Contribution to evaluating the impact of port resources on its operational performance: the case of Ivoirian seaports

Abstract

While the research that evaluate the impact of port resources on operational performance have a partial analysis of this causal relationship, the objective of this paper is to enrich existing research. From the literature and interviews, the components of port resources and port performance are identified. Then, an analysis by the method of structural equations under PLS is carried out on the basis of a survey of the main actors of the maritime and port industry. The results of the study show that all resources do not have the same importance in improving the operational performance of the port.

Key words: port resources, operational performance, structural equation modelling, multidimensional hierarchical model, resource based view, Côte d’Ivoire.

Introduction

Most of the works that call for an evaluation of port performance consider it as a central element of its competitiveness on a regional or global scale. Although they implicitly recognize the place of resources in the intensity of performance, these studies do not clearly establish causal relationships between the typology or nature of resources and port operational performance (Caldeirinha & Felício, 2014).

Two types of resource analysis are proposed to assess the relationships between resources and port performance. One considers that the resources directly allow the port to improve its performance (Da Cruz et al., 2013; Caldeirinha & Felício, 2014; Felício et al., 2015). Another is content to explain how the types of resources can be allow the port to have competitive advantages (Gordon et al., 2005; S. G. Azevedo & Ferreira, 2009; Cho & Kim, 2015). Both types of analysis have two main limitations. First, they do not take into account all types of resources (tangible and intangible). Second, it does not study resources with the prism of the resources based view (RBV). This means that the results from this work are sometimes insufficient for a better representation of port resources.

Moreover, the works which are interested on the evaluation of the impacts of resources on operational performance sometimes focus on a single aspect of port performance: efficiency.

Given its gaps, a new contribution to the study of the impact of resources on the operational performance of the port is useful. The objective is to help enrich and elucidate the causal relationships between the two types of variables.

Thus, in this research, we will first identify the components of port resources and operational performance of the port through relevant literature. Secondly, we will present our research methodology which combines both qualitative and quantitative approaches. Then, we will proceed to the empirical evaluation of the causal relationship between port resources and operational performance. Finally, we will analyse and discuss the results.

1-Literature review and development of hypotheses

1-1- Port resources according to the literature
Subhan & Ghani (2008, p357) define port resources as “all the factors (assets) that a port can position as inputs in the production or operating process”. For Gordon et al. (2005) port resources are the assets mobilized by the port for its growth and performance. By referring to these definitions of port resources above and those of resources proposed in the work of Barney (1991, 1995), it is possible to consider port resources as all the tangible and intangible assets that a port can have for build strategies that improve its effectiveness and efficiency.

In the port management literature, port resources are studied explicitly as such or implicitly as characteristics of the port. When they are studied explicitly, most of the work uses the Resources-Based View (RBV) as a framework for analysis. In the other case, there is generally the absence of an explicit theoretical framework (Cho & Kim, 2015). Port resources are of various natures and in work on port management, their importance depends on one of the following objectives: to evaluate port performance or competitiveness, to identify port growth opportunities and to study the conditions for choosing a port by users (port selection).

Some studies place great emphasis on the importance of physical resources in the pursuit of performance (Da Cruz et al., 2012, 2013; Ruto & Datche, 2015). For example, Da Cruz et al. (2013) note, in the Iberian context, that physical resources contribute to 51% of the overall performance of ports. Other studies highlight the contribution of both tangible and intangible resources to port performance or competitiveness. Thus, for Gordon et al. (2005), the resources that allow the port of Singapore to have a competitive advantage as a benchmark transhipment port are both natural (a naturally well-developed port, geographical location of the port) and acquired (infrastructure, employee training, information technology).

### Table 1- The diversity of port resources

<table>
<thead>
<tr>
<th>Internal resources</th>
<th>External resources</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Tangible</strong></td>
<td><strong>Intangible</strong></td>
</tr>
<tr>
<td>Examples</td>
<td>Examples</td>
</tr>
<tr>
<td>Staff</td>
<td>Knowledge and skills</td>
</tr>
<tr>
<td>Equipment Capital</td>
<td>Time and odds</td>
</tr>
<tr>
<td>Capital Infrastructurer</td>
<td>Reputation and brands</td>
</tr>
<tr>
<td></td>
<td><strong>Tangible</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Intangible</strong></td>
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<td></td>
<td>Examples</td>
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<td></td>
<td>Examples</td>
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<tr>
<td></td>
<td>Public and private infrastructure</td>
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<tr>
<td></td>
<td>Innovation Technology</td>
</tr>
<tr>
<td></td>
<td>Customer loyalty</td>
</tr>
<tr>
<td></td>
<td>External expertise</td>
</tr>
<tr>
<td></td>
<td>Support and</td>
</tr>
</tbody>
</table>

Subhan & Ghani (2008) consider that port resources, whether tangible or intangible, can have a scope that is totally internal to the port or partially external to the port. Table 1 lists the essential resources that the port can dispose of. Whether one category of resource (internal or external) or another is taken into account depends on the scale of the analysis and port governance. In fact, the port as an entity generates value in a collaborative way through strategic and operational cooperation between sometimes a public (or even private) port authority and different terminal operators.

