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

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).

$$Y_n = S_n - A_n \quad (7)$$

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:

$$E(Y_n) = 66.5 \quad (8)$$

The average service is:

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

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:

$$\lambda = 0.014 \quad (10)$$

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

$$\mu = 0.015 \quad (11)$$

The average rate of arrivals

$$\lambda = 0.014 \quad (12)$$

We note that

$$\lambda \prec \mu \quad (13)$$

That is to say: traffic intensity:

$$\rho = \frac{\lambda}{\mu} \prec 1 \quad (14)$$

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:

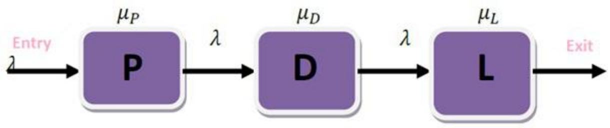

Figure.4: Informational flow of trucks at the weighbridge

• 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:

$$M/M/3/+\infty/+\infty/FIFO \quad (15)$$

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:

$$\mu_P = 1 \quad (16)$$

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

$$\mu_D = \frac{1}{4} = 0.25 \quad (17)$$

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

$$\mu_L = \frac{1}{2} = 0.5 \quad (18)$$

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:

$$\mu_{ble2} = \frac{1}{7} = 0.14 \quad (19)$$

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:

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

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:

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

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 .

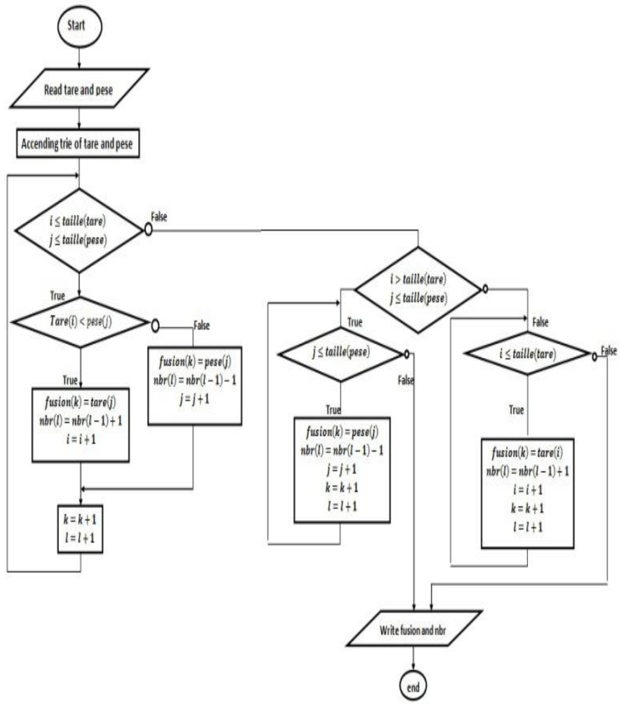

Figure.5: Examination of the change in the total number of trucks in the system

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: