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The performance of Port Supply Chain: Dimensions and Indicators

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Abstract

The first objective of this paper is to verify the existence of a significant correlation between the different dimensions of port supply chain performance. In particular, the performance of the supply chain was studied through its four dimensions, namely the "Financial" perspective, the "Customer" perspective, the "Internal Process" perspective, and the "Organizational Learning and Innovation" perspective.

The field survey allowed us to analyse the synthetic indicators for measuring the performance of the port logistics chain. These indicators are analysed on a sample of 120 companies in order to define for each performance axis the most appropriate indicators to evaluate it.

Keywords:

Supply Chain Management, port, supply chain performance, port stakeholders, partnership, and indicator.

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1. Introduction

The success of a company is largely dependent on the performance of its supply chain. Achieving the level of performance cannot be obtained today by focusing only on the optimisation of internal processes but requires a global vision to improve the performance of the whole supply chain. Thus, the question of SCM performance has become crucial in Management Sciences and many studies deal with the subject. However, there is little convergence both in terms of methods and results (Christine BELIN-MUNIER, 2008).

On the other hand, the success of collaborative practices in industrial chains and their emergence in the maritime and port sphere has led to the development of the concept both in ports and in academic research. Thus, collaboration between all stakeholders of the port network appears to be a key factor of port performance (Cappuccilli (2007), (Song, 2003), (Avery 2000), (Juhel, 2000), (Genoble-chambery 2007), (Pache et al, 1993)).

From this point of view, the logistics chain organisation appears for a large number of authors as a means to develop the performance of the port system. However, we have noted a certain insufficiency in the literature despite the multiplication of writings. On the one hand, there is a lack of contributions on the concrete implementation of supply chain management in port organisations, on its design and on the links and power relations between its actors. Moreover, most authors have focused on local aspects of the chain, which is explained by a strong concentration on port terminals. At the same time, we have seen that in the literature dealing with port performance, the most used criteria are unidimensional and are generally based on an evaluation of the productivity of the terminals. In fact, although there are some studies that have tried to understand port performance according to the typical "cost-quality-delay" and to consider its multidimensional character, they remain both incomplete and scattered.

It is clear that every port in the world is unique, and the task of measuring and analysing performance is not straightforward and is made more difficult by the failure to establish industry standards on what to measure, how to measure it and how to express the measurement in a consistent manner. This difficulty is compounded by the fact that there is no single measure that can summarise all important aspects of the port or terminal performance." (Soner Esmer, 2008).

This work is a step towards defining a tool for measuring supply chain performance while integrating the divergent views of all stakeholders and the multidimensional aspect of performance.

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2. Methodologie

We started from a conceptual framework of performance constructed from a literature review in order to collect the performance indicators retained by the authors.

These indicators taken from the literature were adapted to our study context through a qualitative study.

Thus, semi-directive interviews conducted with maritime and port stakeholders allowed us to integrate the divergent visions of the different stakeholders. The actors met during the interviews were

representatives of the maritime and port community, in particular representatives of maritime transport and logistics associations, port operators, shipping companies, ship consignees and forwarding agents. This choice is explained by the need to integrate the visions, new constraints and requirements of each stakeholder in any effort to evaluate the performance of the logistics chain.

These interviews also allowed us to integrate certain performance constructs, for which we did not find established measurement scales in the literature review.

We completed our work with a quantitative study in order to verify the reliability and quality of the theoretical representation *we* arrived at at the end of the previous step.

The data collected was analysed using cross-tabulations and Hierarchical Ascending Classification. The objective is to select for each performance dimension the most representative indicators.

3. Literature review

3.1 Performance factors :

In this section, the literature on port performance factors is reviewed, firstly by outlining the factors of port competitiveness and the criteria for choosing a port, and secondly by focusing on the role of information and communication technologies, good governance, social capital and collaboration.

In the context of globalisation, ports are facing increased competition. The port's main customers (shippers and shipowners) are expressing increasingly high standards. Thus, the choice of the port is no longer made exclusively on the basis of price but combines a variety of criteria relating to quality, reliability, regularity of service and duration of the port passage.