### Table 2- The most important port resources in the literature

<table>
<thead>
<tr>
<th>Resources</th>
<th>17 works referring to port resources in the literature on port management</th>
<th>Number of citations out of 17</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location</td>
<td>(Azevedo &amp; Ferreira, 2009; Bennett &amp; Gabriel, 2001; Caldeirinha et al., 2013; Da Cruz et al., 2013; Felício et al., 2014; Cho &amp; Kim, 2015; Da Cruz et al., 2013)</td>
<td>13</td>
</tr>
<tr>
<td>Infrastructure and equipment</td>
<td>(Subhan &amp; Ghani, 2008)</td>
<td>11</td>
</tr>
<tr>
<td>Information and communication technology</td>
<td>(Azevedo &amp; Ferreira, 2009; Caldeirinha &amp; Felício, 2013; Caldeirinha &amp; Felício, 2015; Da Cruz et al., 2013; Gavin &amp; Voss, 2015; Deloache et al., 2015)</td>
<td>9</td>
</tr>
<tr>
<td>Human capital</td>
<td>(Felício &amp; Caldeirinha, 2013; Gordon et al., 2005; Jacobsson et al., 2018; Mahfouz &amp; Arisha, 2009; Mira et al., 2019; Ruto &amp; Datche, 2015; Subhan &amp; Ghani, 2008; Trujillo &amp; Nombela, 1999)</td>
<td>8</td>
</tr>
<tr>
<td>Reputation</td>
<td>(Jacobsson et al., 2018; Mahfouz &amp; Arisha, 2009; Mira et al., 2019; Ruto &amp; Datche, 2015; Subhan &amp; Ghani, 2008; Trujillo &amp; Nombela, 1999)</td>
<td>6</td>
</tr>
<tr>
<td>Governance</td>
<td>(Subhan &amp; Ghani, 2008)</td>
<td>5</td>
</tr>
</tbody>
</table>

### Source: from several sources

Among the resources identified in the literature, those that come up frequently are: location, infrastructure & equipment, information & communication technology, reputation, human capital and governance & organization (Table 2). Consequently, we retain these resources as being those allowing the port to implement a strategy that improves its operational performance (Barney, 1991; Barney & Clark, 2007).

### 1-2- The components of the operational performance of the port
Since the mid-2000s, more and more research calls for taking into account, in the evaluation of port performance, other performance indicators other than those of efficiency (Baltazar & Brooks, 2001; Bichou & Gray, 2004; M. Brooks & Pallis, 2013; Talley, 2014). For these researchers, the efficiency dimension alone does not allow the port/terminal to have a competitive advantage and higher performance. Consideration should be given to customer satisfaction by providing efficient services. Performance is therefore to be sought between effectiveness and efficiency.

One of the main reasons why research on port efficiency has taken precedence over that on effectiveness during the last three decades could be linked to the desire of ports to attract more traffic and large ships through the port by improving their technical efficiencies (Schellinck & Brooks, 2016). In the same vein, many studies limit themselves to port efficiency because the data are more factual and calculable and not because it is deemed systematically important by users (Brooks et al., 2011a, 2011b). There may therefore be a bias between the performance of the port from the point of view of its managers and the performance from the point of view of the users. While the former may think they have good performance indicators (for example because quayside production is high), user complaints may increase (for example because of a high port transit time). Thus, if the services offered by the port are not in line with the expectations of users, this means that the port is not making a value proposition to its customers and therefore there are "global" operational performance problems (Brooks et al., 2011b).

For Woo et al. (2011), it is because there is a change in the logistics environment and the evolution of ports that the supply chain perspective is the best approach to evaluating port performance and that other forms of approaches have become obsolete. Changes in the logistics and port environment are at the level of the logistics chain, intermediaries and logistics service providers, the maritime industry and finally the port industry.

Therefore, eight (8) factors in the port environment are undeniably a source of port performance. In other words, the performance of the port in the supply chain context must be understood from the customer's point of view (quality of services, price of services, customer orientation) from the point of view of the port (efficiency of operations, security and safety) and according to logistics (connectivity, networks and cooperation and value-added service) (Woo et al., 2011).

