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Key Performance Indicators Evaluation and Performance Measurement in Dry Port-Seaport System: A Multi Criteria Approach

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Abstract

Dry port-seaport services are key elements of a multimodal transport. They represent the needed infrastructure for its development. In this case, evaluating and improving their performance is necessary to achieve international competitiveness. The purpose of this paper is to develop a new model of performance measurement for the dry port-seaport system. To this aim, we have consolidated available researches and existing studies in order to identify and develop our proposed model framework. In this paper, a multi-criteria hierarchical model framework using MACBETH for dry port-seaport system has been developed. This framework can be used by managers at different levels of the system. The proposed model has been developed by exploring measurement gaps in multimodal transport field and by discovering prospective options from this area. The results and the methodology are practical. We obtain the global performance level of our involved system using our methodology, which can help managers in taken decisions and increase global performance of this system.

Keywords: *Dry port, Seaport, Multimodal Transport, Performance Measurement, Multi-Criteria Approach*

Anahtar Performans Göstergeleri Değerlendirme ve Kara Limanı - Deniz Limanı Sistemi Performans Ölçümü: Çok Kriterli Yaklaşım

Öz

Kara limanı hizmetleri çok modlu taşımacılığın temel unsurlarındandır. Gelişim için gerekli olan altyapıyı oluşturmaktadırlar. Bu sebeple, uluslararası rekabet başarısına ulaşabilmek için performanslarının değerlendirmesi ve iyileştirmesi gerekmektedir. Bu çalışmanın amacı kara limanı sistemleri için yeni bir performans ölçüm modeli geliştirmektir. Bu amaç doğrultusunda, model çerçevesini belirlemek ve geliştirmek amacıyla mevcut çalışma ve araştırmalardan yararlanılmıştır. Bu çalışmada, kara liman sistemleri için MACBETH kullanılarak çok kriterli hiyerarşik bir model çerçevesi geliştirilmiştir. Bu çerçeve farklı seviyedeki müdürler tarafından kullanılabilecektir. Önerilen model çok modlu taşımacılık alanında performans değerlendirme boşluklarını ve ileriye dönük muhtemel seçenekleri öngörerek geliştirilmiştir. Sonuçlar ve metodoloji uygulanabilirdir. Karar vermede yöneticilere yardımcı olabilen ve sistemin küresel performansını yükselten bu metodoloji kullanılarak küresel performans seviyesini elde etmiş oluruz.

Anahtar kelimeler: *Kara limanı, Deniz limanı, Çok modlu taşımacılık, Performans Değerlendirme, Çok Kriterli Yaklaşım*

1. Introduction

In a worldwide economy where there is a significant competitive and dynamic environment, dry port-seaport system management is essential to help increase multimodal transportation effectiveness. Hence, the efforts made to manage and improve the effectiveness and efficiency of the dry port-seaport system are critical in order to remain competitive on international trade which is becoming more global, and where competition is getting tougher and tougher. Dry port-seaport dyads are a complex system. They are composed of different parties, dealing with different activities and offering a large variety of services. Today the rise of containerization flow in multimodal transportation require the integration of logistics strategies into the seaport industry in order to stay competitive. Multimodal transportation plays an important role in global supply chains [1]. To ensure efficient container transfers, the capacity of seaports is one central dimension of their overall function as transport nodes. For this, it is important to optimize seaport management in order to accelerate and reduce the cost of containers moving [2].

That is why, over the last three decades, there has been a rising quantity of both theoretical and practical works on the seaport performance measurement and benchmarking [3], but works on the dry port-seaport system performance measurement are very rare. However, academic literature on seaport performance identifies the seaport hinterland as a strategic base of logistics activities and the main factor that influence the seaport performance [4]; [5]. Notteboom [6] and Van Klink and van den Berg [7] indicates that many seaports and shipping companies vertically integrate to control the hinterland. Seaports today compete not only in terms of efficiency and transshipment tariffs, but also in terms of the quality of services offered, such as speed and reliability of deliveries to customers [8]. Bichou [3] proposes an integrative framework to seaport performance by conceptualizing seaports from a logistics and supply chain management approach. Indeed many shipping companies consider land logistics as the most vital area to minimize costs. Also, Hayuth [9] observes the vertical increase of shipping companies to manage the logistics and supply chain. He notes that one of the results of this behavior is that the seaport choice is increasingly determined by factors such as multimodal infrastructure on the land side. Similarly, Heaver et al. [10] reports that many shipping companies also control the seaport's hinterland. Accordingly, efficiency of inland transport and hinterland connection has become a significant factor in a seaport's potential future to evaluate seaport competitiveness [11]. As a consequence, it is widely accepted that seaport's hinterland is one of the most important concepts in the shipping industry, in that various economic activities such as logistics value-adding, multimodal transports and maintenance. In the past, seaports, for instance, functioned as a gateway for loading and unloading but currently seaports have to perform a variety of roles such as a transfer system, a storage system and inland terminals [12]. Dry ports are one type of inland terminals and they have been playing a significant role in the expansion capacity of seaports [13]. Hence, the need to measure dry port-seaport performance. The traditional seaport performance measures focus on sea access rather than land-side connections, and there is a need for better measurement of the global system (dry port-seaport system). Cohen and Roussel [14] provide the following definition of performance measurement: "Performance measurement refers to the indicators of the work performed and the results achieved in an activity, process or organizational unit". Performance evaluation plays an important role in all areas of business management, both in private and public sectors, because it explains how much and how organizations have reached their goals

besides providing subsidies about how they can promote improvements ([15]; [16]). Forslund [17] defines the steps of performance management as follows: set objectives and strategies; define metrics; set targets; measure; analyze; evaluate; and then act to improve the process.

