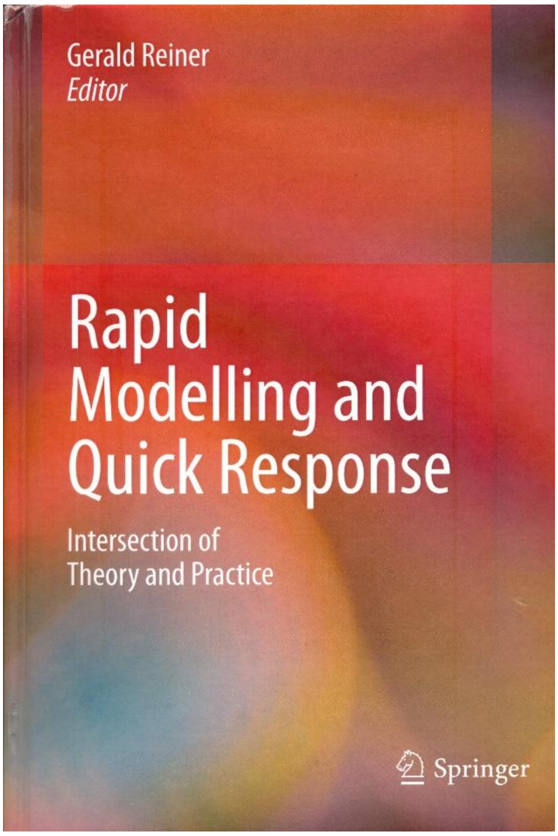
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Indeed, this work consists, more specifically, in determining the optimal number of trucks to be used in each process that minimizes the waiting time of trucks and GQ (Gantry of Quay). This is a multi-objectives optimization problem, exactly a stochastic bi-objectives optimization problem. For that, we have modeled the problem by an open network which is the most suitable for this situation. After the identification of the process parameters, we conclude that the model is an open network of unspecified queues ($G^{[X]}/G/1$, $M/G/1$, $G/G/N/0$,...). In the literature, there is no exact method for analyzing this kind of networks. For this, we have established a simulation model that can imitate the functioning of each system.

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The simulations allowed us to evaluate the performances of the park with containers according to the number of the trucks used, on the basis of current conditions and in the case of variation of the flow of arrivals of ships and the service rate of the trucks. This allowed us to determine the optimal number of trucks to be used in the loading process and unloading process. We have also determined the performance of the stock, on basis of current conditions.

1 Introduction

The performance of a Terminal with containers is measured by the time of stopover, the speed of the operations, the quality of the service and the cost of container's transit. For that, in order to ensure the best functioning of the Terminal with containers at the level of the BMT Company (Bejaia Mediterranean Terminal - Bejaia's Harbor), studies of performance's evaluation were initiated. The first study was carried out in 2007 (Sait et al, 2007). It had for objective the global modeling of the unloading/loading process and had shown that if the number of ships [having a mean size of 170 ETU (Equivalent Twenty Units)], which was of 0.83 ships/day, increases to 1.4 ships/day, the full park will undergo a saturation of 94%. The second study was carried out in 2009 (Aïssani et al, 2009; Aïssani et al, 2009). It was intended to suggest an alternative approach for modeling the system. The authors proposed an approach which consists of decomposing the system into four independent subsystems, namely: the loading process, the unloading process, the full stock process and the empty stock process. The study showed that the park with containers has a possibility to handle 116226 ETU for an entry rate of 0.6104 ships / day for the loading process and 0.7761 ships/day for the unloading process.

The study showed also that for a 30% increase in the number of ships arriving at the port of Bejaia, we note a small increase in the average number of ships in roads and in the quays. On the other hand, there is a clear increasing in the total number of treated containers which passes from 116226 ETU to 148996 ETU. We note also an increase in the average number of containers in the full park which passes from 3372 to 4874 ETU. As for the number of treated ships, it passes from 240 to 305 ships at the loading and from 296 to 382 ships at the unloading.

In the present work, we propose to supplement this last study where we try to minimize the number of trucks to use in the treatment of the ships. The interest of this analysis comes from the fact that the permanent increase of traffic constrains the BMT Company to exploit other quays. To this end, in order to optimize the existing equipments, the problem will be modeled by an open network, which belongs to the multi-objectives optimization problems. Because of the complexity and the unavailability of analytical methods for analyzing this type of models, we apply the simulation approach.

2 Park with containers and motion of the containers

In this section, we are going to give a brief description of the Terminal of BMT Company, where we will present different operations and movements of a container and its capacities and equipments.

