Resources Optimization Handling Operations in Ports Multipurpose Terminal

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Abstract: The multipurpose terminal in a port, is an intermodal platform that links the ship to the truck, or to another vessel in the case of transshipment. This paper presents an approach which aims to optimize the massive volumes processing of goods in order to arrive at a reduction in the time loading trucks, specifically; to reduce the time between the tare weighing and loaded truck. In order to achieve this optimization, we considered all the unexpected elements that can disrupt the supply chain or delay, and we also discussed the crew scheduling, being an important planning companies production [1]. Based on the Pareto principle as a tool for decision making, we were able to identify the causes that strongly influence the production and create more delays and congestion. Therefore, and based on the analysis of the stability and performance of system, we were able to highlight the most significant areas requiring the most attention to maximize production while minimizing resources and disrupting elements, and we were able to improve performance at a lower cost and without interrupting the activity.

Key-Words: Queues trucks, weighing, performance measures, stability.

1 Introduction

Climate change manifests itself in various forms around the world, but whatever form it heavily influenced the stocks of livestock and cereals of countries, which requires the import of large quantities from abroad so as to meet the demands of citizens as well as livestock rearing. Such process creates additional pressure on ports, which do not correspond with the preparations and expectations of the ports management. This contributes to the development of an enormous traffic congestion, which makes drivers and transport staff alike suffer in ports, disrupting the unloading and weighing of trucks, and causing conflicts and long delays. It is within the framework of ensuring operational management in real time in order to guarantee maximum productivity and minimize the delays that the approach I intend to adopt in this article is based. We are interested in analyzing the delivery weighing of the bulk traffic (direct exit) to the multipurpose port terminal, that is to say the goods which the vessel load directly into the trucks without delay when staying at the terminal. Afterwards, the trucks leave the port after passing through the weighbridge. Then we have a network of queues.

At the weighbridge, the route of the trucks is characterized by a probabilistic manner; the next station is the dock, if this is his second weighing, he moves outside. This is therefore a deterministic cyclic routing. Figure 1 demonstrates the physical circuit of the truck inside the multipurpose terminal. Making a field visit, we notice the existence of a traffic jam, goods of different types on the ground, trucks blocking traffic and more cars from service personnel. With regard to the weighbridges, we notice a traffic congestion due to a large number of trucks which arrive to load from the ship, and a large queue of trucks even before entering the main gate. This problem of congestion also has other impacts; longer service period, conflicts among truck drivers, and also traffic jam at the terminal especially with the goods which are put on the ground and staff cars, which can result in reducing the number of clients in the port.

These trucks, which we are discussing, are part of the port customers, because it is the importer who sent them to retrieve the goods. It is for this reason that the port cannot handle the arrival times of the trucks which is random and unbalanced during the day. But planning in advance the time slots for unloading each type of bulk in the case of large vessels can play an important role in avoiding such waiting for those trucks interested in a different type of bulk which the crane is in the process of unloading. It is therefore important to regulate the discipline of the queued trucks. In recent years, several authors have analyzed various models of queues in discrete time, and a number of new results have been reported in the literature, see [22]. The most popular model is the expectation M / G / 1 queue with a Poisson arrival process. [2].

The distribution of the duration of treatment of a service depends on numerous factors, such as the experience of staff and client characteristics [12]. The arrival rate of trucks vary from on period to another during the same day, and the distribution of arrival rate over time (also referred to as profile for early arrival of passengers, [13] depends on several criteria. For instance Barros and Falling as they addressed the aeronautical field, have taken, as criteria for passengers, the category of flights, and time of day. Thus the average arrival time in the morning is much shorter than in the afternoon [14] For the delivery that we study in this paper, the rate of entry of trucks to the multipurpose terminal is much higher in the early morning hours, and this is due to the fact that truck drivers are paid by the number of loads carried by day, hence they prefer to come early in the morning so as to return in the afternoon to take a second load. Furthermore, when the trucks arrive, they do not have the choice of weighbridges; they are obliged to go through the weighbridge they have been assigned even if there aremany other empty ones, while self-assignment of trucks at the level of weighbridges can reduce the length of waiting and delays. This principle has been effective for waiting passengers at the registration service in the airport [15] Indeed numerous air campaigns offer a free check-in service to reduce the duration of time at a registration agency. In our case we shall consider that we have a single server since the truck was not allowed to go through the other weighbridges, and we will find the complete Kendall notation of delivery weighing, based on numerical results for a long period of time in order to go through all the possible cases of delivery weighing during the day.

The arrival time of each truck does not depend on the time of arrival of the truck that it precedes, the same goes with the length of service. Hence, we can consider an M/G/1 server. The performance of this type of server has been studied in many articles using several approaches [16] well as the discrete time Markov arrival process may include special cases such as the arrival process Bernulli [17], [18] Service to customers is measured by the average length of the queue, the average waiting time, and service levels, that is to say, the waiting time for customers must be below a certain threshold. This has been well discussed by Graham [19], who analyzed in detail the waiting process of check-in at airports, proposing an approach for performance analysis that is applicable also to queues in the ports. the field of operations research has also given many pushed together and results to optimize routing clients and assignments to servers in the system, [3], and many heuristics have been proposed for the analysis and flus scheduling [4], but in our case ,this technique will not be useful because the allocation of trucks to weighbridges is submitted to another constraint which is the position of weighbridges from the docks.