At present, most of the studies of dry port and seaport focus on the location of dry port, but there are little researches on performance evaluation of the global system. In this paper, we bridge this gap; we present a global approach to evaluate performance of the dry port-seaport system.

This paper is organized as follows: a literature review of the different approaches and methods of performance measurement in section 2. The dry port-seaport process description is presented in section 3. Section 4, performance will be devoted to indicators identification, analysis and assessment using MACBETH approach. Finally, conclusion is presented in Section 5.

2. Literature Review

Performance measurement plays an important role in the development of dry port-seaport system. Dyson [18] claims, performance measurements plays an essential role in evaluating productivity, because, it can define not only the current state of the system but also its future. Performance measurement helps to move the system in the desired direction through the effect exerted by

Table 1. Gives an Overview of Some Methods Used in Performance Measurement.

Methods and Models	Authors
Data Envelopment Analysis (DEA)	Diaz-Hernandez et al. [19]
	Talley et al. [20]
	Wan et al. [21]
	Hung et al. [22]
	Wu and Goh [23]
	Cullinane et al. [24]
	Valentine and Gray [25]
	Tongzon [26]
Stochastic frontier analysis (SFA)	Ju and Liu [27]
	Suarez-Aleman et al. [28]
	Cullinane and Song [29]
	Estache et al. [30]
	Chang and Tovar [31]
	Cheon et al. [32]
	Estache et al. [33]
Free Disposal Hull (FDH)	Lu [34]
	Cullinane et al. [35]
	Wang et al. [36]
Technique for order performance by similarity to ideal solution (TOPSIS)	Celik et al. [37]
Preference ranking organization method for enrichment evaluation (PROMETHEE)	Castillo-Manzano et al. [38]
Measuring Attractiveness by a Categorical Based Evaluation Technique (MACBETH)	Madeira et al. [39]
Analytic Hierarchy Process (AHP)	Li and Jiang [40]
	Kunadhamraks and Hanaoka [41]

the behavioral responses towards these performance measures that exist within the system. There are several models available in the literature dealing with seaport performance. Table 1; gives an overview of some methods used in performance measurement in different area. As can be seen from the literature, studies on dry port-seaport system performances using multi-criteria method are poorly considered. We can find one article [40] in literature that discusses the global system performance dry port-seaport. Authors evaluate the cooperation performance between seaports and dry ports. The previous performance evaluation on literature has evaluated the seaport performance and partly neglected the dry port-seaport system performance. To bridge this gap, we will present a novel approach and new model framework using multi-criteria method to evaluate performance of the dry port-seaport system in order to have a global overview of the global performance level.

3. Process Description

Within the seaport hinterland, dry ports have become more and more identified as a means for improving seaport capacity, facilitating intermodal transport and increasing seaport's hinterland. Dry ports are proposed as nodal infrastructures handling the same functions as the seaport. Essentially, four functions take place in cargo terminal: the cargo transfer, most of time by unit between two modes; the storage of goods awaiting treatment; and delivery and control of logistics flow [42]. In addition to all the functions mentioned above, services such as maintenance of containers, clearance and other added value services should exist in a dry port according to customer needs [43]. When containerization is bumming, seaports often meet with lack of capacities for containers storage areas. A dry port is a port situated in the hinterland servicing an industrial region connected with one or several seaports by rail transport and it offers specialized services between the dry port and the transmarine destinations. In general the dry port is container and multimodal oriented and has all logistics services, which is required for shipping and forwarding agents in a seaport. Usually extending the seaport areas by satisfying docks and dam, new sea areas resolve the space problem [44]. To stop the sea area is very problematic in view of environmental protection of coastal sea land. The growing problem of transporting goods to and from the seaport all the way through the city, in addition to the expensive costs of establishing novel docks have created preconditions to set up hinterland terminals or dry ports, which almost can handle all of the seaport related services [44]. The development of dry ports is consequently a crucial instrument to encourage sustainability and effectiveness of maritime transport related transport chains. To guarantee an effective dry port there are two common objectives: (1) consolidation of maritime goods in multimodal short and long distance transport flows and (2) assembling and distribution of local, regional and international transports. To reach these two objectives, it is necessary for the terminal to transmit out the following services: Hinterland warehousing; Management of container flows to different seaports based on consolidation of individual container flows; Expansion of rail transport; Offering special- and extra services; Reduction of transport costs; Increase in the firms of ship owners and the seaport influence to ensure the intensification of the transport chains effectiveness [44]. Therefore, the concept of dry port can help to identify less harmful means of transfer for the environment, relieve seaports cities from congestion, handle goods in a more efficient manner as in seaports and facilitate improved logistics solutions for shippers in the hinterland of the seaport in order to satisfy customers [43].

As seen in Figure 1, after that the import

containers have been unloaded from vessels and placed in the marshalling area, they are transferred to Load in the train. The containers are transferred from the seaport to dry port by rail connections. When containers arrive at the dry port, dry port agents proceed in discharging them. They must be placed in storage areas until they are needed for deliver to the final customer. slots. Phase (5), containers delivery: dry port administration notifies clients by the arrivals of their containers in order to deliver containers and complete the administration procedure. In follow, Section 4 proposes the identification, analysis and the assessment of dry port-seaport performance.

