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AN EVALUATION MODEL FOR FORECASTING METHODOLOGIES USED BY PORTS

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INTRODUCTION

The deregulation of the port industry as well as the increased significance of ports in the transportation chains has deliberated hidden potential. Policy- and business decision-makers have shifted their interest to port operations and mainly to the collaboration of transportation means at the nodal point of a port, seeking primarily for a more active role of the ports along the logistics chains. This paper is based on experiences gained from various research and development projects, mainly from the Tools and Routines to Assist Ports and Improve Shipping (TRAPIST) funded by the European Commission. Therefore much of the information provided is referred to European cases and pattern. However it is expected that similar problems have also been identified and have to be addressed in other regions as well.

At a European level, the role of ports is increasing and there is an issue of promoting the significance of small and medium ports (SMP) along the logistics chains. Most commonly these ports do not possess enough resources and expertise for the drafting of marketing plans or for the launching of aggressive strategies. Furthermore there is a gap in the management culture, as most SMP were and still are operating in sheltered business environment due to the regulation or due to the limited options users enjoyed in the past. However this is not the case in the coming years, as users enjoy more transport options because of the launching or the completion of various infrastructure projects. Consequently regardless of the institutional pattern SMP will face competition in their region.

A finding from the research was that most SMP do not base their forecasts on a specific methodology but a combination of historical data and conferring with the major users. Given also the results of the European Seaports Association (ESPO) survey, many ports base their forecasts on national macroeconomic data (ESPO, 2001), but this is not a very sound method as many trades are regional and not national or pass transit through the port. In many cases there are no adequate regional data or the correlation of commonly used macroeconomic parameters with the transit movements is weak (Psaraftis et al, 2003a).

The purpose of this paper is to present a methodology assisting SMPs to select a forecasting methodology. As there are practically three main categories of forecasting methodologies, a port has to focus on a specific one and then to customize it to the specific needs (or available data). The outcome of the methodology has to be an answer to the problem what methodology to choose, and therefore to prepare the management for the trade-off between quality and resource-utilization. The projection methodologies are strongly depended on the available data, their integrity and quality. Data collection is a rather complicated task as it is not only time-consuming and effort-demanding but it stipulates planning months and years ago, in order to achieve a specific goal. In many cases it is also necessary to combine data from various sources. This issue melts down to the trade-off between resources and accuracy. Last but not least the whole reengineering of the forecasting process in a SMP demands also a change in the management culture as well as the commitment of the senior management towards the new direction.

In the literature there is no previous work found to the best of the authors' knowledge. As long as the procedure is concerned, the Analytic Hierarchy Process (AHP) has not been used yet for the valuation of forecasting methodologies, also to the best of the authors' knowledge. There is no relevant example in the Dictionary of Hierarchies (Saaty and Forman, 2003), as well as in the related literature.

The issue of traffic or volume flow projection has been an old one and has been thoroughly treated in the literature. There are various demand- and supply-side approaches, replying to several related problems at a different level of accuracy. Nevertheless, the most of the methodologies are used by research institutions or in cases demanding sophistication and advanced analytical procedures. Most of them are not used by ports on frequent basis. In a recent survey released by the ESPO it has been made known to the wider academic and business community that ports collect data and proceed to forecasting for reasons of internal organization and planning as well as to justify infrastructure requests or financial support from the local or national authorities. It seems that forecasting is mainly an internal operation of the port, which is practically seldom outsourced to specialized agencies or consultants who work along with the port. Another result is that projections are rather short-term: few ports plan ahead as the business horizon may be completely different within a decade. Ports planning for the next 10 to 25 years are concerned on investing in costly infrastructure therefore they have to justify the involved risk. But, commonly, ports seem to concentrate their efforts in short periods, no more than five years. This complies also with the necessity to report and plan with the national and regional authorities. Maybe this also reveals the inability of ports to estimate future traffic relatively accurately. Research and experiences support that ports use mainly past statistics and economic indicators. The use of historical data cannot accurately assist in predicting figures for a long period of time, although it can predict quite satisfactorily the figures for the next fiscal or operational period. It is however interesting to note that ports tend to get data from their clients (shipping operators), their sub-contractors (terminal operators) and the competition. This is a good amount of information, which is however not easily quantifiable and harmonized (ESPO, 2001).