Various approaches in the literature [9, 5, 6, 7] have been proposed to improve the queues of M/G/1 type and integrate changes service time to reduce it [2, 8, 10], but most of these approaches are based on automation servers. This is often not applicable, especially when it is a system that is already in activity, and suggestions are too expensive, or that space presents a major constraint. Our approach proposes no expensive modifications that can be applied without interrupting the activity or require time or staff. Then we can increase the service capacity without increasing the cost of service.

We will begin this article by describing the physical circuit of trucks between the dock and weighbridges, analysis of the problems encountered, and accuracy of the mathematical model selected. The second chapter will primarily focus on the performance of the system through a conceptual study, then finally ending up with suggestions and conclusions of the last chapters .

2 Analysis of the circuit of trucks

2.1 Mathematical modeling of the physical circuit of trucks

There exist many weighbridges in multipurpose terminals as well as several docks, but in this study we shall consider that we have solely one weighbridge and only one dock, since our goal is to analyze the circuit of a truck inside the terminal, and each truck must pass through the weighbridge that it was assigned even if there other empty ones, and then through a specific dock. We may then diagram the circuit of the truck as follows:

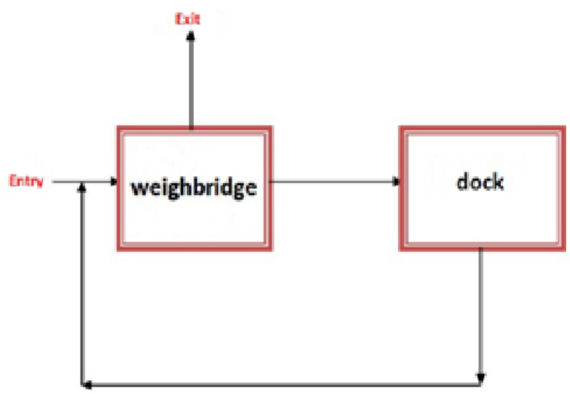

Figure.1: Physical circuit of the truck inside the multipurpose terminal

We are in the case of an open network of queues, because the trucks coming from outside circulate in a network across different stations (weighbridge, dock, back to weighbridge), then leave the network. The number of clients that may be found at any given time in an open network is not limited.

In our case, trucks represent clients, while the weighbridge and the dock represent the stations. The purpose of what follows in this chapter is to study the structure and calculate the characteristic values allowing to describe the performance of this system.

There are several mathematical models that can be chosen in this modelization, but we chose the single server model with exponential time service (time exponential service will be demonstrated in what follows). We could think of the multiple servers model with exponential time service, but we can not choose it in our case, because the average rate of service is not the same for all servers [11, 20]. The queue of trucks is at an unlimited capacity, and we are before the FCFS discipline (first come first served); the first client to arrive shall be the first to start his service, nothing then prevents a client who starts his service after it, ends before; (in the case of the arrival of two trucks that will not load the same type of goods, the crane assigned to the ship discharge one type, and once it clears its quantity, it, then, turns to the second type and so on; for instance truck 1 is interested in type X, and truck 2 is interested in type Y, if the crane is already working on the Y type, although truck 1 had arrived before truck 2, it will be served after it, because even if it has weighed before it, it will still be obliged to wait at the dock, and hence it is indeed the FCFS discipline).

By detailing our service (tare weight + load from the ship + gross weighing), we can determine the Round-Robin discipline (cyclic). Indeed, all the trucks queue move to the weighbridge alternately, conducting the tare weight, then repositioning it in a new dock for loading and so forth until the service is all completed. We deduce then that the notation of Kendall of our queue is as follows:

$$M/M/1/{+\infty}/{+\infty}/FCFS \qquad (1)$$

The first element M , which denotes the inter-arrival distribution, is a Markov process since the arrival time of each truck does not depend on the time of the arrival of the truck preceding it (we will see later that this is a Markov jump process). The second M denotes the distribution of service. It is also Markovian since the length of service of each truck does not depend on the length of service of the trucks which precede them. The third element (1), denotes the number of servers. As we have already mentioned, each truck must go through a weighbridge even if the others are empty.

Furthermore, we shall later discuss the service as weighing + loading, then we will consider the existence of a single server (weighbridge + dock). The two infinites denote the capacity of queue which is infinite, and the users population is also infinite since the number of trucks entering the system is not limited, and therefore the FCFS denotes the discipline which we have already talked about. We aim to specify our system by characterizing the process of arrival of trucks and the process of service. For that, we shall, in what follows, consider the double weighing and loading as a single service, which can be schematized as follows:

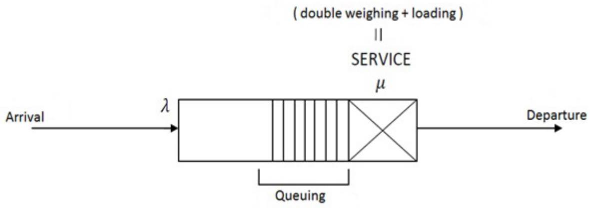

Figure.2: The trucks service in multipurpose terminal

The arrival of trucks to the system will described using a stochastic counting process $(N_t)_{t\geq 0}$.