The author ELKHAYAT Mustapha (2002) determines five factors of port competitiveness, namely the geographical situation, the links with the interior, the efficiency and availability of the services, their prices and the socio-economic stability of the port, the author also insists on

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the interest of the implementation of a clear commercial strategy that unites the whole port community while maintaining a climate of healthy competition between the various actors.

Geoffroy CAUDE (2006) groups together a selection of assets that ports try to use in their favour. Firstly, he mentions the quality of the nautical situation, the quality of the maneuverability of the nautical accesses, the number of regular maritime lines as well as the regularity of the connections with the hinterland. In a second paragraph, the author emphasises the contribution of technological innovations. The standardisation of messages exchanged and the use of the Internet and the development of localisation tools that have facilitated the localisation of ships (GPS, RFID, VHF, AIS). These systems have led to the reduction of waiting times in the harbour and the automation of container movement operations in the terminals thanks to the deployment of automatic guided vehicles, as well as the automation of certain quayside-ship transfer stages. A final asset announced by the author is the mobilisation capacity of the port. This is the result of the collaboration of all the players in carrying out joint and attractive promotional and marketing actions.

Fernando González Laxe (2008) considers that the main criteria for choosing shipowners are: handling costs, reliability and productivity.

Hilde Meersman et al (2010) admit that the objective of the management, the port or the other actors involved is obviously to minimise the cost of transhipment and vessel delay. Thus, this cost minimisation policy involves all members of the transport chain. In order to achieve this, it is necessary to aim at the lowest possible cost of the whole chain. In theory, the ports that contribute to the minimisation of the costs of the logistics chain are the most likely to be requested by customers.

For shipowners, two categories of expenditure are considered: Fitting out expenses are a function of time, the total duration of the voyage and therefore they are incurred even when a ship is in the lay-by area or loading or unloading on the quay, while loading or unloading cargo. Commercial expenses are contingent on the time of the voyage. They are incurred only when the ship is moving. Thus, moving to more distant ports will result in higher total costs.

In today's economy, the integration of logistics chains is a reality. It is clear that ports can no longer develop their attractiveness on geographical position alone. Ports are now chosen not only on the basis of their efficiency and location, but rather on the quality and reliability of the logistics chain to which they belong. For shippers, port selection becomes more a function of the overall performance of the global port chain. Ports are chosen on the basis of faster, more efficient and more cost-effective access to markets in which shippers are competing to satisfy

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the end customer. Ports must offer the resources and capabilities necessary to create value and improve the competitiveness of its shippers in a competitive market. Indeed, the performance of ports is no longer distinct from the performance of the supply chain.

Today's shippers demand a global logistics offer. In order to satisfy them, 3PLs play the role of service integrators by offering them a fairly complete range of services. This allows shippers to focus on their core business. As a result, when choosing a transport solution, shippers pay less attention to the port itself, but are more interested in the entire maritime-port chain.

Although there is no consensus among authors on who is the dominant actor in the port selection process, there is a growing tendency to view port selection as a complex set in which several actors are involved and for which not only port characteristics, but first and foremost the integration of the port into a broader set of global supply chain criteria are important. (Magala and Sammons 2008; Bichou and Gray 2004, Olaf Merk, et al 2011),.

The efficiency and performance of port facilities are studied in terms of traffic levels, service frequency and connectivity quotients (Talley, 2006).

Notes that the port selection made by the shipping line when making a shipping line is interrelated with the choice made by the shipper(s) and both choices are only part of the supply chain selection process.

D'Este and Meyrick (1992) studied the carrier selection process in a Ro/Ro ferry trade in the Bass Strait market and concluded that shippers consider ports as one factor among others in the process of choosing the overall operator.

The study suggests that shippers base their choice on a combination of maritime and port factors. It lists the proximity of the port to the shipper, the total distance from the point of origin to the point of destination, port congestion and the size of the amateur fleet as key factors determining the choice of port. However, it omits other links in the logistics chain such as rail operators, road operators, customs agents, logistics service providers, freight forwarders.

This finding is very important for our further work. It suggests that when shippers choose a transport line or a port, it is based on the overall assessment of the supply chain system.