Moreover, it became evident that the port does not employ sophisticated methods for the forecasting of its future business. Most of such ports collect data on aggregated form per commodity category or even worst per tariff structure class. These data reflect flows of cargo handled in the specific port. The management of the port usually gets the picture on the logistics chains servicing these cargoes mainly from information provided by clients or agents, but this picture often is not reflected in any statistics (Psaraftis et al, 2003b)

It has been admitted that most of the ports collect data on an aggregate form, which are usually elaborated in an unsophisticated way; such as extrapolation of differences between years, basic regressions and correlations with macroeconomic data, such as the GNP or the production index. In most cases the results of these techniques are not tested from a statistical point of view and therefore their forecasting capability is rather limited. Also, large ports with advanced collection capabilities extend their analyses to two-digit NSTR classifications and check their forecasts with agents or clients of the specific niche of the market. Lately some large ports have acquired advanced software and systems for the forecasting of flows. Most of them are based on time-series analysis (Psaraftis et al, 2003a).

In both cases, the result is practically the same: ports usually do not base their forecasts on sophisticated methodologies. Additionally, they do not base their projections on logistics-related data but on historically handled volumes. The difference between large and small ports is that large ports have a data-warehouse with a capability to provide information at various levels of detail, and the smaller ports do not. In general, the forecasting methodologies have to offer a sound decision-support mechanism to the port management. In the contemporary business pattern this means that logistics aspects, such as the time and the cost to and from the target market of the port have to be taken into account, so the port management can set targets for internal operations and compete with other ports, routes and modal sequences.

The valuation methodology followed is based on the Analytic Hierarchy Process (AHP). This method is widely applied and has been extensively discussed in academic journals. AHP is a powerful tool when the sample of alternatives (in this case the number of methodologies under evaluation) as well as the number of criteria is relatively small. Furthermore the use of relative comparisons suggests and highlights the subjective point of view a decision-maker may have, given the operational framework and personal experiences. Last but not least is that the method can easily come to a conclusion if only consistency ratios are kept under given limits, avoiding calibration or other relevant procedures. In any case the hierarchical structure of the problem is essential for any methodology used and reveals the level of understanding and sophistication of the decision-maker (Saaty, 1994, pp.95-98). Three groups of methodologies will be evaluated in this paper:

1. the time-series analyses,
2. the transport-supply methods based mainly on the idea of generalized cost, and
3. the simulation techniques.

Of course the model can incorporate other methodologies but necessary understanding of the AHP method is necessary to accommodate more alternatives (forecasting methodologies).

This document is structured as follows: in the next section the hierarchy of evaluation of forecasting methodology is presented. Then this problem is approached with the assistance of AHP and discussed accordingly. As AHP is a rather well known technique, even the basic aspects of the methodology are omitted. The results of the analysis are presented in the next section and their meaning as well as their limitations is taken into further consideration. The paper concludes with a brief concluding summary.

THE FORECASTING METHODOLOGY EVALUATION HIERARCHY

The hierarchy constructed for the specific port forecasting problem is presented in the figure below (Chart 1). It is a hierarchy having as a focus the validation of three specific methodologies, labeled M_1, M_2, and M_3. Therefore the numerical outcome of the mechanism will be a number ranking every alternative, i.e. every methodology. The top index, i.e. the ranking of the methodologies, is typically called Level I. In the lower levels, criteria, sub-criteria and the alternatives are provided. In the Level II, three desirable main attributes of the methods are used as main criteria sets:

1. Usability [U],
2. Validity [V], and
3. Ability to support decisions [A].

These are considered the three basic desirable properties for the validation of the methodologies. At the next level of the hierarchy, Level III, criteria, attributes, aspects and characteristics of these three basic properties are presented. As it will be shown in the coming paragraphs, six criteria fall under the ‘usability’ set (U_1, U_2, …, U_6), five under the ‘validity’ (V_1, V_2, …, V_5) and four under the ‘ability’ (A_1, …, A_4). Then the alternatives, i.e. the methods M_1 to M_3, are evaluated for every single one of them.