We denote by A_n the random variable measuring the arrival time of the nth truck in the system and thus will have : $A_0 = 0$ (by agreement) and $A_n = inf\{t; N_t = n\}$,which means that the first time that the number of trucks is found in the system is equal to n.

We denote by D_n the random variable measuring the time between the arrival of $(n-1)^{th}$ truck and the n^{th} truck (inter-arrival). We have then: $D_n = A_n - A_{n-1}$.

Let us find the inter-arrivals rate λ' : We are interested in times of congestion, that is to say the moments when the inter-arrivals are very short $(D_n \leq 3)$, and this is the case of early morning hours. An observation of a dozen trucks allows us to establish the following calculations :

We have seven trucks with $D_n = 1$, two trucks with $D_n = 2$, and one truck with $D_n = 3$.

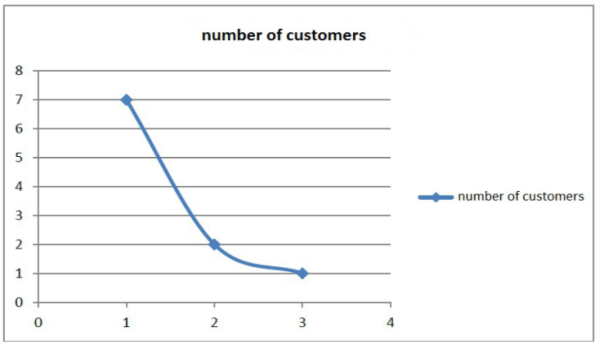

Figure.3: Number of customers for each interarrival

We note that the shape of this graph is similar to that of the exponential law, and also the empirical average of inter-arrivals is:

$$E(D_n) = 1.4 \tag{2}$$

This is the average interval between two consecutive arrivals. The empirical variance of interarrivals is:

$$Var(D_n) = 0.48 \tag{3}$$

We have:

$$Var(D_n) \approx \frac{1}{E(D_n)^2} = 0.51 \tag{4}$$

However there exists a law of probability, the exponential law, such as:

$$Var(X) \approx \frac{1}{E(X)^2} \tag{5}$$

Therefore, it is logical to assume, given the digital results, and the shape of the graph, that the empirical distribution of interarrivals can be adjusted by an exponential law, with parameter:

$$\lambda' = \frac{1}{E(D_n)} = 0.71 \tag{6}$$

This is the inter-arrivals rate. In addition we have:

$A_0 = 0 \quad and \quad A_1 < A2 < A_3$

and we have : $P(D_n > t) = P(N_{t_0+t} - N_{t_0} = 0)$ since $N(t)$ is an independent process, then :

$$P(D_n > t) = P(N_t = 0) = p_0(t) = e^{-\lambda t}$$

but we have $N(t)$ follows the Poissonian law (λt)

so $P(D_n > t) = e^{-\lambda t} 1 - P(D_n \leq t)$

so $P(D_n \leq t) = 1 - e^{-\lambda t} \Leftrightarrow D_n$ follows the exponential law (λ) by integrating we find a density of exponential law ($\lambda exp(-\lambda t)$). so D_n follows the exponential law.

The random variables $(D_n)_{1 \leq n \leq +\infty}$ are independent and identically distributed, because they shame the same probability law and are mutually independent. Therefore, the counting process $(N_t)_{t \geq 0}$ is a renewal process. We have found that the interarrivals are exponential and are characterized by a single parameter: the rate of interarrival λ' So, the process of arrival of trucks in the system is a Poissonian process.

- Time of service: We note:

S_n: the random variable measuring the start time of the n^{th} client system

Y_n: the random variable measuring the service time of the n^{th} client (the time separating the beginning and end of the service).

$$Y_n = S_n - A_n \tag{7}$$

The variables (Y_n) are independent and identically distributed. Indeed, the service time of each truck does not depend upon that of the truck that precedes it, and the distribution of service time the exponential distribution which is characterized by the property Without memory.

The following table demonstrates the consecutive service times of trucks; observation is made on the same dozen trucks we have seen previously.

truck	1	2	3	4	5	6	7	8	9	10
Y_n	82	85	61	65	60	52	53	64	68	75

Table I: Service times of trucks in minutes

The average duration (or average service time) is the mathematical expectation of the random variable (Y_n) , it is the empirical average:

$$E(Y_n) = 66.5 \tag{8}$$

The average service is:

$$\mu = \frac{1}{E(Y_n)} = 0.01 \tag{9}$$

We will now study the stability of the system.For this, let us find the average rate of arrivals λ.

The expected arrival of trucks that is the empirical average number of truck arrivals is equal to 68.16Therefore the arrival rate is:

$$\lambda = 0.014 \tag{10}$$

We have found in the foregoing the following results: The average rate service

$$\mu = 0.015 \tag{11}$$

The average rate of arrivals

$$\lambda = 0.014 \tag{12}$$

We note that

$$\lambda \prec \mu \tag{13}$$

That is to say: traffic intensity:

$$\rho = \frac{\lambda}{\mu} \prec 1 \tag{14}$$

So the queue is stable .It is true that reality shows an explosion in the same during certain period of the day. That is because in these periods, all trucks come in the same time (the same importer who sent them), and both inter-arrivals are null. It is therefore logical that with these constraints, any system will appear unstable, when it is not.