Efficient maritime-logistics chains can be compared to well-oiled machines where all cogs and mechanisms are perfectly tuned: Modern seaports are crucial links in international logistics chains and associated networks (Eddy Van de Voorde & Thierry Vanelslander, 2009). The performance of logistics chains is dependent on the competitiveness of ports and the performance of seaports is dependent on the competitiveness of the logistics chains to which they belong. This pattern is valid for all other actors in the maritime chain. It is obvious that

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the efficiency of a port actor is not only a result of its infrastructure and organisation, but is also dependent on a range of external factors.

In a comparative study between the ports of North-Western Europe, carried out by means of a survey of decision-makers in the port centre (shipowners, terminal operators, shippers, logistics groups and European logistics centres), Le Havre scores particularly low in terms of lack of hinterland connections, reliability and flexibility. The last two points are justified by the instability due to frequent strikes.

The main indicators that are mentioned in several port choices are: I) maritime accessibility; II) hinterland; III) competition; IV) efficiency; and V) environment.

3.2 Port performance indicators

In the face of increasing containerised flows and new competitive constraints, performance evaluation is one of the major challenges facing ports. Tongzon (1995) suggests that when designing a port reform, special attention should be paid to improving port performance. Indeed, it should be added that it is strictly impossible to optimise performance if it cannot be measured. In this respect, performance indicators play a crucial role. They have three main functions. They provide the necessary information for the management of organisations, they are used to compare performance (of organisations and other units, such as countries), and they are also used to communicate with relevant stakeholders (Peter de Langen et al, 2007).

In the literature, port performance has long been a one-dimensional concept. Port performance has generally been focused on productivity indicators (Peter B. MARLOW et al, 2002). Similarly, value added and employment are widely used indicators to compare the economic performance of seaports.

Some authors have considered the port as a "business organisation". They measure the performance of the port strictly on the basis of the profits generated. Vigarié André et al (1990) study port performance from the point of view of its added value. Value added is produced from the difference between port revenues and port costs. It varies according to the type of ship and cargo. Despite its originality, Leonard's model limits port activity to a wharf on the operations side (ship-to-ship services and cargo handling) while neglecting other port activities (Yang Lei, 2007).

Indeed, port performance can be measured in various ways that can be grouped into three main categories: physical indicators, factor productivity indicators, and economic and financial indicators (Trujillo, L. and Nombela. G., 1999).

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Physical indicators deal, in the majority of cases, with measures of time. They concern either the vessel or the cargo. They include turnaround time, waiting time, quay occupancy rate, vessel dwell time and cargo dwell time. Productivity indicators look at the labour and capital deployed to load and unload cargo. The most commonly used economic and financial indicators are operating surplus or total revenue and related expenses or total cost per Twenty Foot Equivalent Unit (TEU).

However, Bowersox and Closs (1996) suggest that logistics performance can be understood through other measures, namely cost, customer service, management and quality. UNCTAD (1999) distinguishes between macro performance indicators that assess the economic and social impact of a port and micro indicators that measure the performance of port operations (Table 25). At this level, UNCTAD has published various monographs proposing a selection of indicators of port activities (UNCTAD, 1976; UNCTAD, 1983; De Monie , G. , 1987; ISL , 1990).

Tableau 1. Les indicateurs de performance portuaire (CNUCED, 1976)

Financial Indicators	Tonnage handled Berth occupancy revenue per tonne of cargo Cargo handling revenue per tonne of cargo Labour costs Total crane costs per hour per vessel Total cost per tonne Total cost
Operational indicators	Delayed arrival Waiting time Dockside operation time Vessel rotation Tonnage handled per ship Time spent by ship in port Number of shifts per ship Tonnage handled per working hour per vessel Tonnage handled per hour spent at berth Tonnage handled per hour spent in port Inactivity time of berth

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Thomas and Monie (2000) have grouped port performance indicators into four categories: output, productivity, utilisation and service measures. Output reflects the level of economic activity. Indicators are used to represent the flow of cargo, in terms of tonnes handled or containers handled per unit time. These indicators are (vessel throughput, quay throughput capacity, container handling capacity, receiving and delivery capacity).

Productivity measures are particularly important to terminal operators as they are directly related to the cost of operating the terminal. These measures essentially include vessel productivity, quay productivity and crane or gantry productivity.

Utilization measures allow management to determine how intensively resources are used. The most common and relevant utilisation measures are: platform utilisation, storage space utilisation, gantry utilisation and equipment utilisation.