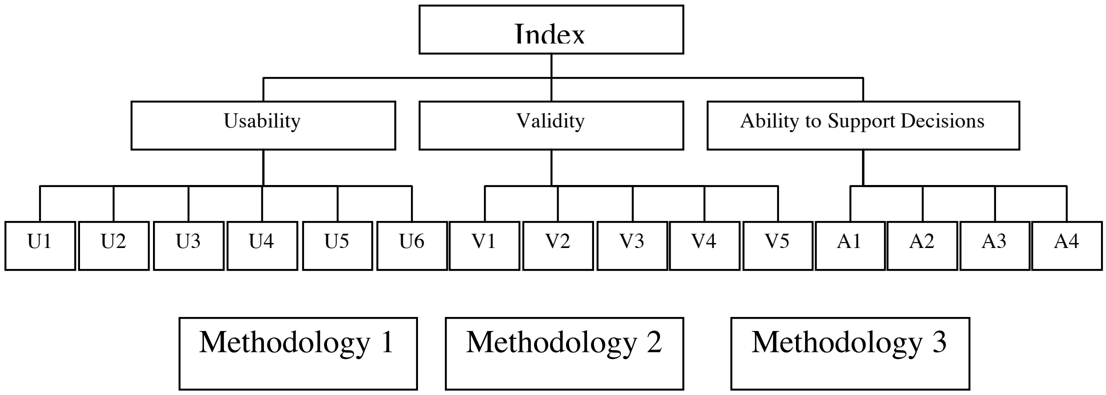

Chart 1: The Hierarchy of the Problem

By *usability* we mean a set of characteristics and capabilities of a method that determine the extent to which this method can be used in practice. These characteristics and capabilities form also the criteria at the next level. These criteria are namely the following:

U1:	easiness of data collection	The degree of difficulty in data collection limits the ability of the management for trade-offs among resources. As cargoes pass through the gate, data are collected by electronic clearance devices for the commodities entering or leaving the port zone. A methodology that can make use of such data maximizes the positive effects for the organization.
U2:	use of modern technology (or automation capability)	It deals with the exploitation of current technological facilities in ports. It is very important that a port can make maximum use of the installed technology in the yard. Usually, the port uses wireless technology, while shippers and carriers use mobile telecommunications, satellite applications and advanced internet-based systems. Evidently these systems may collect every necessary data for the needs of the statistics department. The higher the degree of compatibility of the data structure of the methodology and of the collection system the better rate will the methodology get finally.
U3:	cost (initial or maintenance cost)	As cost element in the hierarchy is considered the initial or the operating cost, that is necessary for the continuation of the application of a methodology.

U4:	time and effort devoted towards a result	The time and effort element completes the cost-related attributes of the hierarchy. By time and effort it is understood an expense of resources for the execution of the methodology from the starting point of collecting the data up to the end. a.
U5:	resources (people and level of experience)	Further to U3 and U4, the ‘quality’ of the resources, mainly the quality and the expertise level of the people, who were assigned the forecasting task, affects the outcome of any methodology. Generally, complicated and advanced methodologies demand a higher level of expertise.
U6:	necessity to cooperate with other parties in order to get a result	If the required data for a methodology can be found from the port archives, then this methodology has an inherent advantage for the port. Data collected from various sources have to be compiled and properly combined together; this task is not always easy as various sources collect data for different purposes. Therefore the decision-maker has to evaluate the need stemming out of a methodology to use data from various sources.

