0.077$; $p < 0.005$) supporting the third hypothesis (H3) from the model that OC has a positive effect on OE. Thus, the fostering of good OC can have a direct influence on OE of an organization. This result is in agreement with Ogbonna and Harris (2000) that culture is positively and directly linked to performance of organizations. Based on the coefficients of the three hypotheses in Table 6, IT may have a great direct effect on OC of a firm ($b = 0.894$) than on OE ($b = 0.134$). This could be true since operational efficiencies is usually influenced by various factors and very difficult to notice whether any one factor, such as (in this study) IT, will dominantly determine the overall efficiency of the organization. The results also show that OE is more influenced by IT ($b = 0.134$) than by OC ($b = 0.077$). This indicates that IT produces a good organizational cultural behavior toward OE, and OC of the firm, in turn, lead to improve OE of the firm. The result finally proves from the standardized estimates which are significant at 0.01 level that; there is a positive total effect of IT on OE ($b = 0.203$) and an indirectly effect of IT on OE through OC (thus enhanced IT and OC performance will together positively affect OE) ($b = 0.069$). This implies that as IT increases by one unit, OE will have a corresponding increase of 6.9%. The entire SEM result supports the model that IT has a direct impact on OE and an indirect impact on OE through OC which can be seen in the difference of the estimated beta values of the direct effect of IT on OE ($b = 0.134$) and the total effect of IT and OE (0.203). Thus, without the introduction of OC into the model, the effect of IT on OE was 0.134 but after the introduction of OC (the mediating variable the effect of IT on OC has increased to 0.203 clearly indicating that the relationship between IT and OE is mediated by OC).

Test of mediation effect

After the model confirmed mediation effect of OC on the relationship between IT and OE, the researcher performed Sobel test to test the significance of the mediation effect (Venkatraman, 1989). The Sobel test is calculated with the following formula

$$Z - \text{value} = \left[a \times b \Big/ \text{sqrt}(\text{SE}_a)^2 \times b^2 + (\text{SE}_b)^2 \times a^2\right]$$
$$Z - \text{value} = \left[0.894 \times 0.077 \Big/ \text{sqrt}(0.128)^2 \times 0.077^2 + (0.089)^2 \times 0.849^2\right]$$
$$Z - \text{value} = 0.859$$

The result shows that the Sobel test statistics is 0.859. The p-value of the Sobel test is >0.05 implying that the mediation effect of OC on the relationship between IT and OE is statistically insignificant. Given the rule of thumb that Z-value > ±1.96, it indicates that the mediation effect is not statistically significant that is with the Z-test value (0.859) different from zero (see Figure 4).

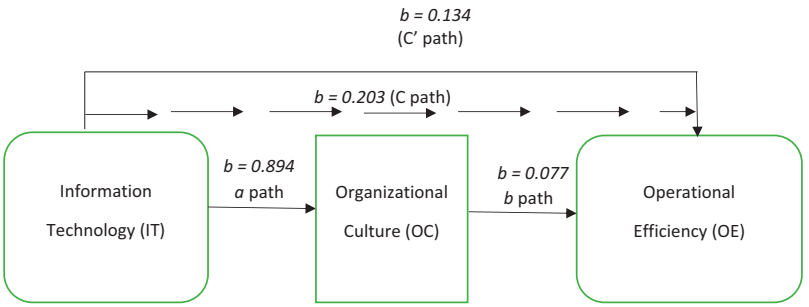

Figure 4.
Model path coefficients

With the estimated beta values transposed on to the model give the statistical model in Figure 3. This study however focused on the causal effect of IT on OE and IT on OE through OC and ignored the possible recursive relationships. It is possible that the enhanced OC and OE could have improved the levels of IT. The increase adoption of an OC of a firm may allow the firm to improve on its information technological achievements due to the need to outperform competitors. Likewise, enhanced OE could increase the OC of a firm. For example, a firm practicing and engaging in good delivery time will enhance the organizational cultural practices of the firm to gain competitive edge over competitors.