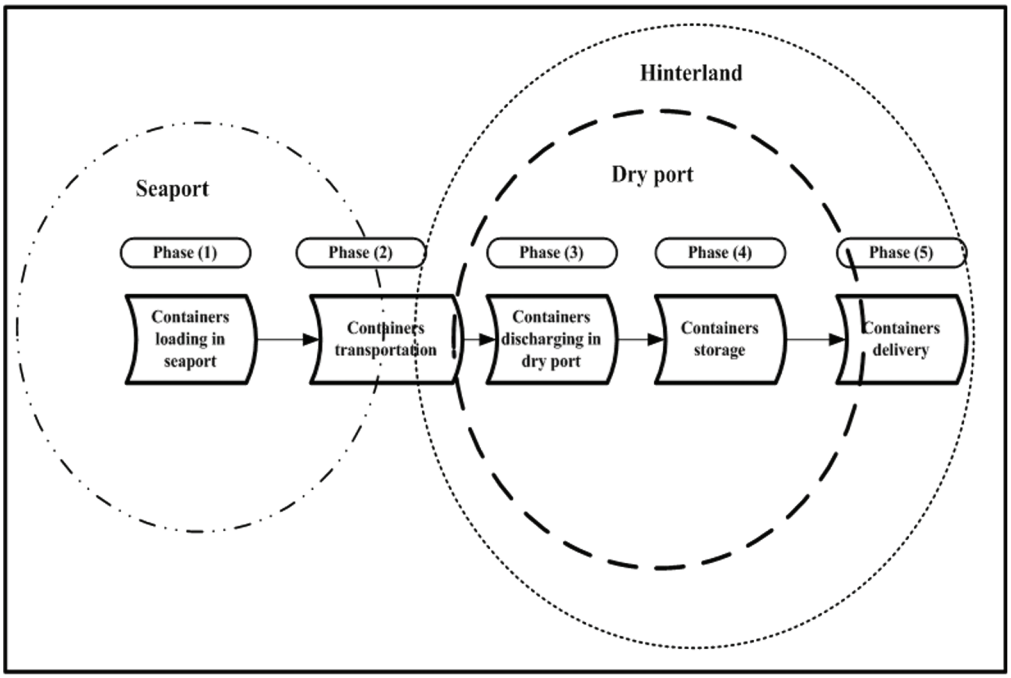

Figure1. *Seaports Connected to Dry Ports and Container Flows in This System*

We can describe this process in five phases as follow: phase (1), containers loading in seaport: consists on loading containers already discharged from vessels, in order to transport them from seaport to dry port via rail connection. Phase (2), containers transportation: consists of transporting containers via rail connection from seaport to dry port. Phase (3), containers discharging in dry port: when containers arrived in dry port, dry port workers precede in discharging containers with special equipments in order to transfer them to the storage area. Phase (4), containers storage: dry port workers moved containers in their specific

4. Research Framework and Methodology

4.1. Key Performance Indicators Identification

The common purposes of performance management are to reduce cost and to improve efficiency and effectiveness [45]. Therefore a series of indicators is needed to properly assess the performance of the dry port-seaport system. The performance measurement process is made via performance indicators [46]. A performance indicator is a designation for a certain type of performance measurement. Indicators are used by companies or organizations to help assess their internal performance

or the performance of a particular activity in which they are engaged [47]. Also, key performance indicators are used for improving processes performances. The key performance indicators for the dry port-seaport system integrate both the operational and the financial indicators as. The objective of our investigation is to propose a novel framework of performance measurement of our involved system. There are a number of performance indicators which are generally considered decisive [48]. The identification of the most common dry port-seaport system key performance indicators was based on (1) literature resources and (2) industrial expert judgments. Primarily (1) We are based in some literature references in order to collect key performance indicators ([49]; [50]; [13]; [20]; [51]; [52]; [30]; [53]; [54]; [55]; [56]; [57]; [26]; [25]; [58]; [59]; [39]. Secondly (2) Regarding industrial expert judgments an exploratory research, individuals with different types of expertise related to dry port, rail transport and seaport were approached to collect key performance indicators. Meyer and Booker [60] define an expert as: someone who has knowledge of an issue at an appropriate level of details and who is capable of communicating their knowledge. Expert judgments are a routine and necessary part of key performance indicators analysis. An expert can be defined by their professional standing, or by their performance. It is generally true that most experts are overconfident in their ability to estimate quantities. The degree of overconfidence is related to their cognitive style [61]. The scale of conceptual understanding and comprehension of the key performance indicators varied highly between the experts. Interviews were conducted during different phases of the system process (i.e. phase1 experts chosen from seaport field, phase 2 experts chosen from rail transportation field …). Different experts might have a different viewpoint about key performance indicators in dry port-seaport system. The participants in our brainstorming consisted of three panels of experts, namely:

- Seaports panel (1). 11 Moroccan seaport experts (Casablanca seaport) are contacted to brainstorm with us in order to collect and discuss seaport key performance indicators.
- Rail transportation panel (2). 6 Moroccan rail transportation experts (ONCF: office nationale des chemins de fer) are contacted brainstorm with us in order to collect and discuss rail transportation key performance indicators.
- Dry port panel (3). 7 Moroccan dry port experts are contacted brainstorm with us in order to collect and discuss dry port key performance indicators.

Data were collected using mail survey, web survey, and field visits to (1) decrease the cost of data collection, (2) decrease any prejudice of using a single survey methodology, and (3) develop the quality of data by using a multi-survey methodology [62].

A combination of interviews and questionnaires were prepared for each panel of experts, consisting of: An on-line questionnaire was designed for seaport and dry port managers in order to investigate their perception of key performance indicators. In some cases, surveys were conducted and administered over the telephone panels 1 and 3. Extensive telephone and face to face open interviews were used to get in touch with Panels 2. We used open ended and structured questions depending on the type of information required. The acceptable response rate (54%) is attributable to the good selection of participants showing a direct curiosity in the subject of investigation. The results were considered acceptable given the novel studied research. Therefore, key performance indicators and data collection involved brainstorming and focus group activities conducted in the dry port-seaport system with managers from the organizations via interviews, phone

Table 2. *Presents Details in Each Panel of Experts.*

Panels of Experts	Number of Participants	Number of Responses	Responses as Percentage	Time and Place	Interviewed Specifications
Panel 1	11	6	55	April, 2014; Casablanca Seaport	Operations director; financial director…
Panel 2	6	3	50	June, 2014; ONCF	Managers; traffic director
Panel 3	7	4	57	September, 2014; Casablanca Dry port	Operations director; financial director…
Total	24	13	54		

calls and E-mails in the five phases of our studied system. Further, two focus groups were organized in order to attain common agreement along with all the system members on the relative importance of the different key performance indicators.