Validity stands for another set of criteria related to the methodology. The aim of this set of criteria is to explore the soundness of the methodology, highlighting attributes related to the data and the output. These criteria are:

V1:	revealed or stated preference	Revealed preference techniques are based on historical data, which reveal a trend but not necessary the reasons generating the trend. As sophisticated the model becomes, i.e. as many parameters there are involved the researcher may get into the essence of the problem, provided that there are enough data supporting the modeling and the samples are manageable. The stated preference techniques use sampling statistics and may focus to the heart of the problem. A decision-maker has to use this criterion of revealed vs. stated preference in order to determine the methodology that leaves as fewer gray zones as possible in the final result. That depends heavily on the nature of the port and

		the trade its serves..
V2:	data input procedure	This criterion applies obviously to the way data are entered in the system. This criterion is complementary to the criteria U2, U3, U4 and U5. The data input procedure is critical and in many cases, raw data entering automatically the system without any previous filtering may lead to flawed results. On the other hand keyed-in data may incorporate too many human errors, especially when humans do not have a clear understanding of or control over the data (Schinas et al, 2002).
V3:	data manipulation	In many methodologies, it is possible to manipulate data in such a way so to lead to desired or specified outcome. This is not necessary decayed but it may also be obligatory bringing the model back to the target-track. However, there are other methodologies not so sensitive in data manipulation and even if the user intervenes to the data base, then the outcome is not practically altered. Generally the wider and the deeper the data base is, the less sensitive is to data-manipulation. Data manipulation may also permit the extraction of other results, such as what-if scenarios or sensitivity checking.
V4:	Output	The outcome of any methodology shall be reviewed under two sub-criteria: the soundness of the results according to market practices, common sense and the rationality governing normal operations, as well as the sensitivity of the outcome over small changes of data. The sensitivity analysis provides also proof for the soundness or the robustness of the outcome.
V5:	self-control loops	The ability of the method to check the integrity of the procedure by filtering the data at various stages is a very important feature, as large amounts of data are commonly processed.

Finally the last set of attributes is the ability to support decisions; this set deals with the practical use of the outcome.

A1:	Product vs Aggregate results	In the modern logistic chains it is necessary for a port not only to focus on aggregated flows: unitized – bulk, import-export, but also on product specific ones. By the term 'product specific' it is not necessarily understood a specific product but a product range, a notion similar to NSTR or SITC 3-digit classification or in some cases of 2- or 4-digits. Evidently as ports become integral parts of logistics chains, which in most cases are product-based for consumption, packaging, marketing and value of time grounds, ports shall focus more on the characteristics of the transported cargoes.
A2:	reliability	The issue of reliability is as critical as the *data-manipulation* and the *data-input-procedure*. Obviously the reliability of the methodology depends heavily on the reliability of the data especially for deterministic systems, such as the time-series analysis and the transport-supply methodologies. For the stochastic systems, the issue of the reliability is critical as well but the methods incorporate also a degree of vagueness for the used data. In any case the reliability of the data is critical, as well as the reliability of the method as such. A problem of stability of the solution is usually dealt with sensitivity analysis but not always, and is in most cases an issue for an academic institution or research center.
A3:	Endurance	The endurance of the results against time is an essential criterion for the selection of costly forecasting method. The longer the results stand to time the better for the methodology
A4:	strategic vs tactical decisions	A strategic decision is taken by the upper management of the port and has also longer effect in the organization. A tactical decision is taken by the middle management, most commonly, and aims to fulfill the needs or the requirements of a strategic decision. In the case of port-potential quantification, a strategic decision is related to an issue of market penetration or expansion, while a tactical one is related to issues of generalized cost

		or other relevant data, by changing them cargo is attracted to pass through the port. Both decision levels are important but in most cases it boils down to an issue of available resources, management sophistication and structure of the market.

This hierarchy will be used for the evaluation of the forecasting methodologies. For the purposes of this paper and the accuracy of the results, it cannot be altered so to accommodate more or less criteria. A hierarchy reflects the understanding of the problem by the decision-maker and this level of accuracy is considered as adequate for the needs of SMP. Obviously another decision maker with a different perspective could use a different hierarchy.