2.2 Mathematical modeling of the informational circuit of trucks

Details regarding the weighing process inside the weighbridge:

In this section, we are interested in the weighbridge, that is to say, one of three stations in our network, and more specifically the second weighing of trucks.

At the level of this station, the truck is placed on the weighbridge and the deriver descends to show the weighing ticket he had during his first weighing, and get the stamp of the customs officer along with the delivery note.

We have then an informational flow of trucks inside the weighbridge office, for it is the documents of trucks that move and not the trucks.

This is yet another network of queues with three stations which are:

• Weighing: Office containing a computer system which ensures the loads of trucks and display their weight under the supervision of a weighing agent, who prints the weighing ticket containing all the necessary information of the trucks and the goods it carries.

• Customs: Office containing a customs officer who verifies whether the weight of the goods carried exceeds the declared weight, recopies on his register all the extra information on the weighing ticket, fill the exit note and on its back filled in and puts the stamp on the customs liquidation.

• Surveillance: Office containing a delivery agent who controls the quantity of the goods, ensures the delivery of the destination and records all information in order to give a delivery note.

To modeling the informational flow of trucks , we can diagram the informational flow of trucks inside the weighbridge as follows:

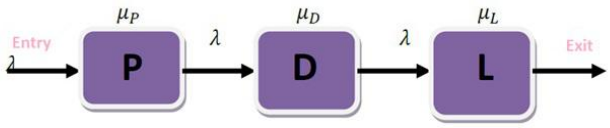

Figure.4: Informational flow of trucks at the weighbridge

• Type of queue: We have then a system which consists of three servers that work in tandem. When a client arrives, he is first directed to the ”P” server, and as soon his service is completed he is directed to the ”D”server where he performs a new service and then directed to the ”L”server. The system is described by the triplet $X_t = (X_t^1, X_t^2, X_t^3)$ where, for i=1,2,3 , X_t^i ,is the size of the system (number of clients in the queue of server i , including the client still in service by the server i). We suppose that the arrival process is a poissonian process with the parameter λ , and the times of services are independent variables, and independent of the arrival process.

We suppose that the times of services of server i follow exponential laws of parameter μ_i This is a special case of Jackson’s networks.

• Kendall’s notation : Kendall’s notation of our queue is as follows:

$$M/M/3/+\infty/+\infty/FIFO \tag{15}$$

Indeed, the arrival processes and services in the various stations are Markovian. The capacity of the queue and the servers are infinite, the number of servers is three, and the discipline of service is FIFO.

• Accuracy of the model parameters: Notice that this is indeed a network of queues. To study its parameters, we can either study the parameters of the entire system, or study the parameters of each of its various stations. We shall opt for the second option, which provides us with the maximum details for a better analysis. Concerning the arrival rate for each station, it is the same as the one found in the second chapter which is 0.014. For the service rate, it changes from one station to the other; using a stopwatch a each station, we find the following: The service time at the ”P” station is fixed in one minute, (it is fixed because it is the system that weighs). The service rate therefore is:

$$\mu_P = 1 \tag{16}$$

The service time at the ”D”station is an average of four minutes. The service rate therefore is:

$$\mu_D = \frac{1}{4} = 0.25 \tag{17}$$

The service time at the "L" station is an average of two minutes. The service rate therefore is:

$$\mu_L = \frac{1}{2} = 0.5 \tag{18}$$

Hence the service time at the weighbridge (second weighing) equals the sum of the service time at each station, it is therefore seven minutes.

We deduce then that the service rate at the weighbridge is:

$$\mu_{ble2} = \frac{1}{7} = 0.14 \tag{19}$$

2.3 Performance of service provided to trucks

Consider the system behavior in a given period of time, for instance between $t = 0$ et $t = \theta$.

X_t is the total number of clients in the system at the instant t.

Taking interest in the system behavior of the time interval $[0, \theta]$ is tantamount to considering the transitional regime system. We take

$[0, \theta] = [0,960]$ in minutes . The choice of $\theta = 960$ is tantamount to considering both shifts of the day $(16h = 960min)$ to go through every possible state of the system during the day (congestion, vacancy of system, balance, explosion ,...) .

• Average rate of entry: the average rate of entry is the average number of clients who arrived to the system per unit of time. over the observation period 0.960, it is therefore:

$$d_e(\theta) = \frac{\alpha(\theta)}{\theta} \qquad (20)$$

With $\alpha(\theta)$ Number of clients arriving to the system during the period so: That is to say one truck every 8 min.

• Remark :The average exit rate is the average number of clients who have left the system per unit of time. over the observation period $[0, \theta]$ it is therefore:

$$d_s(\theta) = \frac{\delta(\theta)}{\theta} \qquad (21)$$

With $\delta(\theta)$ is the number of clients who have left the system during the period $[0, \theta]$.

In our case $d_s(\theta) = d_e(\theta)$ Since we have taken as time interval all shifts, and at the end of the day no truck remains in the system, so the number of trucks that arrived to the system is itself the same number leaving it.

•Total time during which the system contains n trucks: $T(n, \theta)$ Total number of trucks in the system during the observation period θ. The purpose of this paragraph is to observe the change in the number of trucks in the system over time. We have as data the " $tare$" table which contains instants of tare weighing, and "$pese$" table which contains instants of gross weighing. We define the "$fusion$" table which contains all the instants during which the system has witnessed an arrival or departure of a truck ascending. This is obtained by making an increasing fusion of two preceding tables., and the "nbr " table which, for each instant or each case of "$fusion$" table, specifies the number of trucks present in the system.