2.1 *Motions of the containers*

Any container (ship) arriving at the Terminal of BMT Company passes by the following steps:

- **The step of anchorage:** Any ship arriving at the Bejaia harbor's is put on standby in the anchorage (roads) for a duration of time which varies from one ship to another, because of the occupation of the quay stations or unavailability of pilot or tug boats.
- **The step of service:**
  - **Service of accosting:** The accosting of the ships is ensured by the operational section of the Harbor Company of Bejaia, such as the section of piloting and towing.
  - **Vessel handling:** the treatment of a ship is done mainly in three sub-steps:
    1. **Service before operations:** It is the preparatory step of the ship for the handling (Loading/Unloading).
    2. **Step of Unloading/Loading:** It consists of the unloading/loading of the containers. This is carried out with the two gantries of quay which have carriages being able to raise the containers from the container ships, to put them on trucks and to raise the container from the trucks and put them on board the container ship, if it's the loading process.
    3. **Service after operations:** It is the preparatory step of the ship for accosting towards outside.
- **Deliveries:** The delivery concerns the full containers or discharged goods. The means used to perform this operation are: RTG (Rubber Tyre Gantry), trucks, stacker and forklifts if it's necessary.
- **Restitution of the containers:** At the restitution of the containers (empty containers), two zones are intended for the storage, one for empty containers of 20 units and the other for empty containers of 40 units.

2.2 *The BMT Park with containers: capacity and equipments*

The Terminal of the BMT Company is provided with four quays of 500 m (currently only two are in the exploitation), a draught of 12 *m* starting from the channel, and a storage capacity of 10300 ETU, the Terminal with containers of Bejaia offers specialized installations for the refrigerating containers and the dangerous products. Moreover, this Terminal is the only Terminal with containers in Algeria, sufficiently equipped and has specialized equipments (Gantry of Quay, RTG . . .), handling and lifting, which can reduce the times of stopover, making it possible to fulfill waiting and the requirements of the operators (See Table 1).

Quay /Anchorage	Length:	500 m
	Depth:	12 m
	Basin surface:	60 h
	Quay:	4
	Utilisation rate of the quay	70%
Full Park	Capacity:	8300 ETU
	Area:	68500 m^2
Empty Park	Capacity:	900 ETU
	Area:	15200 m^2
Refrigerating Park	Capacity:	500 Catches
	Area:	2800 m^2
Zone for Discharge / Potting	Capacity:	600 ETU
	Area:	3500 m^2

Gantry of Quay	Numbers:	2
	Tonnage:	40 Tons
	Type:	Post Panamax
RTG (Rubber Tyre Gantry)	Numbers:	5
	Tonnage:	36 Tons
	Stacking:	6+1 on the ground and 4+1 in Height
Stakers	Numbers:	4
	Tonnage:	36 Tons
Spreaders	Numbers:	4
	Tonnage:	10 Tons
Lifting trucks	Numbers:	02 of 03 Tons, 02 of 05 Tons 02 of 10 Tons and 02 of 28 Tons
Truck-Tug	Numbers:	8 of 60 Tons and 4 of 32 Tons

Table 1 Characteristics and equipments of the Terminal of BMT Company.

3 Mathematical Models

After analyzing the main movements of a container at the level of BMT's Terminal, we chose to model the problem by network, which is most suitable for this type of situation. To this effect, we obtained four models, namely: the empty stock, the full stock, the loading and the unloading processes which are given respectively by Figures 1 and 2.

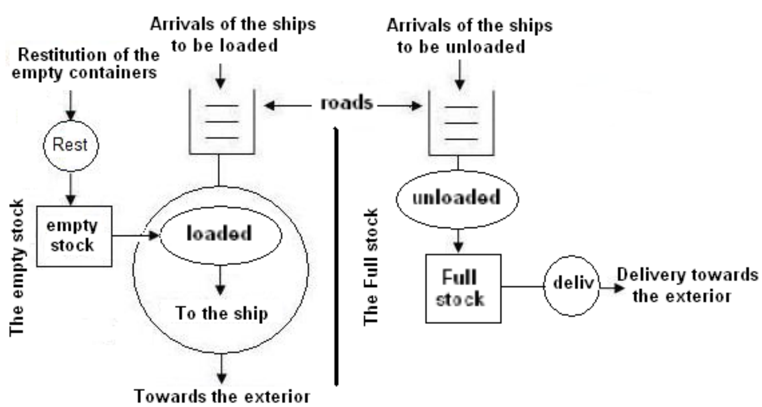

Fig. 1 Diagram of the models of the storage processes.