APPLICATION OF THE MODEL

The methodologies under evaluation are presented thoroughly in the literature and are practically known to everybody with basic knowledge of transportation engineering and planning. The AHP methodology is very well known in the academic community as well as to practitioners. Given the hierarchy one can proceed to relative comparisons of the alternatives per attribute. The relative comparisons are based on the fundamental scale:

Verbal Value	Numerical Values
Equally important, likely or preferred	1
Moderately more important, likely or preferred	3
Strongly more important, likely or preferred	5
Very strongly more important, likely or preferred	7
Extremely more important, likely or preferred	9
Intermediate values to reflect compromise	2,4,6,8

Table 1: The fundamental scale (Saaty, 1994)

An illustrative example is the following: say that three alternatives (say the methodologies) have to be evaluated according to an attribute (say sub-criterion U2), then the evaluation in a tabular format is the following:

	A	B	C
A	1	5	7
B	1/5	1	3
C	1/7	1/3	1

The elements of the table are commonly symbolized as a_{ij}. The meaning of unit value along the diagonal of the table reflects the idea that the result is the same when comparing alternative i with itself. The upper triangle is the one a decision-maker fills with data; the elements of the lower triangle have to comply with the idea of reciprocal values, i.e. $a_{ji}=1/a_{ij}$ The meaning of this condition stems out of rationality; when comparing A to B by a_{ij} then when comparing B to A the element a_{ji} shall be equal to $1/a_{ij}$

When the tables with the judgments are set the priorities can be extracted by various methods. The priority vector expresses the relative importances implied by the previous comparisons. Saaty asserts that one has to estimate the right principal eigenvector of the matrix. As there are various eigenvalue approaches, for the scope and the needs of the current study the revised method is selected: the geometric mean of a row elements is calculated and then the numbers are normalized by dividing them with their sum. The consistency of a judgment table has to comply with the simple rule $a_{ij} = a_{ik}\, a_{kj}$. As in very few cases all comparisons are consistent, Saaty has developed a coefficient ratio (CR) that has to be less than 10% for a table.

The same approach applies also for tables that consist of criteria as in the case of level I and level II. After the alternatives are compared with each other in terms of each one of the decision criteria and the individual priority vectors are derived, then the next step is to involve the criteria in the calculations. The priority vectors become the columns of a decision matrix. The multiplications of the weights of criteria and of the priority vectors yield the final priorities:

$$A^i_{AHP} = \sum_{j=1}^{N} a_{ij} w_j$$

for i = 1, 2, …, M

If a problem has M alternatives and N criteria then the decision maker has to construct N judgment matrices (one for each criterion) of M×M order and one judgment matrix of N×N order (for the N criteria). Finally all A^i are calculated as above.

The judgment matrices are not presented due to space limitations. The weighting of the criteria at level III is provided in the following paragraphs, while the weighting of the level II is used for scenario analysis. The final results will be presented in the following section. The relative comparisons of the sub-criteria at level III consist an interesting task that reveals the subjective-perspective of the decision maker. As long as the ‘usability’ set of criteria the judgment matrix is the following:

	U1	U2	U3	U4	U5	U6	priorities
U1	1	5	1	1	3	5	29%
U2	1/5	1	1/3	1/3	½	1	7%
U3	1	3	1	1	3	3	24%
U4	1	3	1	1	3	3	24%
U5	1/3	2	1/3	1/3	1	1	9%
U6	1/5	1	1/3	1/3	1	1	7%

CR 1.24%

The elements of cost (U3 and U4) as well as the attribute of easy data-collection are considered as very important, therefore the priorities vector yield almost the same importance for these three sub-criteria. This is an assumption and a subjective point of view simultaneously yet it is not considered that it contradicts common practices. For the validity-related set of criteria the following judgment table is produced:

	V1	V2	V3	V4	V5	priorities
V1	1	1/3	1/3	1/5	1	7%
V2	3	1	3	1	3	30%
V3	3	1/3	1	1/5	3	14%
V4	5	1	5	1	5	41%
V5	1	1/3	1/3	1/5	1	7%

CR 5.09%

Similarly to the previous judgment matrix, the result that V2 (data-input) and V4 (output) sub-criteria are considered as most important, does not contradict common practices. However it is important to note that V3 (data-manipulation) is also an important feature, contrary to V1 and V5 that are not so important from a practical point of view. Finally, the judgment matrix for the 'ability to support decisions' sub-criteria is presented:

	A1	A2	A3	A4	priorities
A1	1	2	2	1/3	23%
A2	1/2	1	2	1/3	16%
A3	1/2	1/2	1	1/3	12%
A4	3	3	3	1	49%

CR 4.49%

The sub-criterion A4 (strategic vs tactical) is considered as the most important, while all others are also important but not dominant.