These two tables cannot be made by hand due to the large size of our database. This requires a computer program. Therefore, we have established the following algorithm .

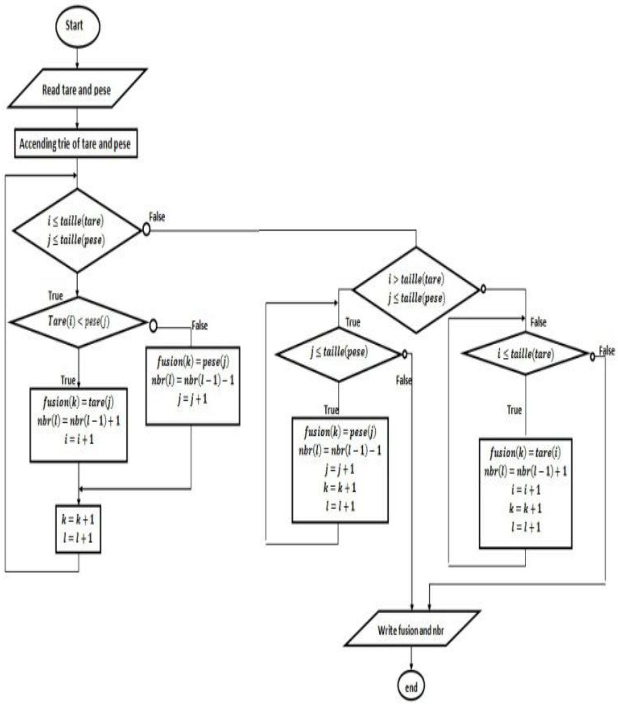

Figure.5: Examination of the change in the total number of trucks in the system

Notes:

• i and j traverse successively the two tables tare and pese.

• k and l traverse successively the two tables, fusion and nbr.

This algorithm proceeds as follows: As input, we introduce the " $tare$" and "$pese$" tables, the two tables "$fusion$" and "nbr "are obtained as output.For the "nbr " table, if the corresponding checkbox in the fusion table is an entry, we increase the number of trucks by one and if the corresponding checkbox in the fusion is a departure, we decrease the number by one.We get the following graph after execution:

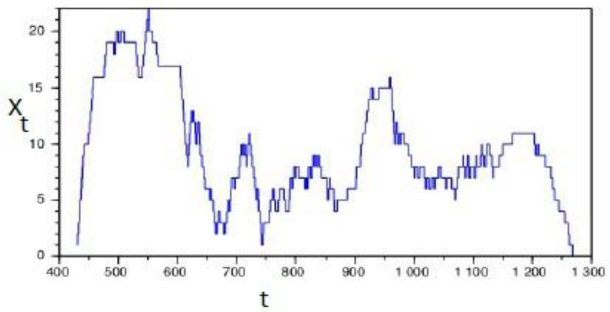

Figure.6: Total number of trucks in the system during the two shifts

It is clear that the maximum number of truck that were in the system during the period of observation 960 min is n=22.

• calcul of $T(n,\theta)$ for a given number n: We note the total time during which the system contains n clients $T(n,\theta)$ which we calculated as the sum of the durations during which there were n trucks in the system during the observation period θ.

It is clear that $\sum_{n=0}^{+\infty} T(n,\theta) = \theta$.

In our case, the calculation of $T(n,\theta)$ amounts to calculating $T(n,960)$ for every n with $0 \leq n \leq 22$.

The calculation of $T(n,960)$ cannot be made by hand due to the large size of our database. This requires a computer program. Therefore, we have established the following algorithm:

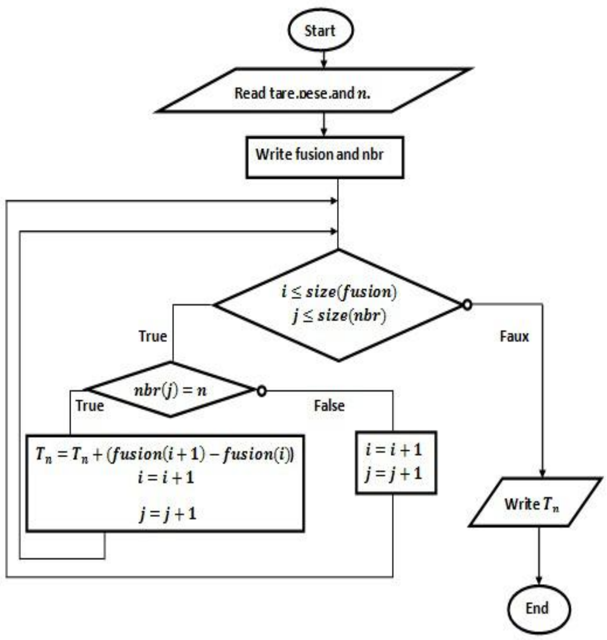

Figure.7: Calculation of the total time during which the system contains n trucks

Notes:

• i and j traverse successively the two tables fusion and nbr.

• to display fusion and nbr tables, it uses the previous program.