Initially, and based on the critical review of literature, two families of indicators were identified operational key performance indicators family (OP), following five phases (phase 1to phase5), each phase contains a number of key performance indicators category, and financial key performance indicators family (FP) in all over the system. Table 3 and 4 present the results of this brainstorming, key performance indicators in different phases in dry port-seaport system process and financial key performance indicators in general all over the process.

As stated by Gunasekaran and Tirtiroglu [63] ‘‘measures and metrics are needed to test and reveal the viability of strategies without which a clear direction for improvement and realization of goals would be highly difficult’’. Yet, ‘‘performance measurement continues to present a challenge to operations managers as well as researchers’’ [64]. The objective of this paper is to develop a novel model as shown in Figure 2 in order to obtain the performance level of dry port-seaport system based on a multi-criteria methodology using MACBETH tool. Our model is based on a scale from 1 to 9 (1 is the lowest performance level and 9 the highest performance level). The fundamental idea is to measure the performance of each phase (which based on five phases) of the system separately and to determine the operational performance level then the financial one, after that we come to finalize by determining the global performance level of the system. The determination of the performance at each step is via predefined fields depending on the nature of each phase. The fields themselves even are assessed on the basis of a set of indicators compatible with each field. The data (D.) collection of key performance indicators uses a multi-methodological approach based on surveys, reports and interviews with staff members and operators, or even through a few Delphi research rounds and formulate. These data types will firstly need to be determined and subsequently used in the process maps to collect the corresponding data for performance category of each phases of operational and financial family. Data collection is necessary for suitable performance analysis and is the key in decision-making. However, in reality, due to a variety of reasons, accurate data are not always gladly available or are very difficult to obtain. The procedure of data collection and analysis was very demanding and time consuming when conducted through extensive telephone and face to face interviews. Parameters provided by the private or public domain

Table 3. *Dry Port-Seaport System KPI's in Different Phases of The Process.*

Phase	KPI Category	Key Performance Indicators	KPI Code
(1) Container loading in seaport	Productivity (PR)	(1) Number of loading containers / hour	1PR1
		(2) The mean time to load a train	1PR2
		(3) The mean time of stops during containers loading / train	1PR3
	Reliability (RI)	(1) Number of erroneously loading containers	1RI1
		(2) Number of unloading containers due to an incident	1RI2
		(3) The mean time of waiting before starting operations by train	1RI3
		(4) The mean time of equipment unavailability / train	1RI4
	Security (SC)	(1) Number of human accident / year	1SC1
		(2) Number of cases of goods theft / year	1SC2
	Workers professionalism (WP)	(1) Percentage of workers with over five years of experiences	1WP1
		(2) Number of training hours / worker	1WP2
		(3) Absenteeism / worker	1WP3
		(4) Number of error due to the human factor	1WP4
(2) Container transportation	Traffic (TR)	(1) Number of train travel per day made / possible maximum travel number	2TR1
		(2) Number of container transported per day per the maximum number of trains	2TR2
	Security (SC)	(1) Number of theft cases / year	2SC1
		(2) Number of train accident / year	2SC2
	Reliability (Rl)	(1) The mean time of train travel / minimum travel duration	2Rl1
		(2) Rate of trains unavailability	2Rl2
		(3) Number of times train stopping due to a technical problem	2Rl3
(3) Container discharge in dry port	Productivity (PR)	(1) Number of container discharged / hour	3PR1
		(2) The mean time of loading operations / train	3PR2
	Reliability (Rl)	(1) The mean time of stop in discharging operations	3Rl1
		(2) Number of erroneously discharging container	3Rl2
		(3) Number of non discharged container due to an incident	3Rl3
		(4) The mean time of waiting before starting operations by train	3Rl4

Table 3. *Dry Port-Seaport System KPI's in Different Phases of The Process.(Cont')*

Phase	KPI Category	Key Performance Indicators	KPI Code
(3) Container discharge in dry port	Security (SC)	(1) The mean time of non-availability of equipment by train	3SC1
		(2) Number of human accident / year	3SC2
		(3) Number of cases of goods theft / year	3SC3
	Workers professionalism (WP)	(1) Percentage of workers with over five years of experiences	3WP1
		(2) Number of hours of training / worker	3WP2
		(3) Percentage of absenteeism / worker	3WP3
		(4) Number of errors due to the human factor	3WP4
(4) Container storage	Capacity (CP)	(1) Number of occupied slots per number of available slots	4CP1
		(2) Lack of space per container / day	4CP2
	Security (SC)	(1) Rate of goods theft	4SC1
		(2) Number of intrusion / year	4SC2
		(3) Reliability of the monitoring system	4SC3
	Organization (OR)	(1) Number of incorrect positioned container	4OR1
		(2) Number of container non-available directly	4OR2
		(3) Rate of compliance with segregation requirements	4OR3
		(4) The mean time of equipment waiting / container	4OR4
		(5) Percentage of compliance with the schedule workers	4OR5
		(6) Availability rate of equipment	4OR6
(5) Container delivery to customers	Capacity (CP)	(1) Number of container delivered per max capacity (per unit time)	5CP1
		(2) The mean time of waiting per the mean time of delivery (per customer)	5CP2
		(3) The mean time of outage per operations (per delivery)	5CP3
	Reliability (Rl)	(1) Number of containers delivered by error / year	5Rl1
		(2) Number of containers no delivered following an incident / year	5Rl2
		(3) The mean time of waiting before starting operations / client	5Rl3
		(4) The mean time of non-availability of equipment / customer	5Rl4