Service indicators assess customer satisfaction with the services offered to them in terms of reliability, regularity and speed. According to the author these indicators are Ship turnaround time, Shore turnaround time, Rail service measures, Road vehicle turnaround time.

To evaluate the port performance in the Canadian Arctic, Pascale Bourbonnais (2010) uses two major indicators, namely the specialisation index and the location coefficient, as well as a rating system for ports that will allow her to rank them. The specialisation index evaluates the degree of specialisation in relation to the type of goods handled in the port. The location coefficient, on the other hand, addresses the degree of concentration of a type of traffic in a terminal in relation to the average of the network studied. The rating system aims to compare and rank ports on the basis of a set of criteria: connectivity and inter-modality, physical environmental conditions, port operations and infrastructure, diversity of port activities, reliability of service and transport supply, and social conditions and local economic development. The objective of this study is to make decisions regarding traffic distribution, port investment and the organisation of the transport network.

G. FASSIO and P. LE MESTRE (2009) emphasise the need to understand the multi-performance of ports based on the triptych cost-quality-delay. Thus, the multi-performance of a port centre seeks to satisfy: a strategy of reducing the costs of the call and the passage of goods; a strategy of services aiming at levels of service (quality) that the stakeholders and a strategy seeking to better control and then reduce the delays necessary for the call of the ship and the passage of goods in the port space (G. FASSIO and P. LE MESTRE, 2009).

Charles-Henri FRÉDOUET et al (2005) distinguish six dimensions of port performance. For each of these dimensions, they assign a selection of indicators:

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- The commercial dimension provides information on the port's traffic and the commercial means for its development. It is evaluated on the basis of the overall volume of traffic, the diversity of traffic, the number of regular lines, the number of ships received, the number of shipping lines represented in the port, the diversity of the origins and destinations of the shipping lines, the range of services to the goods and the ship.
- The operational dimension represents the quality of the operational processes for the transit of goods: the overall time taken to transport goods from the port to the consignee/exporter; the quality of cabotage lines (including feedering); the quality of connections (rail, inland waterway, road) of a port with the hinterland; the overall cost of transit of the goods; the availability of services (24 hours or less); the level of equipment (quays, gantries, straddle carriers, terminal surface, etc.); the productivity of equipment; the productivity of staff; the waiting time of ships; the call time of ships and the location of logistic areas.
- The financial dimension: Respects the constraints of financial balance and profitability and the capacity to finance investments. The financial balance of the actors, the financial balance of the port authority, the number of business start-ups, the overall amount of investments made, the financial profitability of the actors, the amount of subsidies allocated to the port.
- The organisational dimension deals with the quality of the relations between the different actors of the port network. It is represented by indicators such as the flow of information between actors, cooperation between actors, the functioning of consultation and decision-making bodies. The quality of the Community port IT system,
- The social dimension is an appreciation of the general working conditions within the port network. working conditions, number of social conflicts, staff training, level of remuneration and staff satisfaction (case of the port of Casablanca and Marseille).
- The citizen dimension: Is a contribution of the port to the improvement of the Society. The management of the pollution generated by the port activity, the amount of taxes generated by the port activity, the impact of the port on the image of the city or the region, the number of business failures and the number of jobs (direct or indirect) created.

Performance has as many facets as there are observers inside and outside the organisation (Melchior Salgado, 2013). In the port literature, there is no consensus on which performance indicators should be used. Brooks (1985) favours frequency of trips, transit time, adherence to route, loading and unloading time, cost of service, prompt response to requests, history of loss or damage of cargo.

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Other researchers prefer to calibrate performance by comparing ports while putting them into homogeneous balls (categorical homogenisation), a task that is not at all simple (complexity of ports. Céline Rozenblat et al (2004) compare the performance of 73 European port cities and their potential attractiveness through a set of structural indicators. The choice of indicators takes into account port variables related to port equipment, infrastructure and traffic. Thus, four indicators were selected: the relationship between port performance of containerised traffic and storage area at container terminals, the gradient of modernisation and specialisation of containers, the degree of port attractiveness of containerised flows and finally, port inter-modality.