The principle of this algorithm is to introduce as arguments the tables "tare" and "pese" , and n. Specifying the value of n, this algorithm gives us as output, the total time during which the system contains n clients. We obtain the following graph:

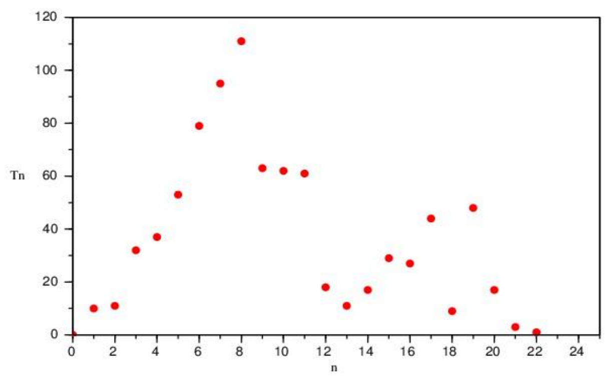

Figure.8: Total time during which the system contains n trucks

• Average number of trucks: the average number of trucks present in the system is the time average X_t , $or X_t$ Over the observation period $[0,\theta]$. this is therefore the area under the curve for X_t.

$$L(\theta) = \frac{1}{\theta}\sum_{n=0}^{22} nT(n,\theta) \qquad (22)$$

We thus obtain $L(960) = 8.476$.

• The average stay time: the average stay time of a client in the system is, by definition, the arithmetic average of stay time of the clients who arrived into the system during the time interval $[0,\theta]$:

$$W(\theta) = \frac{1}{\alpha(\theta)}\sum_{k=1}^{\alpha(\theta)} W_k$$

With W_k is the stay time of k^{th} client in the system .

$$W(\theta) = \frac{1}{120}\sum_{k=1}^{120} W_k = 67min. \qquad (23)$$

• Utilization rate U: we are in the case of a single queue waiting with one server (weighbridge + dock), then we may define the utilization rate of the server which is the proportion of time during which the server is occupied in the interval $[0, \theta]$ as follow:

$$U(\theta) = \sum_{n=1}^{22} \frac{T(n,\theta)}{\theta} \quad (24)$$

so: $U(960) = 0.872$.

That is to say during the day, the system was occupied with 87.2%.It was therefore unoccupied with 12.8%.

• First remark : The utilization rate of a server is also calculated is follows :

$$U(\theta) = 1 - P(0, \theta) \quad (25)$$

With $P(0, \theta)$ is the proportion of time during which the server does not contain any client in the interval $[0, \theta]$.

• Second remark: The utilization rate of server $U(960)$which we have calculated represents the entire server utilization rates (weighbridge, dock, weighbridge). We may easily deduce then that the utilization of the weighbridge is the double of the preceding rate since we use the weighbridge twice .

we note U_{ble} the utilization rate of weighbridge

$$U_{ble}(\theta) = 2 \times 0.872 = 1.744 \quad (26)$$

3 Resources Optimization's

Figures and Tables should be numbered as follows: Fig.1, Fig.2, … etc Table 1, Table 2, ….etc.

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3.1 Problems classification's

To optimize resources in handling operations, or in any industrial environment, we must determine priorities in the actions. For this, we rank the importance of factors to be considered depending a criterion adopted.

In our case, the elements studied are the problems delaying the service trucks, and the criterion is the delay within the service truck.

We will then use the Pareto principle as a tool for decision making, because it is necessary to focus on the problems, which despite the weakness of their appearances, causes the biggest impacts.

The causes must be responsible for delays trucks are listed, and their respective percentages are calculated. The percentages are then used to construct the following graphic:

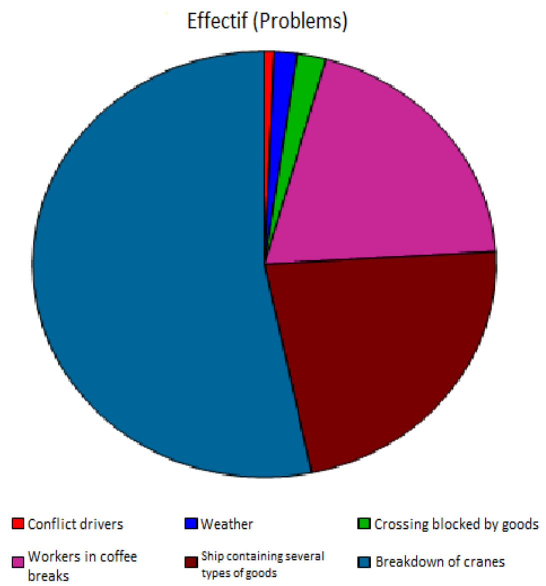

Figure.9: Phenomenons causing the biggest delays

We then conclude that three problems represent 95% of all problems: Breakdown of cranes, ship containing several types of goods, and workers in coffee breaks. These causes should be followed to reduce its effects. As regards the other three problems, it may occur more often, but their effect is not very severe.

3.2 Proposed method and results:

- Problem of breakdown cranes's:

When we verify the databases of the past weighing, we notice the different durations of service. We remark that the trucks have greatly exceeded the average length of service (which is 66 min). By comparing monitoring of these delays, we find that the primary reason which causes the biggest delays is attributed to the breakdown of cranes. It is true that this phenomenon is rare, but it has caused the biggest delays, which impacts on the service of trucks, as well as the length of stay and ship performance. According to the principle of the ABC method , it is necessary to focus on the problems, which despite the weakness of their appearances, cause the biggest impacts.