1-3- Resources as a source of port operational performance

While the level or type of port performance appears to depend on resources, there is little research on resources as a source of port performance (Felício et al., 2015). By analyzing the impact of resources on performance, we can highlight the contribution of each type of resource to the operational performance of the port.

1-3-1 Location (LOC)

The location of a port can reflect its main activity and thereby be a direct or indirect source of operational performance (Azevedo & Ferreira, 2008). Thus, a transhipment port located on the main maritime routes captures a considerable amount of traffic compared to another port located a little further south. There is a relationship between efficiency in terms of handling throughput and port position depending the type of port. Indeed, ports with a competitive advantage in terms of location have a better handling throughput than the average of other ports (Frémont, 2005). Thus, we propose the following hypothesis:

H1: LOC positively impacts port efficiency through efficiency of the maritime and land operations (MLO).

1-3-2 Reputation (REP)

The contribution of reputation to the operational performance of the port can be apprehended indirectly by the attractiveness and loyalty of customers (Rutter et al., 2018). Reputation is built on variables such as image, commitment and trust. It represents everything that the partners perceive of the organization (Thai, 2016). Thus, we postulate that:

H2: REP contributes positively to port efficiency through customer orientation practices (COP).

1-3-3 Human capital (HC)
There is a significant relationship between human resources (HR) practices and port performance (Mira & Odeh, 2019). This assumes, for example, that the more the ports will attract qualified employees, the closer they will come to their goals, which are cost reduction and customer satisfaction. An error in this process will have negative effects in performance. Staff involvement is also a performance factor. When the person is more involved in his work the more he will learn more and also perform more. And this individual performance is reflected in the services rendered. Therefore, we make the following assumptions:

H3: HC contributes positively to port effectiveness through the quality of services (QS) and customer orientation practices (COP).

H4: Human capital contributes positively to efficiency across maritime and land operations (MLO) and operations on cargos (OC).

1-3-4 Governance (GO)

Port governance as a resource for increasing port performance has been the subject of several publications at the beginning of 1990s to the end 2000s (Baltazar & Brooks, 2001; Debre, 2014). The work mainly criticized the mode of public governance of the time, which would be a source of port inefficiency and inefficiency. On the other hand, the privatization of the operational activities of the port, in particular the management of the terminals, would make it possible to achieve, among other things, better operational performance. So when we choose a mode of governance, we choose in a way an input (resources) which, depending on its characteristics, allows to have quality outputs (better performance) (Brooks & Pallis, 2013). The underlying assumptions are:

H5: Port governance (GO) mode positively influences effectiveness through service quality (SQ), customer orientation practices (COP) and price competitiveness (PC).

H6: The port governance (GO) mode positively influences port efficiency through maritime and land operations (MLO) and operations on cargos (OC) and safety and security (SS).

1-3-5 Infrastructure and equipment (IE)

The conclusions of the work of Da Cruz et al. (2012, 2013) suggest that the performance of most ports depends on their physical resource capacities (infrastructure and superstructure). The physical resources of the port would explain 51% of their performance. The authors draw their conclusions from the work carried out on the container terminals of Spanish ports representing 38% of global traffic. Caldeirinha et al. (2013) report that investments in infrastructure and superstructures reduce operational costs and can contribute to the quality of services and therefore contribute to port performance. To do this, we assume that:

H7: IE positively influence port efficiency through maritime and land operations (MLO) and operations on cargos (OC).

1-3-6 Information and communication technologies (ICT)

ICT as a resource facilitate the exchange of information, coordination between actors (Mamad & Chahdi, 2013), cost reduction. ICT can improve safety, reliability, speed, quality of services and reduce the cost of operations along the transport chain (Caldeirinha et al., 2013; Felício et al., 2015). Already in 1994, to explain the contribution of ICT to port performance, El Khayat (1994) took the example of Electronic Data Interchange (EDI) which contributed to four (4) main improvements: 1) reduction of document processing, including transport and customs formalities, in the order of 7 to 10% of the value of the goods; 2) reduction of more than 5 times the time of (re)entry of data; 3) elimination of frequent transcription errors and finally, 4) reduction of ten days in the delivery times for paper documents. For all these reasons, we formulate the following two hypotheses:

H8: ICT positively influences effectiveness through service quality (SQ), customer orientation practices (COP) and service price competitiveness (SPC).