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Table 3. *Dry Port-Seaport System KPI's in Different Phases of The Process.(Cont')*

Phase	KPI Category	Key Performance Indicators	KPI Code
(5) Container delivery to customers	Organization (OR)	(1) Rate of compliance deliveries schedule	5OR1
		(2) Rate of equipment availability	5OR2
		(3) The mean waiting time for equipment / container	5OR3
		(4) Percentage of compliance with the schedule workers	5OR4
	Customer relationship management (CR)	(1) Number of customer complaints / the number of customers	5CR1
		(2) Handling customer complaints / the number of customers	5CR2
		(3) Number of customer satisfaction survey / year	5CR3
		(4) Rate of customer satisfaction	5CR4

sometimes have to be used during the data collection phase traffic. So we estimate the data (D.) collection of key performance indicators and consequently the data for performance category of each phases of operational and financial family (seaport and dry port of Casablanca, Morocco 2013) as presented in Table 4.

Table 4. *Dry Port-Seaport Financial KPI in General*

	KPI Category	Key Performance Indicators	KPI Code
Financial Performance (FP)	Strategic level (SL)	(1) Financial leverage ratios	FPSL1
		(2) Debt ratio	FPSL2
		(3) Investment	FPSL3
		(4) Investor ratios	FPSL4
		(5) Return on asset	FPSL5
		(6) Total asset turnover ratio	FPSL6
		(7) Profitability ratios	FPSL7
		(8) Net profit margin ratio	FPSL8
		(9) Trade volumes (in dollars)	FPSL9
	Tactical level (TL)	(1) Demurrage delay penalty cost	FPTL1
		(2) Fiscal cost	FPTL2
		(3) Account receivable turnover	FPTL3
		(4) Revenue	FPTL4
		(5) Activity ratios (Asset turnover ratios)	FPTL5

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Table 4. *Dry Port-Seaport Financial KPI in General (Cont')*

	KPI Category	Key Performance Indicators	KPI Code
Financial Performance (FP)	Operational level (OL)	(1) Liquidity / working capital	FPOL1
		(2) Transportation cost per train	FPOL2
		(3) Transportation cost per container	FPOL3
		(4) Cash flow	FPOL4
		(5) Containers handling revenue per ton	FPOL5
		(6) Capital equipment expenditure per ton of cargo	FPOL6

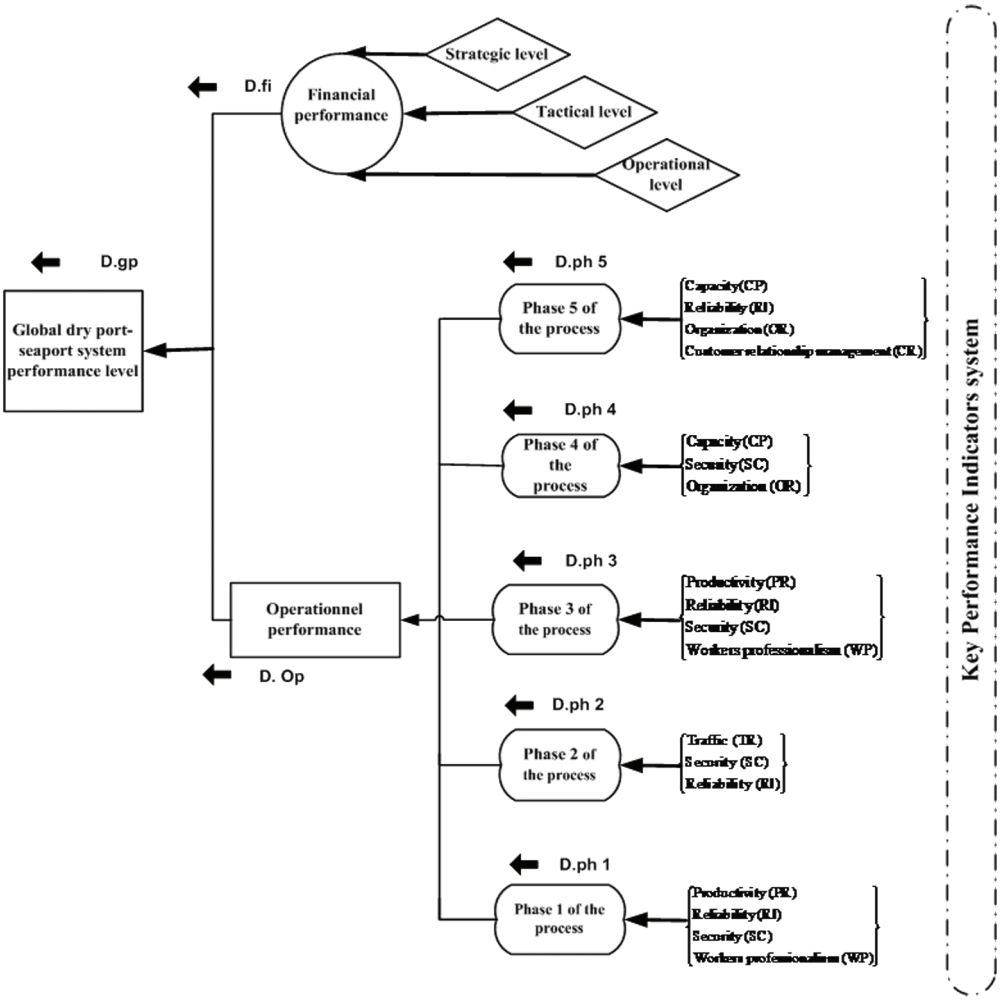

Figure 2. *A Model of Global Performance Measurement of Dry Port-Seaport System.*

Table 5. *Data For Performance Category of Each Phase in Operational and in Financial Family.*