The affectation (crane-ships) is done by choosing among the corresponding cranes nearest the dock where the ship will stop.But we all know that every machine has a lifespan. By comparing the counters of cranes (number of hours worked), we have noticed that there exists a yawninggap in the number of hours worked among cranes of the same capacity. This means that the lifespan of the one with the advanced counter shall be quickly exhausted. We then propose to balance the counters via making a way to give priority to the crane with the least advanced counter when assigning cranes to ships (of course, were talking about cranes of the same capacity).The following algorithm describes the proposed affectation method's:

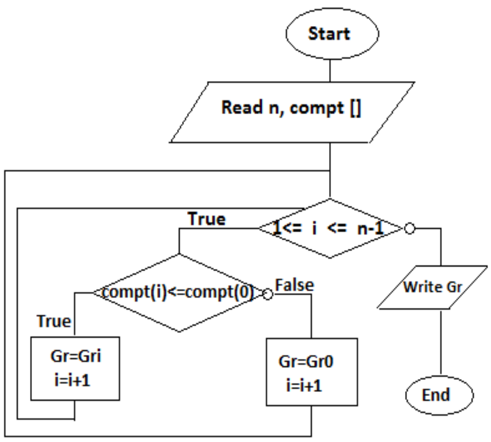

Figure.10 : Crane choices's for affectation

Notes:

- i traverses successively the table compt.
- compt[] is the table containing counters of each crane

We introduce the number of cranes available and having the same capacity, and a table containing the number of hours worked for each crane (the value indicated on the counters). As output we obtaine the crane having worked the least, to assign it to the ship.

As well counters cranes will be balanced, thereby reducing unexpected breakdowns during critical moments of the productrion.

- Problem of ship containing several types of goods:

Along with the problem of the breakdowns of cranes, there is also another problem which often prevents the reduction of delay of truck service. This can be explained through the following example:

If we have a ship containing several types of goods, including wheat and corn, and the crane assigned to this ship begins unloading wheat, it will unload the corn only after it has finished the amount of wheat. So if at a certain time, a truck wishing to load corn goes to the terminal, while the crane is in the process of unloading the wheat, it shall have to wait until all the quantity of wheat carried in the ship is unloaded (every truck wishing to load wheat will be served before him and leave).

It is then impossible to decrease the delay of service trucks wishing to load the goods while the crane unloading started by another type of goods.

To avoid the above problem, we propose to make the truck drivers aware of te first type of goods to be unloaded, and announce a likely margin time for the unloading of each type of goods. That way, we will have a good organization of the arrivals of trucks, and see some stability in the queues.

On the other hand, and to avoid such cases, it will be interesting to encourage the management of the operations of weighing and loading by private companies as well the problem of random arrivals will no longer exist, because the Port Authority will have to put the point with a single agency.

It will also develop the national economy, due to the role and position of the industry into the economy and the absorption of labor force [21].

it is a priority to enhance the security of the port traffic, service quality and diversification of the different services offered to shipping companies.

Remark: In this context and as perspectives, this phenomenon presents an optimization problem.So we propose to use a flexible algorithm to organize the unloading of ships containing several types of bulk,and loading trucks wishing everyone a different bulk of the other, without delay the ship or trucks, and using a minimum of resources.

We judge that the best algorithm to use in our situation is the new modified ABC algorithm [23] , because the performance results have shown that the proposed algorithm has yielded the best performance compared to the standard ABC and two other good ABC variants (BABC1 and IABC) in terms of convergence speed and global minimum achievement.

- Problem of coffee breaks:

The total number of trucks in the system during the two shifts is a very important performance measure's , that we can use to handle the problem of coffee breaks.

In fact, looking at figure 5, it is clear that the number of trucks in the system decreases during the following interval : $[11:02:00, 11:26:00], [12:15:00, 12:27:00], [20:20:00, 22:30:00]$ .It will be very effective to distribute the breaks the workers take during these intervals to ensure their presence during intervals of the explosion of system .

In the other hand, the inoccupation rate of the system is a very important result which allows us to specify the total length of coffee breaks the workers take. In fact, the total length of breaks should not exceed the inoccupation period of the system so as not to negatively impact the production by leaving the trucks waiting.

- Other propositions:

To optimize the stability of a service, the most effective procedure consists in the reduction of the service time. In this context, we propose to eliminate the manual statement identified by the customs officer.

This operation takes an average of three minutes, while the weigher has a system of information which may be used by the customs.

The customs officer will therefore only verify the weight of the goods and seal the back of the exit note, and at the end of his shift he prints all the data needed from the system. The new mission of the customs shall take only 40 seconds, and then we will have a gain of 3 minutes. It is therefore a change in the ”D” station. The new service time will be one minute, and the new service rate at the level of this station will be:

$$\mu'_D = 1$$

• Remark : This change in the delay of service is interesting at the level of the weighbridge (second weighing), but at the level of the entire service (double weighing + load), three minutes remain insignificant compared with 66 minutes as the average duration of service. But throughout the day, this gain is multiplied by the number of trucks passed through the port, which gives a gain of 37% at the service time, and this will help to serve more trucks per day, especially cambining it with changes and reorganizations previously studied.