The performance of port terminals has been an important issue in scientific research. In most cases the term "port performance" is used even though only the performance of the terminal is measured. This is due to the degree of importance of this infrastructure. However, the measurement of port performance is more complex. The port system is a complex dynamic system with a variety of actors, each of which performs a range of economic activities.

The increasing integration of ports into logistics chains has focused attention on performance indicators to assess this integration (Bichou and Gray, 2004). Thus, the development of port performance indicators still remains a subject of research.

a. *Hierarchical ascending classification of customer performance*

Based on the results of the survey and according to the Hierarchical Ascending Classification (HAC) we have classified the indicators of the "customer perspective" into two classes. Group 2 presents the most important indicators with a barycentre of 101.286 and class 1 groups the low importance indicators.

Table 1. Hierarchical Ascending Classification of the 'customer perspective' of our sample

Observation	Classe
Diversity of traffic	1
Number of ships that dock	1
Number of operators	1
represented in the port	1
Accuracy of ship/container positions	2

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Responsiveness of the terminal operator to special requests	1
Waiting time before berthing	2
berth inactivity time	1
Number of shipping lines connected to the port	2
Customer satisfaction rate	1
Range of services to cargo and ship	2
Cost of rail / truck / storage	1
Cost of berthing, pilotage, towing	2
Overall cost of using the port	1
Connectivity / operability to rail / truck	2
Choice of rail/truck/warehouse companies	1
Provision of adequate and timely information	2
TEU dwell time (days)	1

Classe	Weak	Very important
1	92,000	28,000
2	18,714	101,286

b. Hierarchical Ascending Classification of Financial Performance

Table 1. shows that Group 1 has a very high barycentre of 89.444. Thus, the overall traffic volume, the financial balance of the port authority, the operating margin, the capital expenditure per tonne of freight, and the value added (direct and indirect) are the most representative indicators of the financial performance of the port logistics chain.

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Table 2. ***Hierarchical Ascending Classification of Financial Performance in our sample***

Observation	Classe
Overall traffic volume	1
The financial balance of the actors	2
Financial balance of the port authority	1
The overall amount of investments made	2
Operating margin	1
Berth occupancy revenue per tonne of cargo	2
Cargo handling revenue per TEU	2
Labour costs	2
Capital expenditure per TEU	1
Port charges associated with vessels/ Revenue	2
Value added (direct and indirect)	1

Barycentres des classes :

Classe	Weak	Very important
2	78,833	21,167
1	10,556	89,444

c. Classification Ascendante Hiérarchique de la performance processus interne

According to the hierarchical ascending classification of process performance, it can be seen that ship dwell time, quay productivity, storage space utilization, equipment utilization, rail service measures, average customs deposit, quality of port infrastructure, safety/security, proportion of declarations cleared in less than 7 days, cooperation between actors, quality of information system are considered as indicators of very high importance.

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Table 3. Hierarchical Bottom-Up Classification of Process Performance

Observation	Classe
Quay occupancy rate	2
Vessel dwell time	1
Vessel productivity,	2
Quay productivity	1
Gantry productivity	2
Storage space utilisation, Equipment utilisation	1
Vessel turnaround time	2
Rail service measurements	1
Road vehicle turnaround time	2
Average customs depot	1
Truck turnaround and queuing times (i.e., Performance Interface in a container terminal)	2
Quality of port infrastructure	1
Burden of customs procedures	2
Security / Safety	1
Proportion of declarations cleared in less than 7 days	1
Proportion of files released on simple documentary control	2
Dwell time of containers subject to physical inspections	2
Cooperation between actors	1
Equipment management	2
Quality of the information system	1

Barycentres of classes :

Classe	WeaK	Very important
1	14,000	86,000
2	69,083	30,917

d. Hierarchical Ascending Classification of Learning and Innovation Performance

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Table 4. Hierarchical Ascending Classification of Learning and Innovation Performance in our sample

Observation	Classe
Training rate for managers	1
Percentage of turnover	1
Average age of total workforce	2
Management ratio (share of senior managers / total employees)	2
Working conditions	2
Number of social conflicts	2
Percentage of idle time (percentage of time available for employees who work but are not required to work)	1
Training costs/ employees	1

Barycentres des classes		
Classe	Weak	Very important
1	45,833	54,167
2	79,167	20,833

According to the hierarchical ascending classification carried out on the learning and innovation performance indicators, the training rate of managers, the percentage of turn over, the percentage of idle time and the Cost of training/employees are the most representative indicators of the learning and innovation dimension.