H9: ICT positively influences port efficiency through maritime and land operations (MLO) and operations on cargos (OC).
Based on the literature review, the research model to be tested is presented in Figure 1. It is a multidimensional hierarchical model where port resources are the antecedent variables and port performance the variables to be explained. This is multidimensional composed of effectiveness and efficiency as higher order variables and their six dimensions as lower order variables. In such a model, the approach consists in evaluating the relationships of influence between the explanatory variables of lower order and the variables to be explained of higher order (Sarstedt et al., 2019).

2- Research methodology

The literature review was carried out with a view to identifying the different port resources and the components of port performance as well as their dimensions. As a result, the literature allowed us to develop the conceptual research model and identify the items. However, as this research adopts a arranged positivist approach which assumes a combination of a qualitative approach and a quantitative approach, we conducted an exploratory qualitative survey with the actors in the field with a view to adapting or rearranging the variables and items from the literature to the Ivorian context. Then, in the perspective of the quantitative approach, we conducted a quantitative survey in order to conduct a confirmatory analysis.

2-1- Interviews with actors in the field

The interviews took place over a period of 6 months from April 2021 to September 2021. We conducted 14 interviews with port stakeholders, distributed as follows: 2 port terminal managers, 4 managers within port authorities, 2 managers of shipping companies, 2 expert-consultants in supply chain management (SCM) and/or port management, 2 lecturer-researchers in SCM and/or port management and 2 transit company managers. This diversity of resource-person profiles allows us, in our opinion, to better understand the phenomenon studied under various aspects. The theoretical saturation criterion was applied and assumes that the interviews stop when a determined number of interviews provides the necessary understanding of the phenomenon studied so that any additional interview does not bring new elements of understanding (Bryman & Bell, 2007).

The interviews were analysed using the thematic content analysis technique through on the NVivo 10 software. The analysis of the perspectives of the actors in the field showed that the reputation and location variables identified at the start in the literature were not mentioned by the actors in the field. As a result, the research model from the literature is reorganized taking into account the opinions and observations of the field. Thus, we have omitted reputation and location as major port resources in the Ivorian context.

2-2- Model specification and operationalization of variables

In our study, each construct reflects the sub-con structs that compose it. Causal relations therefore go from the main theoretical construct to the sub-constructs closer to the appropriation of reality. Our measurement model is thus specified as being a second order reflexive-reflexive hierarchical construct. One of the ideas advanced to justify this type of model is to say that it reduces the complexity
of the research model and allows greater theoretical and empirical parsimony (Massiera et al., 2018). Indeed, the theory can sometimes require generic constructs with several facets, as is the case with operational performance. Higher order factors allow them to be synthesized into lower order factors as they also do with items (Wetzel et al., 2009).

The operationalization of the variables of the model is part of the perspective of the development of the questionnaire which is the tool for collecting quantitative data. Our variables were operated through items from both the literature and interviews. Thus, for example, the items of the human capital variable come mainly from the work of Thai (2012a, 2012b) and Mira et al. (2019) while the governance items mainly come from interviews. In total, 44 items were identified for all the variables and measured at 5-point Likert scale ranging from "totally disagree" for 1 to "very much agree" for 5.

2-3- Collection of quantitative data

The questionnaire survey was conducted over five months from March to the end of July 2022 with companies in the port and maritime industry in Côte d'Ivoire. Côte d'Ivoire has two commercial ports, namely the port of Abidjan and the port of San-Pedro. The port being a complex organization, studying a phenomenon within it, especially with a logistics or supply chain management approach, requires appealing to the diversity of opinions of its stakeholders (Bichou & Gray, 2004). Thus, the core of the port community in relation to port production activities is made up of handling operators, shipping companies, freight forwarders (Woo et al., 2011) to which it is necessary to add the port authority given its key role in the organization of activities (De Martino et al., 2012).

In our study, we used a mix of methods for administering our questionnaire. First, through contacts with port officials, we had the questionnaire administered by mail. Also, we used the social and professional media LinkedIn. Indeed, faced with the slowness\(^1\) observed in the administration of the questionnaire by port officials, despite several reminders, it was necessary to find an additional solution to speed up its administration. LinkedIn, in the premium version, has a managerial and business tool (Sale navigator) which allows you to carry out targeted searches\(^2\) and contact very specific people. We thus wrote very specific messages and contacted 160 managers of different companies (consignors/ship-owners, handlers, freight forwarders) working in the two Ivorian ports (including 105 for Abidjan and 55 for San-Pedro).

We obtained a total of 74 responses (including 51 for Abidjan and 23 for San-Pedro). A sufficient number for our quantitative study based on the method of structural equations under PLS that we will present in the next section. Duplicates were avoided because people who responded to the survey through port officials reported it to us when we contacted them and vice versa.