	Phase	Performance Category	Data (D.)
Operational performance (OP)	(1) Containers loading in seaport	Productivity (PR)	60%
		Reliability (RI)	50%
		Security (SC)	40%
		Workers professionalism (WP)	50%
	(2) Containers transportation	Traffic (TR)	70%
		Security (SC)	80%
		Reliability (Rl)	60%
	(3) Containers discharge in dry port	Productivity (PR)	70%
		Reliability (Rl)	70%
		Security (SC)	50%
		Workers professionalism (WP)	60%
	(4) Containers storage	Capacity (CP)	85%
		Security (SC)	65%
		Organization (OR)	50%
	(5) Containers delivery to customers	Capacity (CP)	70%
		Reliability (Rl)	60%
		Organization (OR)	50%
		Customer relationship management (CR)	60%
Financial performance (FP)		Strategic level (SL)	50%
		Tactical level (TL)	50%
		Operational level (OL)	70%

We are based on surveys, reports in order to determine data (D.) of the key performance category. We are proceed to increment data with multiples of 5% (in order to simplify expressions), results are presented in Table 5. The estimation of the data (D.) is based on a statistical analysis of Casablanca dry port-seaport data historic. In follow we will use this data (D.) in multi-criteria methodology in order to measure the operational, financial and global performance level.

4.2. Multi-Criteria Approach: MACBETH

The proposed performance evaluation model for dry port-seaport system is based on determining the performance level in each step of the system. Among the existing methods based on this approach which reflect the problem of sorting to generate a ranking of the alternatives (performance level), MACBETH was selected. It determines the value function that best represents the judgments of the decision maker by Linear Programming. This formulation eliminates the inconsistencies and analyzes reparation rates between the points of view (criteria), as well as the level of impact of the alternatives for every point of view [65]. MACBETH proposes a performance level of our involved system. It allows a qualitative two by two assessment through a non-numerical interactive questioning process that compares two stimuli at the same time, demanding only a qualitative decision about their difference of attractiveness [66]. As the answers are given, the consistency

is confirmed, and a numerical scale that is representative of the decision-makers judgments is then created and argued. MACBETH is a decision support approach to ensure the practical implementation of the entirety of a multi-criteria assessment process. It consists of a set of procedures to facilitate the achievement of each of the major steps of such process. When designing this approach, the first objective was to develop a procedure which aims to help in the assessment i.e. a procedure to help a person (or group of people) J to measure the attractiveness of elements which J is interested. In this procedure, J are asked to compare the elements two by two and when prefers X element to Y element, specify in what terms he would speak of the difference between his feelings of attractiveness of X and of Y. It is a multi-criteria decision analysis approach that requires only qualitative judgments about differences of value to help a decision maker, or a decision-advising group, quantify the relative attractiveness of options. The approach, based on the additive value model, aims to support interactive learning about the evaluation problem and the elaboration of recommendations to prioritize and select options in individual or group decision making processes [67].

It is: (1) Humanistic in the logic that it should be used to assist decision-makers consider, communicate, and talk about their value systems and favorites. (2) Interactive because we are persuaded that this suggestion and learning process can best spread through socio-technical facilitation continued by simple questioning-answering protocols. From a practical perspective, this

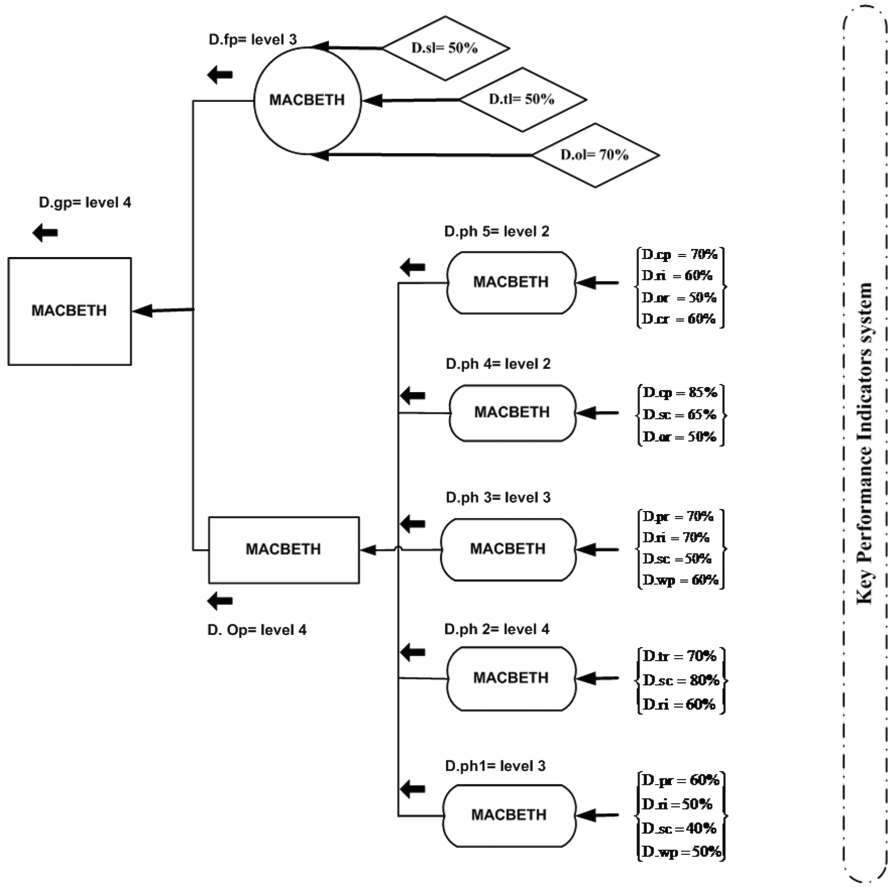

Figure 3. *Performance Level in Each Step of Dry Port-Seaport System Using Macbeth.*

suggests that such communication would greatly benefit from an extremely efficient and user friendly decision support system, as it is actually the case of the M-MACBETH software. (3) Constructive because MACBETH rests on the idea that full-bodied confidences about the kind of decision to make [68].