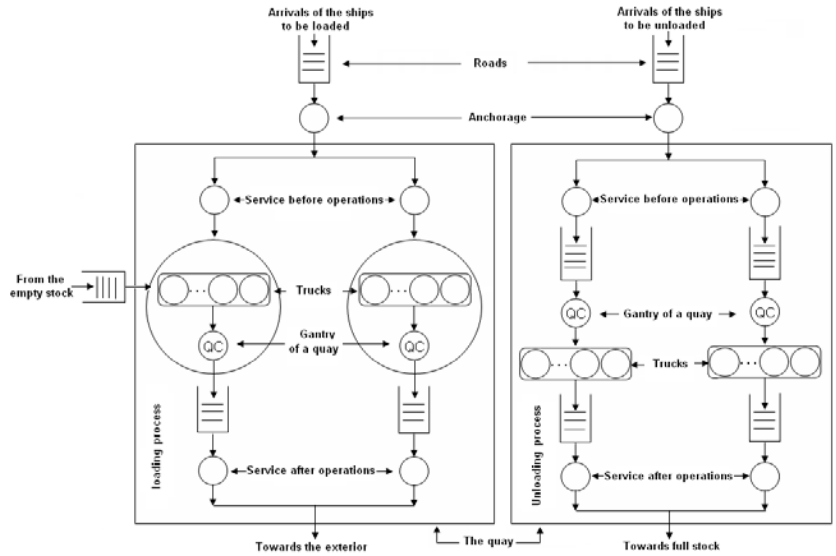

Fig. 2 Diagram of the models of the ship's treatments (unloaded/loaded process).

4 Calculation of the Forecasts

In February 2009, a calculation of forecast had been carried out. The designed series is the number of containers treated (loaded/unloaded) in ETU. The data used were collected monthly and were held forth over a period of two years (from January 2006 to February 2009). The method used for calculation of the forecasts is the exponential smoothing method (David and Michaud, 1983). Figure 3 and Table 2 represent the original series of the number of containers in ETU, as well as the forecasts (from March to December 2009). Thus, it is noted that the objective that BMT Company had fixed at the beginning of the year was likely to be achieved.

5 Performance Evaluation of the BMT Terminal

First, we will conduct a statistical analysis to identify the network corresponding to our system.

Months	Historic				Forecast
	2006	2007	2008	2009	
January	4938	6102	9695	10066	_
February	6006	10083	9928	11448	_
March	6445	8565	9882	_	11579.74
April	5604	9535	8791	_	11941.29
May	6519	8938	10155	_	12314.13
June	5909	8337	8799	_	12698.61
July	6041	7582	9338	_	13095.09
August	7552	7245	9304	_	13503.96
September	5915	8135	9171	_	13925.59
October	5938	7982	8779	_	14360.38
November	7858	7579	10984	_	14808.75
December	7636	9971	11596	_	15271.12
Total					133498.7

Table 2 Original series and forecasts of the number of containers to be treated (ETU) in the year 2009.

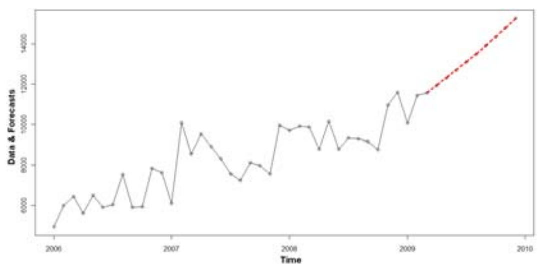

Fig. 3 Graph of original series and forecasts of the number of containers to be treated (ETU) in the year 2009.

5.1 Statistical Analysis and Identification of Models

The results of the preliminary statistical analysis (estimate and test adjustment) on the collected data for the identification of process parameters are summarized in Table 3.

According to this preliminary analysis, we conclude that the performance evaluation of the Terminal of Bejaia is really a complex problem. Indeed, the system is modeled by an opened network of unspecified queues, because it consists of queues of type $(G^{[X]}/G/1,\ M/G/1,\ G/G/N/0,$ with blocking,...). Therefore, we cannot use analytical methods (as for the Jackson networks or BCMP) to obtain the characteristics of the system. This is why we will call upon the simulation approach to solve the problem.