3-4- Data analysis methods and process

Given that the formation of theoretical links established and then rearranged after the interviews, we must proceed, at the end of the quantitative survey, to the empirical validation of these relationships. To do this, we use both an exploratory factor analysis and an evaluation by structural equations under PLS.

Thus, first, we proceed to a preliminary evaluation of the unidimensionality of the items intended to measure the lower-order constructs. Indeed, it is essential to analyse and refine the measurement scales in order to ensure the quality of the scales of the measurement model. This analysis consists of a classic exploratory factor analysis called principal component analysis (PCA) under SPSS software and will be accompanied by a reliability test through Cronbach’s alpha.

After having carried out the primary evaluation of the measuring instruments, we move on to the evaluations of the measurement scales of the measurement model and the structural relationships through the PLS method. Research in structural equations under PLS offers several approaches to administrative activities are generally very cumbersome in Côte d’Ivoire.

\(^1\) Port officials met during the interviews wanted to help us in distributing our questionnaire, especially since official emails had been sent to the general managers of the two ports. However, in practice, two to three months after the questionnaire was submitted for administration to businesses in the port community, things seemed to have stalled. Indeed, the procedures and other

\(^2\) Several filters are possible: by function, sector of activity, responsibility, company name, etc.
evaluate hierarchical models. However, among these approaches two seem to be dominated. These are the approach by repeating indicators and the two-step approach (Sarstedt et al., 2019, 2021). The results of the evaluations are quite close. In our study, we opted for the approach of repeating indicators. The reason is that this approach is more suitable and easier to use for reflexive-reflexive models (Sarstedt et al., 2019). It consists of transferring the indicators of the lower-order constructs to the corresponding higher-order constructs.

We evaluate the measurement model by studying the quality of the variables. In the repetition approach, the reliability and validity of lower order variables and higher order variables are assessed with the same metrics and techniques with a few precautions (Sarstedt et al., 2019). Four steps are recommended by Hair et al. (2019, 2021) to assess reflexive constructs. The first is the examination of the factorial contributions (loadings) which must be greater than 0.5. The second is the study of the reliability of internal consistency, which makes it possible to know whether each measurement indicator (items) is consistent with the other items. We use Cronbach's alpha (α), the composite reliability (CR or ρhc) and the reliability coefficient (ρOA or PA) which must be greater than 0.7. The third is convergent validity, which is concerned with how the items that constitute a measurement scale of a latent variable are correlated with each other and with this latent variable and must be greater than 0.5. Discriminant validity, which is the fourth and final step in the study of the quality of constructs, is interested, for its part, in the way in which the measurement indicators of a construct differ from those of another construct of the model. It is assessed through the heterotrait-monotrait (HTMT) of correlations (Voorhees et al., 2016). The HTMT values to assert that there is discriminant validity must be less than 0.90 (Hair et al., 2019).

The validation of the structural model or internal model relies on the predictive relevance of its higher-order latent variables and their lower-order antecedents. To do this, the following analyses must be done: tests of predictive and explanatory power and global adjustment of the model. We study the predictive and explanatory power through the R² coefficient of determination and the Stone-Geisser Q² coefficient (Hair et al., 2019). The R² value varies between 0 and 1 and higher values indicate greater explanatory power. When Q² is positive, this means that the model has predictive validity if not no predictive validity (Fernandes, 2012). The last metric retained for validating the structural model is the GoF (Goodness-of-fit) index. This index aims at the global validation of the model. It is the geometric mean of the mean of the communities and the mean of the R². It must be greater than 0.1 to be considered good (Hair et al., 2014).

After the study of the predictive and explanatory power, follows the test of the hypotheses which makes it possible to apprehend the significance of the structural relations. The PLS approach is based on the estimation of the coefficients of determination (R²) which expresses the explained variance of the variables to be explained. The R² must be greater than 0.1 or 0.2 for the standardized structural coefficients to be considered significant (Hair et al., 2021). Thus, a hypothesis will be validated or not by taking into account the value of the structural coefficient (also called regression coefficient or path coefficient) but also the value and the level of significance of p-value of the Student test. For the respective values of Student 2.57, 1.96, 1.64 the corresponding significance thresholds are respectively 1%, 5% and 10%. The significance threshold in our study is 5%.