Discussions

As the study was poised to examine the influence of IT on efficiency in the port industry, the study discovered that IT have been adopted and implemented in their operations, and this has significant effect on organizational performance and efficiency of the port. The use of IT has improved levels of service delivery, improved customer's satisfaction and improved employee efficiency as well as increased flexibility in most organizational functions such as billing time and reduction in operating costs. On the basis of the analysis coefficients in Table 5, IT may have a great direct impact on OC of a firm ($b = 0.894$) than on OE ($b = 0.134$). This could be true since operational efficiencies is usually influenced by various factors and very difficult to notice whether any one factor, such as (in this study) IT, will dominantly determine the overall efficiency of the organization. Bardi *et al.* (2004) in support of the argument pointed out that the ability of a firm to optimize its logistics costs and service levels is affected by the IT uses. As revealed in the work done by Sgouridis and Angelides (2002), the use of IT as technology-based tools has more positive impact on overall congestion management. A study conducted on Mombasa port in Kenya by Chen *et al.* (2013), proved that using IT in port operation reduced truck waiting time and averages to about 35% percent less time spent than the traditional way of operations. Hence, implementations of terminal appointment systems could reduce truck turnaround time by 30–35% to enhance operations at the port. Several surveys (Gustin, 1995; House and Jackson, 1976) have also revealed that the computerization of business logistics operations has been generally embraced and accepted.

The results also show that OE is more influenced by IT ($b = 0.134$) than by OC ($b = 0.077$). This indicates that IT produces a good organizational cultural behavior toward OE and OC of the firm in turn and leads to improve OE of the firm. Thus, there is a clear merit in implementing solutions with IT to manage and evenly distribute traffic flows across the operating hours of port terminals. It is to be noted that the port community must support congestion management initiatives and make the best possible use of the systems implemented that can be achieved through deliberation with stakeholders. It could be seen from the result that a firm's OC could be integrated into the practices of organizations' IT practices to enhance its OE. Therefore, management's engagement of employee participation in management decisions and employee empowerment will boost and motivate employees to give their best toward the efficiency of operations.

The result finally proves from the standardized estimates that are significant at 0.01 level that there is a positive total effect of IT on OE ($b = 0.203$) and an indirectly effect of IT on OE through OC (thus enhanced IT and OC performance will together positively affect OE) ($b = 0.069$). This implies that as IT increases by one unit, OE will have a corresponding increase in 6.9%. Supporting the reality that business operations are shifting from national to transnational, IT is being recognized as an important driver of business performance within today's global marketplace (Bardi *et al.*, 2004). The results also agree with Mlimbila and Mbamba (2018) that relationships exist between information systems usage and the perceived decrease in shipping and trucking costs, timely delivery of goods and services, perceived increase in trade volume and improved organizational logistics capability.

Conclusion

The study provides empirical justification for the framework and describes the relationships between the variables of the study. The study concludes that there is a direct effect of OC on OE of the port's operations. Thus, effective and relevant communication is needed to manage the expectations and also shape behaviors of employees that can have a bottom-line long run effect on the performance and efficiency of operations as proved by Ogbonna and Harris (2000) that competitive culture is directly and positively linked with the performance of organizations. The study finally concludes based on the study findings that IT has a positive direct effect on port OE and an indirect effect on port OE through OC supporting the entire hypothesis of the study model. However, the mediation role of OC is statistically insignificant.

In summary, the outcome of our study provides the following implications for sea port digitization management and policy. The study showed that sea port digitization contributes to an enhance port operation. Thus, the introduction of IT enhances port operation. This underscores the fact that IT remains an important aspect of rapid and accurate transfer and processing of large volumes of data processed in port operations. Additionally, the outcome of our study implies that the higher usage of IT in the port operations translate into better or enhance OE. This implicates that when organizations invest in information technologies, they stand the chance to improve their OE; however, managers must endeavor to identify most suitable technologies on their quest to introduce emerging technologies. The study has also showed that both IT and OC has significant impact on OE of port operations. Thus, the management of ports must continue to invest in emerging technologies and also encourage employee by way of developing good through building capabilities of the staff and their adaptability to IT and the willingness of port users in accepting change. Despite the contribution of our study to contemporary view of IT and seaport operations literature, we caution readers to interpret our outcome in the context of port operations. Future studies could expand the domain of IT by considering IT implementations cost and its effect on the operation performance of the port with the shipping lines and import and export agencies as the target population.