By applying scenarios in the judgment table at level II it is possible to highlight the importance of a specific criterion over the others and make some reasonable remarks over the meaning of this analysis. The last judgment matrix is the following:

	U	**V**	**A**
U	1	w_{12}	w_{13}
V	$1/ w_{12}$	1	w_{23}
A	$1/ w_{13}$	$1/w_{23}$	1

By setting w_{ij} as in the following table and by executing the necessary numerical calculations the following result table per scenario is extracted:

	enhanced usability	moderate usability	enhanced ability	moderate ability	enhanced validity	moderate validity	neutral
$\mathbf{w_{12}}$	7	3	1	1	1/7	1/3	1
$\mathbf{w_{13}}$	7	3	1/7	1/3	1	1	1
$\mathbf{w_{23}}$	1	1	1/7	1/3	7	1/3	1
Result Cells							
CR	2.33%	2.43%	2.67%	2.64%	2.78%	7.03%	2.59%
A (time series)	**56%**	**51%**	30%	35%	**45%**	39%	**43%**
B (supply-side)	30%	34%	**52%**	**48%**	39%	**45%**	41%
C (simulations)	14%	15%	18%	17%	16%	17%	16%

Table 2: Result Table

First of all it has to be noted that the judgment matrices are consistent because the total consistency ratio of the hierarchy is less than 10%. In case that a scenario had a CR>10% then it would be necessary either to revaluate the sets of criteria used or rethink the attributed judgments per criterion and alternative.

From the above table is easy to understand that ports considering ‘usability’ as the most important criterion shall use time-series techniques for the necessary forecasting. Evidently this is consistent also with the experience from ports of various sizes and not only SMP. Furthermore ports with a neutral attitude towards these criteria would also select time-series as forecasting method. On the contrary ports highlighting the importance to base decisions on the results of a methodology would prefer the supply-side forecasting techniques. As expected also from the judgment tables, supply-side techniques can offer a better understanding over the logistic chains and insights for product and aggregate flows. For ports seeking validity in the final result, the above scenario analysis suggests that the selected methodology would be either time-series or supply-side techniques. The compliance of the results with current practices at ports is also a measurement for the effectiveness of pairwise comparisons and of the deriving priorities (Saaty, 2001, p.p. 84-85).

Simulation techniques seem to attract limited interest for port applications. As in no priority vector gets no more than 20%, they would easily be eliminated from further analysis. A more detailed analysis would include only the other two alternatives. In case that a port had to select a methodology out of the two, group decision making techniques could enhance the validity of the final result and include all parties in the discussion (upper and middle management, other parties involved, etc). However a group decision making problem does not fit in the current research context and is well described in the literature (e.g. Saaty, 2001). In such a case more or other criteria can also be incorporated in the hierarchy depending on the formulation of the problem.

The limitations of the model are not severe at the strategic level and basically are the ones of a multi-criteria problem and of the used evaluation methodology: AHP. First of all a hierarchy imposes a stringent limitation of the given number of criteria and their crisp attributes. Despite the fact that a methodology reflects the understanding of a decision-maker there is an error in the whole approach. By using Saaty's ideas and observing the result table, the degree of confidence is high as in most cases the error accounts less than 5%. Furthermore the CRs of the judgment tables are also considerably lower than 10%. The criteria-sets have not been applied only in that case and have produced results of adequate significance in other cases as well (Schinas et al, 2002).