Process	Variable	Distribution	Parameters of the distribution
Loading	Inter-arrivals of the ships to be loaded (minutes)	Exponential	$\lambda = 2710$
	service duration of the anchorage (minutes)	Normal	$\mu = 57.595$ et $\sigma^2 = 18.174$
	service duration of before operations (minutes)	Normal	$\mu = 99.175$ et $\sigma^2 = 38.678$
	Size of groups to be loaded	Geometric	$p = 0.0059$
	service duration of the gantries of quay (minutes)	Normal	$\mu = 2.944$ et $\sigma^2 = 1.097$
	Service duration of the trucks (minutes)	Normal	$\mu = 8.823$ et $\sigma^2 = 5.359$
	service duration of the after operations (minutes)	Normal	$\mu = 99.175$ et $\sigma^2 = 38.678$
Unloading	Inter-arrivals of the ships to be unloaded (minutes)	Exponential	$\lambda = 2710$
	service duration of the anchorage (minutes)	Normal	$\mu = 57.595$ et $\sigma^2 = 18.174$
	service duration of before operations (minutes)	Normal	$\mu = 99.175$ et $\sigma^2 = 38.678$
	Size of groups to be loaded	Geometric	$p = 0.007$
	Service duration of the gantries of quay (minutes)	Normal	$\mu = 2.947$ et $\sigma^2 = 1.072$
	Service duration of the trucks (minutes)	Normal	$\mu = 9.228$ et $\sigma^2 = 4.994$
	service duration of the after operations (minutes)	Normal	$\mu = 99.175$ et $\sigma^2 = 38.678$
Storage	Size of groups of delivered containers/day	Uniform	Mean=145
	Storage Size of groups of restored containers/day	Uniform	Mean=140

Table 3 Results of the statistical analysis on the collected data.

5.2 Determination of the optimal number of trucks by simulation

In this section, the aim is to determine by simulation approach the optimal number of trucks to use during the loading process and unloading process. For that, we propose two approaches.

5.2.1 First approach

We designed a simulator for each model under the Matlab environment. After the validation tests of each simulator, their executions provided the results summarized in Table 4.

Where:

- The 3rd column represents the mean number of ships in roads to be loaded (respectively to be unloaded) during one year.
- The 4th column represents the mean number of ships loaded (respectively unloaded) during one year.
- The 5th column represents the mean number of containers loaded (respectively unloaded) during one year.
- The 6th column represents the mean number of blocking of the server "GQ" according to the number of trucks used during the loading (respectively the unloading) on one year.
- The 7th column represents the mean time of blocking of the server "GQ" during the loading (respectively the unloading) on one year.
- The 8th column represents the mean number of blocking of the server "trucks" in the loading process (respectively the unloading) on one year.

Process	N-trucks	N-ship	D-ship	N-Cts (ETU)	N-GQ	W-GQ	N-trucks	W- trucks	Proportions
Loading	1	1.20	191.09	49020	27495	3349.5	2927	72.6	0.0909
	2	0.87	193.88	49397	18804	1118.1	11878	342.1	0.3642
	3	0.88	193.74	49681	11775	449.2	18797	588.3	0.5757
	4	0.79	196.08	50204	7150.8	196.7	22876	761.4	0.7094
	5	0.78	195.63	50298	4749.0	103.8	25723	899.6	0.7818
	6	0.85	196.59	50753	3442.5	66.3	27543	1001.7	0.8190
	7	0.83	196.00	50090	2577.0	47.5	27453	1030.7	0.8365
	8	0.89	194.59	49577	2079.3	38.1	27699	1068.1	0.8463
	9	0.84	195.64	50233	1725.9	32.2	27428	1080.7	0.8496
	10	0.93	194.34	49717	1548.9	29.3	28240	1133.8	0.8517
	11	0.84	193.90	49260	1316.9	25.6	26870	1095.6	0.8509
	12	0.84	192.93	49187	1268.9	25	28594	1181.4	0.8512
Unloading	1	0.90	192.13	41689	24112	2955.5	2099	50.40	0.0770
	2	0.90	191.57	41523	15930	947.7	9289	259.90	0.3418
	3	0.73	193.00	42321	9035	342.8	13713	406.95	0.4952
	4	0.80	197.20	42093	3731.5	102.4	15794	435.37	0.5734
	5	0.87	196.70	41971	1025.2	21.6	16544	516.73	0.6023
	6	0.73	191.33	41087	166.83	2.9	16386	548.40	0.6095
	7	0.90	199.60	42798	19.80	0.3	17103	537.75	0.6103
	8	0.77	195.13	42548	1.50	0	17002	545.60	0.6106
	9	0.77	192.97	40966	0.10	0	16378	549.78	0.6109
	10	0.83	194.90	43800	0	0	17525	551.85	0.6115
	11	0.70	194.40	43401	0	0	17359	546.22	0.6111
	12	0.73	192.97	41572	0	0	16607	539.27	0.6104

Table 4 Some performances of the processes obtained by simulation approach.