4 Conclusion

In this article we showed that a good reorganization of excistant infrastructures could avoid us adding expensive new infrastructure.

Using a stochastic study, we have explained the delay trucks and congestion problems within the ports, by the hazard of truck arrivals, and not by the instability of the system. But applying the suggestions previously, we can reduce the time of the tour trucks without interrupting the activity or require budget.This approach allowed us to win 37% of the service time. To further enhance the performance of handling within the port, and since the supply chain of the company is linked to other processes, it is beneficial to extend this study by analyzing the possibility of create deposits of bulk goods out of the ports.

We also focused on the problem of breakdowns of cranes, which causes a lot of damages in terms of production and requires a lot of investment for repairs, while a simple and inteligent assignment can avoid these problems.

References:

[1] D.Mou, Y. Zhang, Multi-objective Integer Programming Model and Algorithm of the Crew Pairing Problem in a Stochastic Environment,Issue 8,Volume 12,August

2013.WSEAS TRANSACTIONS on MATHEMATICS
[2] T. Koderaa, M. Miyazawab, An M=G=1 queue with Markov-dependent exceptional service times , Academic Publishers, Boston, 2001, pp. 365-407.
[3] L.Chen, N. Bostel, P. Dejax, J. Cai,L. Xi, A tabu search algorithm for the integrated scheduling problem of container handling systems in a maritime terminal. European Journal of Operational Research 181 (1), (2007)4058.
[4] J.M. Proth, N. Sauer, 1998,Scheduling of piecewise constant product flows: A Petri net approach. European Journal of Operational Research 106 (1),(1998) 45-56.
[5] A.Demiriz, U.Kula, N. Akbilek, A framework for balanced service and crossselling by using queuing science, Journal of Intelligent Manufacturing 20 (2),(2009) 249-257.
[6] A. El-Sherbiny,H. Zamani, N. Ismail, G. Mokaddis, M. Ghazal, A. El-Desokey, M.S. ELSherbeny, M.S., E.Al-Esayeh, O. Olotu, Transient solution to an infinite server queue with varying arrival and departure rate,Journal of Mathematics and Statistics 6 (1),(2010) 1-3.
[7] S.M.T.F.Ghomi, A.A.Jaafari, Simulation - A queuing theory based approach,Journal of American Science 7 (1) (2011).
[8] H. Minton, Waiting and queuing in the check-in hall: An ethnographic study of queuing and waiting for check-in services at Manchester Airport,Journal of Airport Management 2 (3),(2008) 249-264.
[9] T. Koderaa, M. Miyazawab,An M=G=1 queue with Markov-dependent exceptional service times, , Operations Research Letters 30 (2002) 231 - 244.
[10] J.F.Shortle, P.H.Brill, M.J.Fischer, D.Gross, D.M.B.Masi, An algorithm to compute the waiting time distribution for the M/G/1 queue,Journal on Computing 16 (2),(2004) 152-161.
[11] M.Snipas, E. Valakevicius, Markov model of multi-class, multi-server queuing system with priorities, Journal of Communication and Computer 7 (1), (2010)62.
[12] L.Brunetta, L. Righi,G. Andreatta ,An operations research model for the evaluation of an airport terminal: SLAM (simple landside aggregate model),Journal of Air Transport Management, 5, (1999)161-175.
[13] d. A. G. Barros,D. D. Tomber, Quantitative analysis of passenger and baggage security screening ar airports.,Journal of Advanced Transportation, 41(2),(2007) 171-193.
[14] C.Robertson, S.Shrader,D. Pendergraft, L.Johnson, K.Silbert, In E. Ycesan, C. -H. Chen, J. Snowdown, J. Charnes (Eds.), The role of modeling demand in process re-engineering, Proceedings of the Winter Simulation Conference,2002, pp. 1454-1458.
[15] R. Stolletz,Analysis of passenger queues at airport terminals, Research in Transportation Business Management 1 (1), (2011)144-149.
[16] R.Stolletz , Approximation of the non-stationary M(t)/M(t)/c(t)-queue using stationary queuing models: The stationary backlog-carryover approach, European Journal of Operational Research, 190(2) (2008) 478-493.
[17] C. Blondia, T. Theimer, A discrete-time model for ATM traffic, RACE document PRLB 123 0018 CC CD/ UST 123 0022 CC CD, October 1989.
[18] A.S. Alfa, M.F. Neuts, Modelling vehicular traffic using the discrete time Markovian arrival process, Transportation Science 29 (1995) 109-117.
[19] A.Graham, (2003). Managing airports An international perspective (2. ed). Elsevier.
[20] D.Worthington, Reflections on queue modelling from the last 50 years,Journal of the Operational Research Society 60, (2009)S83-S92.
[21] D. Zhang, Empirical Research on the Performance of Circulation Industry Based on Input-Output Analysis –Evidence from Zhejiang Province, China,March 2013, WSEAS TRANSACTIONS on MATHEMATICS.
[22] M.L. Chaudhry, in: W.K. Grassmann (Ed.), On numerical computations of some discrete-time queues, Computational Probability, Kluwer.2000
[23] N.Sulaiman, and J.Mohamad-Saleh, Modified ABC Variant (JA-ABC4) for Performance Enhancement, Proceedings of the 2014 International Conference on Mathematical Methods, Mathematical Models and Simulation in Science and Engineering.