4. Discussion of the results :

The results obtained from this quantitative analysis will be discussed below.

After studying the answers we obtained during the survey and according to the Ascending Hierarchical Classification (AHC), we note that group 1, which represents the class of great importance, is made up of the following indicators: Turnover, production costs and demurrage costs.

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Table 5 shows the performance indicators used to explain the "customer" perspective of port logistics chain performance. The results obtained from this quantitative analysis will be discussed below.

After studying the answers we obtained during the survey and according to the Ascending Hierarchical Classification (AHC), we note that group 1, which represents the class of great importance, is made up of the following indicators: Turnover, production costs and demurrage costs.

Table 5 shows the performance indicators used to explain the "customer" perspective of port logistics chain performance.

Table 5. Summary table of indicators from the "Customer" perspective of port logistics chain performance

The "Customer" perspective
Accuracy of ship/container positions
Waiting time before berthing
Number of shipping lines connected to the port
Range of cargo and ship services
Cost of berthing, pilotage, towing
Rail / truck connectivity / operability
Provision of adequate and timely information

For a long time, financial performance was the only way of estimating port performance. For Leonard (1990), port performance is assessed by value added. This is the result of income and expenditure (Leonard, 1990). In the context of our research, the companies emphasised the important role of the port authority, its investments and its financial equilibrium. According to several players, the port authority must play a major role in investment decisions and their financing.

The operators of the port of Casablanca also give priority to the volume of traffic, as this has an impact on the profits made. Table 6 details the indicators of the "Financial" perspective of the performance of the port logistics chain.

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Table 6. Summary table of indicators from the "Financial" perspective of the performance of a port logistics chain

Financial Perspective
Overall volume of traffic
Financial equilibrium of the port authority
Operating margin
Capital expenditure per TEU
Value added (direct and indirect)

As far as the learning and innovation dimension is concerned, we note that it is still underestimated by the port players questioned. In fact, only the management training rate indicator is considered very important by more than half of the companies surveyed (54.167%). However, achieving social objectives makes it possible to achieve economic and financial objectives (Bass B.M, 1952).

Learning and innovation are an undeniable source of value creation, innovation and competitiveness, and a strategic choice. The current context commits port operators to a logic based on a modern and dynamic vision of human resources and talent management, given the major constraints imposed by stakeholders. It would be very difficult for SCM strategy efforts to produce the hoped-for results if appropriate organisational structures and staff training and motivation practices are not put in place. However, we attribute the lack of awareness of the opportunities offered by this essential aspect of performance among the players interviewed to the recent introduction of SCM practices.

Table 7 shows the indicators for the "Learning and innovation" aspect of port supply chain performance.

Table 7. Summary table of indicators for the "Learning and innovation" perspective on the performance of a port logistics chain

Learning and innovation
Management training rate
Turnover rate
Percentage of idle time (percentage of time available for employees who work but are not obliged to work).
Cost of training/ employees

Internal process performance is clearly appreciated by the companies surveyed. In the indicators selected, we find all the elements that make it possible to assess the coherence of the value

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creation process, which is based mainly on lead time, productivity, capacity, infrastructure quality, safety/security, cooperation and information system quality.

The table below details the indicators for the "Internal Process" axis.

Table 8. Summary table of indicators from the "Internal process" perspective of port logistics chain performance

Internal process perspective
Vessel dwell time
Quay productivity
Use of storage space, use of equipment
Rail service measures
Average customs clearance
Quality of port infrastructure
Safety / Security
Proportion of declarations cleared in less than 7 days
Proportion of files released on the basis of a simple documentary check
Cooperation between stakeholders
Quality of the information system

We were also able to see that the players in the port of Casablanca attach paramount importance to satisfying their customers' needs. In a highly competitive environment with falling traffic, the only way to stand out is through quality of service. To achieve this, the players build their scorecards around three relevant indicators: the satisfaction rate, market share and the number of customer complaints.

The table below (Table 9) shows the performance indicators used to explain each dimension of the port operators' performance.