- The 9th column represents the total mean time of blocking of the server ”trucks” in the loading (respectively the unloading) on one year.
- The 10th column represents the probabilities of the blocking of the servers ”trucks” in the loading process (respectively the unloading process); for example: the value 0.5757 of the third row represents the blocking probability in the case of three servers ”trucks” in the loading process, which is the sum of the probabilities of blocking of one server, two servers and three servers.
  These probabilities is distributed as following: $P(X=0)=0.4276$,
  $P(X=1)=0.4117,\ P(X=2)=0.1492,\ P(X=3)=0.0148$,
  where X: ’number of servers ”trucks” blocked and
  $P(X=1)+P(X=2)+P(X=3)=0.5757$. This distribution is illustrated by the figure (left).

Interpretation and discussion of the results

- **Loading process**

- From the obtained results, we note that the variation of the mean number of the loaded containers in ETU during one year is independent of the number of trucks used . Indeed, the mean number of the loaded containers varies only between

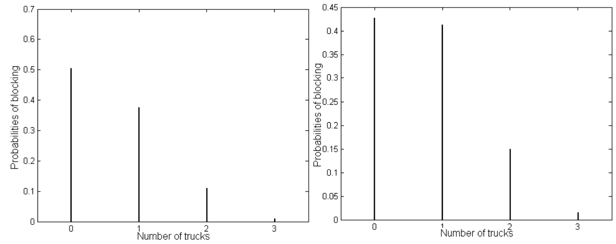

Fig. 4 Probabilities of blocking of the servers "trucks": case of three trucks (loading process on the left and unloading process on the right).

49019.5401 ETU and 50753.3083 ETU which is practically the same. This independence can be explained by the fact that the inter-arrivals of ships to be loaded are very large compared to the time spent by ship at the quay. Similarly, for the loading process, the mean number of ships on the roads is also independent of the number of trucks used, except in the case of one truck, where the mean number of ships in roads is a bit high (1.2000 ships). But, according to the dashed curve, we note that the mean waiting time of the trucks (blocking of servers "trucks") is proportional to the number of the used servers "trucks". So, to minimize the blocking duration of the servers "trucks", we must use the minimum possible of servers "trucks".

- This problem can be formulated (written) mathematically as follows:

$$\begin{array}{lcl} \begin{array}{l} \min \longleftarrow T_1, \\ \min \longleftarrow T_2, \end{array} & & \min \longleftarrow (T_1, T_2) \\ S.C. \begin{cases} \text{Capacities of the company,} \\ \text{Available equipments,} \\ \text{Processing time.} \end{cases} & or & S.C. \begin{cases} \text{Capacities of the company,} \\ \text{Available equipments,} \\ \text{Processing time.} \end{cases} \end{array} \tag{1}$$

Where T_1 and T_2 represent respectively the mean waiting time of the server "GQ" and the mean waiting time of the servers "trucks". Here, we note that we are facing a stochastic multi-objectives optimization problem, specifically a stochastic bi-objectives problem. So, to determine the optimal number of trucks to use in the loading process, it is necessary to find a compromise between the blocking time of the server "GQ" and the blocking time of the servers "trucks". It is thus necessary to find the number of servers "trucks" which minimizes the blocking time of the server "GQ" and minimizes the blocking time of the servers "trucks" at the same time.

So, we transform the problem (1) to the following form Weighted Sum Scalarization (see Ehrgott, 2005; Bot et al, 2009):

$$\min \longleftarrow \alpha T_1 + (1-\alpha) T_2,$$

$$S.C. \begin{cases} \text{Capacities of the company,} \\ \text{Available equipments,} \\ \text{Processing time.} \end{cases} \quad (2)$$

Where: α is weight reflecting the preference of the waiting time of the server "GQ" and $1-\alpha$ the weight reflecting the preference the waiting time of the servers "trucks". In this work, we assume that there is not a preference between the waiting of the servers "trucks" and the waiting of server "GQ" i.e $\alpha = 0.5$. In this case, we determine the minimum of the sum of the blocking times of the server "GQ" and servers "trucks" which is represented by the solid curve on the Figure 5 (left). According to this curve, we note that the optimal number of trucks to be used (which minimize the sum of the blocking times for loading process) is four (04) trucks.