Examining the hierarchy and the results from a numerical point of view through detailed sensitivity analysis as described in the literature one can easily understand the limitations of a model (even rank reversals) as well as improve his decision-making capabilities. The sensitivity analysis for such a problem has to determine the most critical criterion and the most critical performance measure a_{ij}. By using approaches presented in the MCDM literature such as the most critical criterion, the following results are extracted (Triantaphyllou et al, 1997, p.p.8-10):

- in the neutral condition, the 'validity' set of criteria is a 'robust criterion', i.e. the a_{i2} elements affect the ranking of the alternatives the least.
- by altering the weight of a_{12} by 0.0742 (in absolute terms) or by 26% (in relative terms) then the current ranking of the alternatives is violated.
- the most sensitive criterion in terms of weighting is the one related to *ability*
- regarding the 'validity' scenarios, one can find that in the case of '*moderate validity scenario*' the a_{12} element is the most critical in absolute terms (0.1599) and the a_{13} in relative terms (29%). The '*ability-to-support-decisions*' is the most sensitive criterion in this scenario. In the '*enhanced validity scenario*', the a_{13} element is critical element in absolute and relative terms (0.1437 and 25% respectively) and the ability-related criterion the most sensitive one.

In practice is not easy to determine the most sensitive criterion uniquely, as there are at least four theoretical approaches (see more in Triantaphyllou et al, 1997).

CONCLUDING REMARKS

Ports currently face the need to expand their forecasting capabilities as well as to position themselves actively or more efficiently along the logistics chains. Historically ports have not developed or used advanced forecasting techniques as there was no such need due to operational, institutional or other limitations. Currently as markets and regions integrate, ports have to quantify their potential market. As this quantification task shifts from simple import-export (or production-consumption) statistics and more transportation-related data enter into the calculations, ports have to adopt new techniques. Nevertheless, as in any other business unit, resources are limited and expertise is lacking, so port management has to face and decide on trade-offs between available resources, needs and forecasting characteristics, such as accuracy, endurance, and many other described above.

The scope of this paper was to offer an evaluation tool for the port management adequate to support a decision on the dilemma, which of the three major groups of forecasting methodologies to select: time-series analysis, supply-side calculations based on the generalized cost or advanced simulation techniques. The trigger for such a tool stems out of the framework of European Commission (EC) funded research project, called TRAPIST that aims to provide ports with ‘soft’ tools to improve their operational capabilities.

As the evaluation of alternatives (forecasting methodologies) is a multi-criteria decision making problem, the well known and user-friendly Analytic Hierarchy Process (AHP) methodology has been selected and applied. The hierarchy of the problem used, i.e. the understanding of the insights, is a refined version of similar hierarchies used in other research and development projects. Nevertheless as there is no relevant work in the literature, the application of the hierarchy is considered as innovative.

The scenario analysis is based on alterations of the weighting elements between the major criteria-sets, namely those of usability, validity and ability to support decisions. For six biased cases (enhanced and moderate levels of bias) and one neutral case (all weights equal to the unity so no bias is expressed) the analysis yields the most preferable forecasting methodology. It was expected that in the neutral, enhanced and moderate usability the analysis yielded the time-series analysis as the most favorable one; this is consistent with the current practice and the needs of ports that focus on short-term planning horizons, regardless of the size. On the other hand ports that envisage a better positioning along the logistics chains –enhanced and moderate ability to support decisions cases- would select the supply-side calculations based on the generalized costs of various options, as more insights of the trade and the service are revealed. Regarding the moderate and enhanced validity scenarios the model does not yield a straightforward result as in the previous cases. The selection will be decided among time-series and supply-side modeling. This is merely expected from relevant experience. Simulation techniques do not attract practitioners’ interest as expected.

The importance of the results for ports is significant at strategic level; since there is a structured hierarchy that ensures an adequate degree of soundness, as it reflects current practices, and the management of the port can be guided towards a specific methodology according to local needs and limitations. The port can either reconstruct the model in a spreadsheet or even pick up the suggested methodology that fits better to the seeking attribute. The application of the model is not limited to a geographical context (e.g. Europe) or to the size of the port. From the sensitivity analysis it became also clear that the most sensitive criterion is the one related to the ability to support decision, which is considered also as essential for practical applications.

This evaluation approach can be expanded to tactical decision-making by considering the opinion of many port-officers or other interested parties (say the State and the users) by applying group decision making techniques. AHP can accommodate group decision making in a very robust way, which is a reason for its wide application in marketing and relevant problems. Furthermore the hierarchy can be expanded accordingly in order to focus on more tactical issues, yet a basic understanding of AHP and multi-criteria decision making is imperative.

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