3- Empirical analysis by the method of structural equations under PLS

3-1- Evaluation of the unidimensionality of measurement scales by PCA

Table 3: The items retained, percentage of the variance and Cronbach's alpha of the explanatory variables

<table>
<thead>
<tr>
<th>Variables</th>
<th>Items retained</th>
<th>Item's code</th>
<th>% of variance explained</th>
<th>Cronbach's alpha</th>
</tr>
</thead>
<tbody>
<tr>
<td>HC</td>
<td>4</td>
<td>HC1, HC2,</td>
<td>62.690</td>
<td>0.796</td>
</tr>
<tr>
<td></td>
<td></td>
<td>HC3, HC4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>GO</td>
<td>5</td>
<td>GO1, GO2,</td>
<td>66.757</td>
<td>0.874</td>
</tr>
<tr>
<td></td>
<td></td>
<td>GO3, GO4,</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>GO5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IE</td>
<td>5</td>
<td>IE1, IE2,</td>
<td>66.065</td>
<td>0.865</td>
</tr>
<tr>
<td></td>
<td></td>
<td>IE3, IE4,</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>IE5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ICT</td>
<td>4</td>
<td>ICT1, ICT2,</td>
<td>76.275</td>
<td>0.895</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ICT3, ICT4</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The Table presents a summary of the items retained for each of the port resource variables after purification by principal component analyses and reliability tests by Cronbach's alpha.
After examining the validity and reliability of the 3 items of the first-order constructs of port efficiency, we excluded the first-order construct SS and at the same time, two new constructs HO (Handling operation) and MO (Maritime operation) emerged from the first-order construct OMT. On the other hand, the first-order constructs of port effectiveness have all been retained. The Table summarizes the items selected for each first-order construct after purification.

<table>
<thead>
<tr>
<th>First order constructs</th>
<th>Items code</th>
<th>% of variance explained</th>
<th>Cronbach's alpha</th>
</tr>
</thead>
<tbody>
<tr>
<td>SQ</td>
<td>SQ1, SQ2, SQ3, SQ4, SQ5</td>
<td>65.127</td>
<td>0.864</td>
</tr>
<tr>
<td>COP</td>
<td>COP1, COP2, COP3, COP4</td>
<td>68.485</td>
<td>0.846</td>
</tr>
<tr>
<td>SPC</td>
<td>SPC1, SPC2, SPC3</td>
<td>85.442</td>
<td>0.915</td>
</tr>
<tr>
<td>HO</td>
<td>HO1, HO2</td>
<td>69.531</td>
<td>0.662</td>
</tr>
<tr>
<td>MO</td>
<td>OM1, OM2, OM3</td>
<td>70.970</td>
<td>0.789</td>
</tr>
<tr>
<td>OC</td>
<td>OC1, OC2, OC3</td>
<td>64.167</td>
<td>0.717</td>
</tr>
</tbody>
</table>

3-2- Evaluation of the quality of the explanatory constructs measurement model

The result of the evaluation of the loadings shows that all the items have loadings greater than 0.7. This demonstrates that each item contributes significantly to the constitutions of its variable.

Examination of the reliability indices indicates satisfactory results for all the variables. Indeed, Cronbach's alphas (α), reliability coefficients (PA) and composite reliabilities (CR) all exceed 0.8. Moreover, the average variances extracted (AVE) are all greater than 0.5 and therefore evidence of good correlations between the items themselves and between the items and their respective variables.

The HTMT indices which measure discriminant validity show that the items of each of the constructs differ from those of the other constructs. Indeed, the different values of the HTMT indices of the different variables are all less than 0.90.

3-3- Evaluation of the quality of the measurement model of the constructs to be explained

Following the exploratory analysis carried out under SPSS, we kept all the 3 first-order constructs linked to the higher-order construct port effectiveness (EFCT). On the other hand, during this PCA analysis, the safety and security (SS) variable was removed from the higher-order construct efficiency (EFIC) because it did not obtain a satisfactory representativeness of its sample, hence the impossibility of perform PCA. On the other hand, the lower order construct maritime and land operations (OMT) which presented 2 dimensions during the PCA was split into 2 dimensions. Which are: handling operation (HO) and maritime operation (MO).

3-3-1 Evaluation of the quality of the measurement model for first-order constructs

The evaluation of the loadings shows that the various items have good contributions to the constitution of their various constructs then that they are higher than 0.6.

With the exception of the HO construct, the reliability indices, namely Cronbach's alpha, the reliability coefficient and the composite reliability are all 0.7 higher for each of the lower-order constructs. Indeed, the Cronbach’s alpha and the reliability coefficient of the HO are significantly lower than 0.7 or 0.5. In addition, the average of the three reliability indices always remains below 0.7 (0.648), which makes it difficult at this stage to retain