- **Unloading process:** With the same manner and same reasoning as in the loading process, we can determine the optimal number of trucks that will be used in the unloading process. In this case, the result is also four (04) trucks.

5.2.2 Second approach

In this part, we propose another approach (reasoning) to determine the optimal number of trucks to be used. This method consists of determining the number of trucks to use in order to minimize the mean time of loading or unloading of a ship (beginning operations - end operations). The obtained results for different number of servers "trucks" used are summarized in the table 5.

Number of trucks	1	2	3	4	5	6
Loading service	26.9163	13.9531	10.3773	8.2871	8.2671	8.4758
Unloading service	23.8718	13.4766	10.2773	9.1891	9.0743	9.3003
Number of trucks	7	8	9	10	11	12
Loading service	8.3842	8.4986	8.4049	8.4796	8.4955	8.3235
Unloading service	9.1870	8.9528	8.6114	8.9666	9.0482	8.6716

Table 5 The Variation of the mean time (hours) of the loading/unloading service, according to the number of servers "trucks".

Interpretation and discussion of results

Loading process: Figure 5 (right) and the second row of the Table 5 show that the mean time of loading service decreases with the number of servers "trucks" from (01) to four (04) servers "trucks", and from four (04) trucks, the mean time of loading service remains almost constant, which means that beyond four (04) servers

”trucks”, the mean time of loading service depends only on the ability of the server ”GQ”. To this end, we conclude that we no interest to use more than four (04) servers ”trucks” in the loading process.

So the optimal number of trucks towing in this case is four (04) trucks.

Unloading process : for the same arguments as the loading process, the optimal number for the unloading process is four (04) trucks.

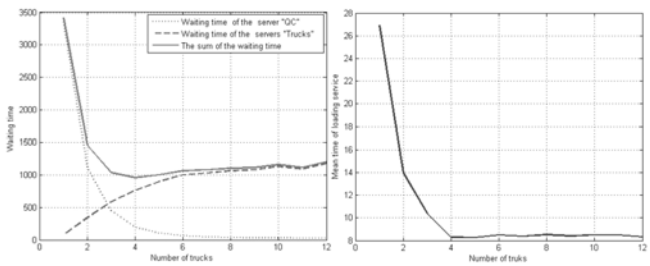

Fig. 5 The mean waiting time of the servers ”trucks” and ”GQ” on one year (left) and he variation of the mean time of loading service (right) according to the number of servers ”trucks”.

6 Performance study of storage process

After the validation tests of empty stock and full stock simulators, their executions provided the results summarized in Table 6. Where the 2nd, 3rd and 4th column rep-

Parameters	Number of trucks	ETU	saturation (%)
Full stock	4	4570.9995	55.0722
	5	4440.8319	53.5044
Empty stock	4	1157.5036	128.6115
	5	1192.9385	132.5487

Table 6 Storage performances.

resents respectively the number of servers ”trucks” used, the total mean number of containers (ETU) in the full stock and empty stock on one year and their saturation rate expressed as a percentage.

Interpretation and discussion of the results

The simulation results show that:

- With the current parameters, the average number of containers in the full park over a period of one year is 4570.9995 ETU in the case of four (04) ”trucks”, and 3610.8734 ETU in the case of five (05) ”trucks” and the mean number of containers in the empty park over a period of one year is 1157.5036 ETU in the case of four (04) ”trucks” and 1192.9385 ETU in the case of five (05) servers ”trucks”.

7 Conclusion

The objective of this work is to determine an optimal management of the equipments of the Terminal with containers of the BMT Company, more specifically the optimal number of trucks to use in the loading process and unloading process. For this, we developed a mathematical model for each process (the ”loading”, the ”unloading”, the ”full stock” and the ”empty stock” process). Indeed, in order to analyze the different processes and determine the optimal number of trucks to use, each system (process) is modeled by an open network. We have also established a simulation model of each system, where the goal of each simulator is to reproduce the functioning of the park with containers. The study shows that:

- For the loading process: For an arrival rate of 0.5317 $ships/day$, a mean service trucks of 8.8234 $minutes$ and a mean service GQ of 2.9440 $minutes$, the optimal number of trucks is four (04) trucks. This mean that the BMT Company can recover a truck from each GQ, i.e in total two (02) trucks.
- For the unloading process: For an arrival rate of 0.5317 $ships/day$, a mean service trucks of 9.2281 $minutes$ and a mean service GQ of 2.9473 $minutes$, the optimal number of trucks is four (04). This mean that the BMT Company can recover a truck from each GQ, i.e in total two (02) trucks.
- Regarding the stock: The study shows that for the current settings at the end of the year 2009 it will undergo a saturation of 55% for the full stock and 130% for the empty stock, hence the need for expanding the capacity of empty stock.