A general idea and some applications of MACBETH are presented in [66], [69] and on www.m-macbeth.com. We therefore propose using a MACBETH approach to obtain the performance level of the global system.

4.2.1. Multi-Criteria Analysis

In our approach, we have proposed a performance measurement approach based on two steps, namely, step 1: key performance indicators identification and classification in a matrix form, grouped by family and phase indicators in our studied workflow process. Step 2: performance assessment by adopting a multi-criteria method (MACBETH), the choice of this method is justified by the fact that this method does not require the assignment of weight when evaluating options. Evaluation of performance levels (options) must take into consideration several point of view and several criteria simultaneously, hence we require a multi-criteria method. This study applied MACBETH to measure the performance value in each phases, to measure the performance value in operational and financial family and finally to measure the global performance value of the dry port-seaport system. As shown in Figure 3, MACBETH was applied to identify the performance level among the system.

We obtain performance level of each phase using MACBETH and based on a scale from 1 to 5 (1 is the lowest performance level and 5 the highest performance level) as follow: phase 1 (D.ph1= level 3); phase 2 (D.ph2= level 4); phase 3 (D.ph3= level 3); phase 4 (D.ph4= level 2) and phase 5 (D.ph5= level 2). From data of phases we can obtain performance level of operational family using also MACBETH and based on a scale from 1 to 9 (1 is the lowest performance level and 9 the highest performance level) as follow: D.op= level 4 and using the same tool and scale we obtain the performance level of financial family as follow: D.fi= level 3. Details about all results are given in Appendix A.

Finally, we obtained the global performance D.gp= level 4 using MACBETH and based on a scale from 1 to 9. Results presented in Figure 4.

In Morocco, seaport provides 98% of external trade and therefore constitutes a vital sector for the economy. It should not only contribute to improve the competitiveness of the national economy, but also capture the opportunity offered by the international shipping by positioning itself in this sector, notably in the

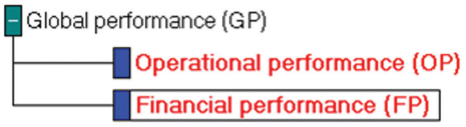

Table of scores

Options	Overall	Operational performa	Financial performanc
[all upper]	100.00	100.00	100.00
level 4	99.00	100.00	95.00
level 5	91.04	91.30	90.00
level 6	82.59	82.61	82.50
level 3	79.13	73.91	100.00
level 2	61.20	60.87	62.50
level 7	51.52	45.65	75.00
level 1	35.34	30.43	55.00
level 8	15.07	11.96	27.50
level 9	0.00	0.00	0.00
[all lower]	0.00	0.00	0.00
Weights :		0.8000	0.2000

Figure 4. *Global Performance Aggregated Assessment For Casablanca Dry Port-Seaport.*

Mediterranean and Europe. To this end, given the geostrategic position benefit of the country, it is important to understand the major role that can play Moroccan seaports and dry ports in Moroccan trade. To modernize the maritime transport sector, Morocco has implemented a seaport reform including the introduction of competition in this sector. It also has undertaken major achievements such as the construction of the new seaport (Tangier Med) and new

dry ports whose rise to power will position Morocco as a must pivot between Western and Northern Europe and Asia [70]. Morocco government has launched a major development program which consists of construction of a dry ports network through the major sites of distribution and consumption in Morocco. Dry port provides multiple services such as: reception and dispatch of containers, customs formalities, loading and unloading of trains and trucks, storage of containers, containers processing in order to increase the global performance (www.oncf.ma).

The strengths of this model, which is based on a multi-criteria approach are not only taken into account within the final judgment of performance level, but also are taken into account the performance level ranking in each step of the model. This model can be very helpful to Moroccan government in order to boost performance of this sector by giving more attention to land part in shipping. From the analysis of the results, it was perceived that there are gaps that can support progresses in this area. These are:

- Collaboration of the researchers with dry port-seaport managers, aiming at the improved recognition of their requirements and the diversity of agents that operate in the dry port-seaport system environment;
- Elaboration of methodologies and approaches for performance evaluation that are more elastic to follow the continuous modifications in the dry port-seaport system;
- Use of tools that are capable to consider and characterize the peculiarities and detailed aspects of the dry port-seaport units studied and the power of the outside environmental variables in dry port-seaport performance;
- Use of tools that are able to exchange with managers about the real performance and propose strategies to activate better performance, therefore encouraging the activity of dry port-seaport management;
- Expansion of potential studies representation the performance in prospect situations, rather than studies based on historical data.

The model proposed in this paper stands as an initiative involving further research and investigation.

5. Conclusions

Today, the dry port-seaport system has become a vital subject of research for the academicians and practitioners in current years. Dry port-seaport system decision-makers have to take in count a big quantity of variables in their actions. In order to help managers to make their decisions, we calculate then assess the system progression in all phases. But, in some situations this assessment is complex either in getting information, actors concerned and their interactions. In this perspective, the present paper contribute in the literature by illustrating the identification of key performance indicators, understanding, and measurement of performance level related to this system for increasing its effectiveness on strategic level. The identified key performance categories were estimated for Casablanca seaport dry port case and analyzed using MACBETH tool. Using the methodology of this paper seaports-dry ports managers will be able to identify which best practices should be adopted and in which processes they must execute those best practices to make agile ports to becoming more agile. It will take dry port-seaport management to measure its performance to establish how facts have been applied in a successful and professional way. Financial performance indicators, together with operational indicators can provide data on the right time when seaports and dry ports are required to be reactive. As results, we obtain the global performance level of our involved dry port-seaport system using our methodology, which can help managers to take decisions and increase global performance. We based our study in academic researches and expert's judgments in the involved area,