Table 5- Reliability and validity indices convergence of explanatory variables

<table>
<thead>
<tr>
<th>Variables</th>
<th>Reliability coefficient</th>
<th>Composite reliability</th>
<th>Reliability coefficient</th>
<th>AVE</th>
</tr>
</thead>
<tbody>
<tr>
<td>CH</td>
<td>0.801</td>
<td>0.813</td>
<td>0.870</td>
<td>0.626</td>
</tr>
<tr>
<td>GO</td>
<td>0.875</td>
<td>0.876</td>
<td>0.909</td>
<td>0.667</td>
</tr>
<tr>
<td>IE</td>
<td>0.868</td>
<td>0.873</td>
<td>0.906</td>
<td>0.660</td>
</tr>
<tr>
<td>TIC</td>
<td>0.896</td>
<td>0.896</td>
<td>0.928</td>
<td>0.763</td>
</tr>
</tbody>
</table>

The HTMT indices which measure discriminant validity show that the items of each of the constructs differ from those of the other constructs. Indeed, the different values of the HTMT indices of the different variables are all less than 0.90.
the HO variable in the model (Balambo, 2012) due to a compromised reliability. The convergent validity values (AVE) show that all the items are correlated with each other and with their respective constructs since they are greater than 0.6 for all the constructs.

Table 6- Reliability and validity indices convergence of dependant variables (first-order constructs)

<table>
<thead>
<tr>
<th>First-order constructs</th>
<th>Cronbach's alpha</th>
<th>Reliability coefficient</th>
<th>Composite reliability</th>
<th>AVE</th>
</tr>
</thead>
<tbody>
<tr>
<td>SQ</td>
<td>0.914</td>
<td>0.968</td>
<td>0.946</td>
<td>0.853</td>
</tr>
<tr>
<td>COP</td>
<td>0.846</td>
<td>0.850</td>
<td>0.897</td>
<td>0.685</td>
</tr>
<tr>
<td>SPC</td>
<td>0.855</td>
<td>0.857</td>
<td>0.896</td>
<td>0.634</td>
</tr>
<tr>
<td>HO</td>
<td>0.562</td>
<td>0.563</td>
<td>0.820</td>
<td>0.695</td>
</tr>
<tr>
<td>MO</td>
<td>0.793</td>
<td>0.797</td>
<td>0.880</td>
<td>0.710</td>
</tr>
<tr>
<td>OC</td>
<td>0.713</td>
<td>0.789</td>
<td>0.838</td>
<td>0.640</td>
</tr>
</tbody>
</table>

Discriminant validity is observed at the levels of the lower-order constructs of the higher-order constructs EFCT and EFIC, and between these constructs and all the other constructs of the model.

Due to the results of the different validity and reliability evaluation indices observed, we do not retain all the items as significantly accounting for the reliability and validity of the higher constructs EFCT and EFIC. Indeed, the items COP1, COP2 and COP3 then HO1, HO2 and OC3 did not satisfy the conditions of loadings and were, consequently, withdrawn from the measurement model of higher-order constructs.

4- Evaluation of the structural model and testing of hypotheses

4-1-Evaluation of the explanatory power of the model

Table 8- Values of $R^2$ and $Q^2$ from the evaluation of the structural model

<table>
<thead>
<tr>
<th>Higher-order constructs</th>
<th>$R^2$</th>
<th>$Q^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Port effectiveness (EFCT)</td>
<td>0.636</td>
<td>0.477</td>
</tr>
<tr>
<td>Port efficiency (EFIC)</td>
<td>0.044</td>
<td>0.029</td>
</tr>
</tbody>
</table>

The $R^2$ values show that the endogenous higher-order construct effectiveness (EFCT) of the structural model has a coefficient of determination of 0.636, unlike the efficiency variable (EFIC) for which this coefficient is only 0.044 (therefore less than 0). We are therefore entitled to be on its validity. Also, the values of $Q^2$ of the set of two exogenous variables are positive and greater than 0 (Table 8).

The calculation of the GoF index gives a value of 0.345. This shows that our structural model has overall high significant validity (Tritah & Daoud, 2021).

4-2-Hypotheses testing
The Table 9 presents the results of the hypotheses testing of the research model under the PLS approach. These results lead to two main analyses to be made. The first concerns the significant relationships and therefore the confirmed hypotheses. The second relates to insignificant relationships, therefore rejected hypotheses.