It would be interesting to achieve this work, by discussing the following items:

- An analytical resolution of the problem.
- Determination of an optimal management of the others equipments of the BMT Company.
- Take account the variation of the parameters of the system.

References

Aïssani D, Adjabi S, Cherfaoui M, Benkhellat T, Medjkoune N (2009) Evaluation des performances du terminal á conteneurs B.M.T. (Port de Béjaia). In:

Actes du Séminaire International ”Terminal Development and Management”, vol PORTEK Company and B.M.T. (Bejaia Mediterranean Terminal)

Aïssani D, Adjabi S, Cherfaoui M, Benkhellat T, Medjkoune N (2009) Forecast of the traffic and performance evaluation of the BMT container terminal (Bejaia's harbor). In: Reiner G (ed) Rapid Modelling for Increasing Competitiveness: Tools and Mindset, Springer Verlag Ed. (Germany), pp 53–64

Bot R, Grad S, Wanka G (2009) Duality in Vector Optimization. Springer Verlag

David M, Michaud J (1983) La prévision: approche empirique d'une méthode statistique. Masson

Ehrgott M (2005) Multicriteria optimization, 2nd edn. Springer Verlag

Sait R, Zerrougui N, Adjabi S, Aïssani D (2007) Evaluation des performances du parc á conteneurs de l'Entreprise Portuaire de Béjaia. In: Proceedings of an International Conference Sada'07 (Applied Statistics for Development in Africa), Cotounou (Benin).

Contents

Appendix A
International Scientific Board

The chair of the international scientific board of the 2nd rapid modelling conference "Rapid Modelling and Quick Response: Intersection of Theory and Practice" consisted of:

- Gerald Reiner (University of Neuchâtel, Switzerland)

  Members of the international scientific board as well as referees are:

- Djamil Aïssani (LAMOS, University of Béjaia, Algeria)
- Michel Bierlaire (EPFL, Switzerland)
- Cecil Bozarth (North Carolina State University, USA)
- Bénamar Chouaf (University of Sidi Bel Abes, Algeria)
- Lawrence Corbett (Victoria University of Wellington, New Zealand)
- Krisztina Demeter (Corvinus University of Budapest, Hungary)
- Suzanne de Treville (University of Lausanne, Switzerland)
- Barb Flynn (Indiana University, USA)
- Gerard Gaalman (University of Groningen, The Netherlands)
- Ari-Pekka Hameri (University of Lausanne, Switzerland)
- Petri Helo (University of Vaasa, Finland)
- Olli-Pekka Hilmola (Lappeenranta University of Technology, Finland)
- Werner Jammernegg (Vienna University of Economics and Business Administration, Austria)
- Matteo Kalchschmidt (University of Bergamo, Italy)
- Ananth Krishnamurthy (University of Wisconsin-Madison, USA)
- Doug Love (Aston Business School, UK)
- Jose Antonio Dominguez Machuca (University of Sevilla, Spain)
- Carolina Osorio (EPFL, Switzerland)
- Jeffrey S. Petty (Lancer Callon, UK)
- Reinhold Schodl (University of Neuchâtel, Switzerland)
- Boualem Rabta (University of Neuchâtel, Switzerland)
- Nico J. Vandaele (Catholic University Leuven, Belgium)

Preface

Rapid Modelling and Quick Response - Intersection of Theory and Practice

This volume is a sequel of the 1st Rapid Modelling Conference proceedings volume that focused on Rapid Modelling for increasing competitiveness. The main focus of the 2nd Rapid Modelling Conference proceedings volume "Rapid Modelling and Quick Response - Intersection of Theory and Practice" is the transfer of knowledge from theory to practice, providing the theoretical foundations for successful performance improvement (based on lead time reduction, etc. as well as financial performance measures). Furthermore illustrations will be given by teaching/business cases as well as success stories on new software tools in this field as well as new approaches. In general, Rapid Modelling is based on queueing theory but other mathematical modelling techniques as well as simulation models which facilitate the transfer of knowledge from theory to application are of interest as well.