Table 9. Summary table of indicators for the 'customer' perspective of port performance

Customer perspective
Satisfaction rate
Market share
Number of customer complaints

Cost-related indicators are the ones most cited by port stakeholders. This indicator shows that the various stakeholders are aware that failure to control costs is a major handicap to efficient logistics.

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Following the 2006 World Bank report, which estimated the country's total logistics costs at around 20% of GDP, the Moroccan authorities undertook a number of reforms in the port, customs and transport sectors. Fortunately, these initiatives have raised awareness of the problem among the various players, who have already embarked on a process of modernisation and optimisation.

Table 10. Summary table of indicators from the "Financial" perspective of port stakeholders' performance

Financial perspective
Turnover
Cost of goods sold
Cost of demurrage

Three variables are assessed by port agents from the "Process" perspective: 1/ Quality through the "Amount of penalties and demurrage" indicator, 2/ Deadlines through the "Delay rate" and "Time taken to process files", 3/ Cost through the "Average operating cost" index.

Table 11. Summary table of indicators from the "Internal process" perspective of port stakeholders' performance

The "Internal Process" perspective
the Delay Rate
average transaction cost
the time taken to process files
the amount of penalties and demurrage

The port sector and its component activities are evolving in a fast-changing environment. In order to anticipate these changes, all the players in the port community must continuously develop and strengthen their human capital. To achieve this, the players at the Port of Casablanca refer to three indicators linked to training, experience and staff turnover.

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Table 12. Summary table of indicators from the "Learning and Innovation" perspective of port stakeholders' performance

The "Learning and innovation" perspective
the cost of training per employee
number of years' experience / employee category
percentage of staff turnover

On the other hand, the results of the multiple correspondence analysis show a strong correlation between almost all the performance dimensions. In fact, we found a significant correlation between sales performance indicators and financial performance indicators. Our test also showed a significant correlation between sales performance and internal process performance. The same result was found between internal process performance indicators and financial performance, as well as between internal process performance and the "learning and innovation" perspective and between financial performance variables and the learning and innovation axis. However, the correlation between business performance and learning and innovation performance was not significant.

In short, this stage of the analysis has enabled us to deepen our study of the performance of the port logistics chain by highlighting the indicators that enable it to be evaluated in all its dimensions, while taking into account the new changes in the maritime and port environment and the specificity of the Moroccan case.

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5. Conclusion

This work is a step towards defining a tool for measuring supply chain performance that takes into account the divergent views of all stakeholders, as well as the multidimensional aspect of performance. It has enabled us to define the most appropriate indicators for assessing each dimension of performance.

Approaches to performance have constantly evolved, and it is now widely accepted that it is unacceptable to approach the concept from a purely financial perspective. The notion of performance is multidimensional. It incorporates financial, commercial, social and societal considerations. In this work, we have used the different perspectives of the Kaplan and Norton (1996) balanced scorecard to draw up a fairly complete and multidimensional vision of the performance of the port logistics chain. We have retained the financial perspective, the customer perspective, the internal process perspective, and the learning and innovation perspective.

The bottom-up hierarchical classification has enabled us to define, for each dimension of performance, the indicators that are most representative of the performance of the port logistics chain. For example, the "customer" perspective is represented by the accuracy of ship/container positions, waiting time before berthing, the number of shipping lines connected to the port, the range of cargo and ship services, berthing, pilotage and towing costs, rail/truck connectivity/operability, and the provision of adequate and timely information.

Financial performance can be represented by the following indicators: Overall traffic volume, Financial balance of the port authority, Operating margin, Capital expenditure per TEU, Value added (direct and indirect). In addition, internal process performance is assessed using the following indicators: Vessel dwell time, quay productivity, use of storage space, use of equipment, rail service measurements, average customs deposit, quality of port infrastructure, security/safety, proportion of declarations cleared in less than 7 days, proportion of files released on the basis of a simple documentary check, cooperation between players and quality of the information system.

The learning and innovation axis is represented by four indicators, namely the management training rate, the percentage of staff turnover, the percentage of idle time and the cost of training per employee.

In short, this analysis has enabled us to deepen our study of the performance of the port logistics chain by highlighting the indicators that enable it to be evaluated in all its dimensions, while

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