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Appendix

Table A1.
Pattern and structure matrix for PCA with Oblimin rotation of three factor solution

	Pattern matrix[a] Component			Structure matrix Component			Communalities Extraction
	1	2	3	1	2	3	
QIT1	0.670	0.056	0.195	0.712	0.175	0.311	0.548
QIT2	0.798	0.072	−0.142	0.786	0.201	−0.004	0.642
QIT3	0.574	−0.062	0.509	0.651	0.051	0.605	0.679
QIT4	0.419	−0.002	0.337	0.476	0.079	0.408	0.337
QIT5	0.193	−0.107	0.763	0.305	−0.049	0.793	0.669
QOC1	0.658	0.090	−0.415	0.603	0.186	−0.300	0.538
QOC2	0.873	0.075	−0.119	0.865	0.217	0.031	0.768
QOC3	0.804	0.127	0.060	0.836	0.264	0.201	0.717
QOC4	0.503	−0.149	0.175	0.508	−0.058	0.256	0.309
QOE1	−0.015	0.709	−0.217	0.067	0.699	−0.196	0.537
QOE2	−0.057	0.746	0.322	0.122	0.747	0.337	0.659
QOE3	−0.012	0.791	0.096	0.137	0.792	0.120	0.636
QOE4	0.160	0.654	0.168	0.298	0.686	0.217	0.533
QOE5	0.164	0.712	−0.204	0.249	0.733	−0.152	0.594
QOE6	−0.065	0.298	0.574	0.083	0.306	0.573	0.414
QOE7	−0.078	0.777	0.099	0.069	0.767	0.112	0.601
QOE8	0.040	0.555	−0.085	0.119	0.559	−0.060	0.320

Note(s): Extraction method: principal component analysis: rotation method: Oblimin with Kaiser Normalization: [a]Rotation converged in 11 iterations

Table A2. Standardized residual covariance's (group number 1 – default model)

	OE8	OE7	OE6	OE5	OE4	OE3	OE2	OE1	OC1	OC2	OC3	OC4	IT1	IT2	IT3	IT4	IT5
OE8	0.000																
OE7	0.613	0.000															
OE6	−0.277	0.435	0.114														
OE5	0.808	−0.840	−0.435	0.107													
OE4	0.468	−0.533	0.312	0.127	0.000												
OE3	0.075	0.400	−0.301	−0.257	−0.687	0.000											
OE2	−0.929	0.628	0.556	−0.114	−0.242	0.397	0.000										
OE1	−0.575	0.505	−1.622	1.332	−0.439	1.019	−0.723	0.000									
OC1	0.192	0.117	−0.087	0.631	0.374	−0.412	−0.144	0.609	−0.150								
OC2	0.421	−0.932	−0.006	−0.068	1.001	−0.061	−0.827	−0.267	0.434	0.238							
OC3	0.449	−0.832	0.416	0.163	1.283	0.607	−0.225	−0.635	−0.273	0.156	0.000						
OC4	−0.650	−1.130	0.391	−0.066	0.348	−0.853	−0.650	−1.670	0.693	0.166	−0.403	−0.087					
IT1	−1.157	−0.590	0.430	0.239	0.801	0.042	0.060	−1.052	−0.076	−0.082	−0.300	0.587	0.000				
IT2	−0.183	0.423	−0.494	0.186	0.866	−0.064	−0.359	−0.286	1.624	0.357	0.374	1.153	−0.130	0.034			
IT3	−0.208	−1.134	0.881	−0.861	0.427	−1.107	−0.456	−1.608	−0.868	−0.454	0.257	1.310	0.354	−0.697	0.000		
IT4	−1.437	−0.021	1.063	0.508	1.281	−0.361	0.114	−0.446	−0.793	−0.127	−0.571	0.119	0.418	0.955	−0.012	0.142	
IT5	0.367	−1.329	1.647	−1.567	0.135	−0.517	0.471	−2.148	−0.585	−0.453	0.968	1.254	−0.470	−1.301	0.270	1.259	0.407

Table A3.
Squared multiple correlations: (group number 1 – default model)

Variables	Estimate
ORG_CUL	0.570
OP_EFFI	0.114
OE8	0.234
OE7	0.452
OE6	0.172
OE5	0.578
OE4	0.461
OE3	0.507
OE2	0.621
OE1	0.323
OC1	0.253
OC2	0.777
OC3	0.906
OC4	0.114
IT1	0.600
IT2	0.469
IT3	0.506
IT4	0.187
IT5	0.143

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