Together with the proceedings volume of selected papers presented a the 1st Rapid Modelling Conference "Increasing Competitiveness - Tools and Mindset" the interested reader should have a good overview on what is going on in this field. The objective of this conference series is to provide an international, multidisciplinary platform for researchers and practitioners to create and exchange knowledge on increasing competitiveness through Rapid Modelling. In this volume, we demonstrate that lead time reduction (through techniques ranging from quick response manufacturing to lean production) is very important but not enough. Additional factors such as risk, costs, revenues, environment, etc. have to be considered as well. We accepted papers that contribute to these themes in the form of:

- Rapid Modelling
- Case study research, survey research, action research, longitudinal research
- Theoretical papers
- Teaching/business case studies

Relevant topics are:

- Queueing Theory
- Rapid Modelling in Manufacturing and Logistics
- Rapid Modelling in Services
- Rapid Modelling and Financial Performance Measurement
- Product and Process Development
- Supply Chain Management

Based on these categories, the proceedings volume has been divided into six chapters and brings together selected papers which present different aspects of the 2nd Rapid Modelling Conference. These papers are allocated based on their main contribution. All papers passed through a double-blind referee process to ensure their quality.

While the RMC10 (2nd Rapid Modelling Conference "Rapid Modelling and Quick Response - Intersection of Theory and Practice") takes place at the University of Neuchâtel, located in the heart of the city of Neuchâtel, Switzerland, it is based on a collaboration with the project partners within our IAPP Project (No. 217891, see also *http://www.unine.ch/iene-kje*). We are happy to have brought together authors from Algeria, Austria, Belgium, United Kingdom, Finland, Germany, Hungary, Italy, Sweden, Switzerland, Turkey and the United States of America.

Acknowledgement

We would like to thank all those who contributed to the conference and this proceedings volume. First, we wish to thank all authors and presenters for their contribution. Furthermore, we appreciate the valuable help from the members of the international scientific board, the referees and our sponsors (see the Appendix for the appropriate lists).

In particular, our gratitude goes to our team at Enterprise Institute at the University of Neuchâtel, Gina Fiore Walder, Reinhold Schodl, Boualem Rabta, Arda Alp, Gil Gomes dos Santos, Yvan Nieto, who supported this conference project and handled the majority of the text reviews as well as the formating work with LaTex. Ronald Kurz created the logo of our conference and he took over the development of the conference homepage *http://www.unine.ch/rmc10*.

Finally, it has to be mentioned that the conference as well as the book are supported by the EU SEVENTH FRAMEWORK PROGRAMME - THE PEOPLE PROGRAMME - Industry-Academia Partnerships and Pathways Project (No. 217891) "How revolutionary queuing based modelling software helps keeping jobs in Europe. The creation of a lead time reduction software that increases industry competitiveness and supports academic research."

Neuchâtel, June 2010 *Gerald Reiner*

Gerald Reiner
Editor
Rapid Modelling and Quick Response
Intersection of Theory and Practice

Rapid Modelling and Quick Response is a proceedings volume of selected papers presented at the Second Rapid Modelling Conference "Quick Response – Intersection of Theory and Practice". It presents new research developments, as well as business/teaching cases in the field of rapid modelling and quick response linked with performance improvements (based on lead time reduction, etc., as well as financial performance measures). This volume is a sequel to the First Rapid Modelling Conference proceedings volume that focused on rapid modelling for increasing competitiveness. The main focus of this second proceedings volume is the transfer of knowledge from theory to practice, providing the theoretical foundations for successful performance improvement. Furthermore, illustrations are given by teaching/business cases, as well as by success stories about new software tools in this field, and new approaches.

The interested reader (researcher, as well as practitioner) will gain a good overview on new developments in this field. This conference volume is a must-have for innovative production managers, as well as for managers of service-providing processes. The theoretical, as well as the empirical/practical, pieces of work presented will change the mindset of the interested reader. *Rapid Modelling and Quick Response* will also contribute to the scientific communities of operations management, production management, supply chain management, industrial engineering and operations research. This volume and the presented research work, teaching/business cases, as well as software tools, can also be used for the education of students and executive managers.

Rapid Modelling and Quick Response is supported by the EU Seventh Framework Programme — The People Programme — Industry-Academia Partnerships and Pathways Project (No. 217891) "How revolutionary queuing based modelling software helps keeping jobs in Europe. The creation of a lead time reduction software that increases industry competitiveness and supports academic research."

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