Table 9- Hypothesis testing result

| Hypothesis | Original sample (O) | Sample mean (M) | Standard deviation (STDEV) | T statistics (|O/STDEV|) | P values* | Validation | H |
|------------|---------------------|----------------|---------------------------|--------------------------|-----------|------------|---|
| HC -> EFCT | 0.279               | 0.296          | 0.081                     | 3.447                    | 0.001     | confirmed  | H3 |
| HC -> EFIC | -0.194              | -0.196         | 0.188                     | 1.033                    | 0.302     | Rejected   | H4 |
| GO -> EFCT | 0.206               | 0.223          | 0.147                     | 1.399                    | 0.162     | Rejected   | H5 |
| GO -> EFIC | 0.488               | 0.517          | 0.167                     | 2.927                    | 0.003     | confirmed  | H6 |
| IE -> EFIC | -0.024              | -0.032         | 0.181                     | 0.131                    | 0.896     | Rejected   | H7 |
| ICT -> EFCT | 0.153              | 0.141          | 0.156                     | 0.979                    | 0.328     | Rejected   | H8 |
| ICT -> EFIC | 0.205               | 0.241          | 0.052                     | 1.993                    | 0.034     | confirmed  | H9 |

*significant at the 0.05 level

The first analyses relate to the relationship between human capital (HC) and effectiveness (EFCT), Governance (GO) and efficiency (EFIC) and finally between information and communication technology (ICT) and efficiency (EFIC). These relationships are approved as significant and are demonstrated through Student's tests which have respective values of 3.447; 2.927 and 1.993. Also, the structural coefficients β (original sample) are respectively 0.296; 0.517 and 0.241 and show that the variables to be explained (effectiveness or efficiency) are in important proportions. Thus, for example, port efficiency is explained at 29.60% by human capital. Thus, hypotheses H3, H6 and H9 are confirmed.

The second analyses relate to the relationships between human capital (CH) and efficiency (EFIC), Governance (GO) and effectiveness (EFCT), Infrastructure and equipment (IE) and effectiveness (EFCT) and between information and communication (ICT) and effectiveness (EFCA). These relationships did not be significant. The values of the Student tests prove this because they are, respectively, only 0.302; 0.162; 0.896 and 0.328. It can therefore be said that in the Ivorian port context, these port resources do not have a considerable positive impact on their respective dependent variables (effectiveness or efficiency). Hypotheses H4, H5, H7 and H8 are therefore rejected.

The validated research model is represented by Figure 2. It shows the confirmed hypotheses and the variables retained.

**Figure 2- Validated model**

4.3- Discussions

We tested 7 hypotheses between the explanatory variables and the variables to be explained. According to the results obtained, 3 hypotheses were validated and 4 were rejected. We discuss below the results of the 3 accepted hypotheses.
First, the impact of human capital on performance efficiency was found to be very significant. This result corroborates with those of Mira et al. (2019) and Yap et al. (2020). These authors, by studying the mediating role of the integration of the supply chain in the relationship between human resources and operational performance, found a very significant direct relationship between resources and operational performance which renders the mediating effect partial.

Then, the influence of governance on performance efficiency turned out to be quite significant. This is a result that corroborates with the work of Brooks & Pallis (2013) who showed that governance as an output contributes positively and strongly to the two dimensions of the operational performance of the port considered as outputs.

Finally, the positive impact of ICT on performance efficiency is consistent with works such as Gordon et al. (2005) and Jacobsson et al. (2018). For example, Gordon et al. (2005) showed that ICT enabled the port to Singapore to have flexibility and to increase its capacity in the handling of goods.

Conclusion

This study contributes to the research on the relationships between port resources and its operational performance in the specific context of Côte d'Ivoire. From the literature and interviews, the components of port resources and port performance are identified. Then, an analysis by the structural equation method under PLS is carried out on the basis of a survey of the main players in the maritime industry.

This study presents theoretical, methodological and managerial contributions. On the theoretical level, the explicit use of resource theory to identify and analyse port resources represents a relevant contribution because most of the work studying port resources lacks an explicit theoretical framework (Cho & Kim, 2015). In addition, the study attempts to make an exhaustive identification of the resources that can be found in a port.

On the methodological level, one of the three main contributions of this work is the adoption of a methodology combining both an exploratory qualitative study based on interviews with actors in the field and a confirmatory quantitative study through a survey of the all port players. Another major methodological contribution is the use of the structural equation method under PLS (Partial Least Squares) to analyse our hierarchical and multidimensional research model. This is a first in logistics and supply chain management research.

On the managerial level, port decision-makers, in their performance research strategies, must judge port resources according to their usefulness. Thus, if the primary objective is to seek efficiency, the emphasis could be placed on staff training. Conversely, if the primary objective is efficiency, the emphasis could, in this case, be placed on governance and ICT. In any case, its 3 resources must be given priority in all operational performance strategies, more specifically in the Ivorian context.

The first major limitation of our study could be the size of the sample which is only 74 respondents. In terms of perspective, this study can be deepened by studying the nature of port resources and their impacts on performance. Researchers can also introduce the mediating effect of port integration in the supply chain to assess the relationship between port resources and operational performance.

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