so that we can judge the reliability of the previous framework model in performance assessment. The method as such is practical but its strong and weak point at the same time is the expert's profile (a good choice of experts led to obtain a valid and reliable study but a bad choice led to obtain a more limited study). Therefore, the main limitation of this study derives from the fact that the experts judgments presented are subjective and depends on expert's performance. With the availability of added dry port-seaport data and the inclusion of more facilities, applying this methodology to other seaport-dry port systems based on a larger sample size represents an interesting area for future research. We regarded the approach as a whole to be reliable and valid, because the choice of a group can almost never be entirely irrelevant. Which leads to, always and in any situation, a realistic assessment, and therefore we can consider it as the strongest aspect of this study. With this paper, we have only highlighted a first step in the debate of a gap existing in the dry port-seaport system performance research and practice.

Appendix A

Phase 1

Table of scores

Options	Overall	Productivity (PR) 60	Reliability (RI) 50%	Security (SC)	Workers professional
[all upper]	100.00	100.00	100.00	100.00	100.00
Performance level 3	92.91	100.00	100.00	81.25	73.33
Performance level 2	80.59	63.16	88.24	100.00	100.00
Performance level 4	62.57	84.21	70.59	25.00	53.33
Performance level 1	26.04	0.00	35.29	50.00	86.67
Performance level 5	19.81	42.11	0.00	0.00	0.00
[all lower]	0.00	0.00	0.00	0.00	0.00
Weights :		0.4705	0.1765	0.2941	0.0589

Phase 2

Table of scores

Options	Overall	Traffic (TR)	Security (SC)	Reliability (RI)
[all upper]	100.00	100.00	100.00	100.00
Performance level 4	98.82	100.00	100.00	88.24
Performance level 3	82.36	88.24	64.71	100.00
Performance level 5	74.12	70.59	82.35	70.59
Performance level 2	37.06	35.29	41.18	35.29
Performance level 1	0.00	0.00	0.00	0.00
[all lower]	0.00	0.00	0.00	0.00
Weights :		0.6000	0.3000	0.1000

Phase 3

Table of scores

Options	Overall	Productivity (PR)	Reliability (RI)	Security (SC)	Workers professional
Performance level 1	13.45	0.00	0.00	35.00	53.57
Performance level 2	67.34	35.00	88.24	100.00	100.00
Performance level 3	94.96	100.00	100.00	85.00	89.29
Performance level 4	77.67	85.00	70.59	70.00	78.57
Performance level 5	39.16	70.00	35.29	0.00	0.00
[all upper]	100.00	100.00	100.00	100.00	100.00
[all lower]	0.00	0.00	0.00	0.00	0.00
Weights :		0.4705	0.1765	0.2941	0.0589

Phase 4

Table of scores

Options	Overall	Capacity (CP)	Security (SC)	Organization (OR)
[all upper]	100.00	100.00	100.00	100.00
Performance level 2	91.70	35.29	91.30	100.00
Performance level 3	89.21	70.59	100.00	85.71
Performance level 4	59.42	100.00	78.26	42.86
Performance level 1	54.89	0.00	52.17	64.29
Performance level 5	6.87	82.35	0.00	0.00
[all lower]	0.00	0.00	0.00	0.00
Weights :		0.0834	0.3333	0.5833

Phase 5

Table of scores

Options	Overall	Capacity (CP)	Reliability (RI)	Organization (OR)	Customer relationshi
[all upper]	100.00	100.00	100.00	100.00	100.00
Performance level 2	97.90	64.29	100.00	100.00	100.00
Performance level 3	86.23	100.00	84.62	85.71	85.71
Performance level 4	56.92	85.71	69.23	42.86	64.29
Performance level 1	51.39	0.00	46.15	64.29	42.86
Performance level 5	2.52	42.86	0.00	0.00	0.00
[all lower]	0.00	0.00	0.00	0.00	0.00
Weights :		0.0589	0.2941	0.4705	0.1765

Financial performance (FP)

Table of scores

Options	Overall	Strategic level (SL)	Tactical level (TL)	Operational level (O
[all upper]	100.00	100.00	100.00	100.00
level 3	95.70	100.00	89.47	90.48
level 4	92.16	89.29	100.00	80.95
level 5	82.57	82.14	78.95	100.00
level 6	68.60	75.00	57.89	66.67
level 7	60.14	67.86	47.37	57.14
level 2	57.63	53.57	68.42	42.86
level 1	39.66	42.86	36.84	28.57
level 8	10.22	7.14	15.79	9.52
level 9	0.00	0.00	0.00	0.00
[all lower]	0.00	0.00	0.00	0.00
Weights :		0.5833	0.3333	0.0834

Operational performance (OP)

Table of scores

Options	Overall	Phase 1	Phase 2	Phase 3	Phase 4	Phase 5
[all upper]	100.00	100.00	100.00	100.00	100.00	100.00
level 4	86.00	100.00	84.00	100.00	84.00	76.00
level 5	82.54	90.00	100.00	92.31	64.00	64.00
level 6	71.74	80.00	92.00	76.92	56.00	52.00
level 3	70.36	65.00	44.00	65.38	100.00	92.00
level 2	56.84	45.00	8.00	46.15	92.00	100.00
level 7	56.42	55.00	76.00	53.85	48.00	44.00
level 1	38.59	20.00	0.00	7.69	76.00	84.00
level 8	34.03	30.00	58.00	30.77	24.00	20.00
level 9	10.12	0.00	36.00	0.00	0.00	0.00
[all lower]	0.00	0.00	0.00	0.00	0.00	0.00
Weights :		0.1875	0.2812	0.1250	0.0313	0.3750

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