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DIGITAL TRANSFORMATION IN FLOW PLANNING: THE CASE OF CONTAINER TERMINALS AT A SMART PORT

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ABSTRACT

Faced with a constantly changing environment, and an international economic context characterized by fierce competition, the digitalization of businesses, and especially medium-sized businesses, has become a sine qua non condition for dealing with this. This article attempts to study digital transformation in correlation with flow planning and its impact on the improvement of international trade in order to address the case of container terminals at the Tanger Med smart port. We have tried to study in detail the various logistics flow planning tools and discussed the case of container terminals in the port of Tangier Med. The action variables discussed in this article are on the factors impacting terminal traffic to Container terminals. The different logistics flows, the planning of logistics flows, the logistics planning tools, the structure of the port of Tanger Med, the evolution of the containerized fleet within the container terminals of the port allow, among other things, the objectives achieved of the paper, This will allow the introduction of very advanced IT solutions in the nearest future within smart ports by aligning with the blockchain.

Keywords: *Information systems, Digital transformation, Information technology implementation, Planning Flow, Blockchain International trade, intelligent system, Smart Port.*

1. INTRODUCTION

The issue of digital transformation has become central to improving the competitiveness of small and medium-sized businesses and the sustainable development of their environment. However, for companies, digital transformation has so far been limited. Our subject will focus on the level of digital transformation, as well as on the performance of companies, more precisely, it will aim to measure smart business, digitalization within companies and its impacts on efficiency and business efficiency. On the other side International trade is now a real source of added value for customers, suppliers and businesses in the form of service reliability, performance, efficiency in terms of time and responsiveness while calling for an efficient logistics system. In addition, logistics is the main place for the profitability of the company, through the process aimed at optimizing production capacities, stocks and costs. But logistics still faces a difficult problem: By its scope, it is concerned with the management of operations and production from upstream to the very downstream of products by customers; by the complexity of the questions to be resolved, it collects thousands of data in order to successfully optimize different flows through the multiplicity of stakeholders, since all the actors are involved (Producers, planners, controllers, etc.). Making the product " smart logistics" using the digital transformation is a prerequisite for good chain management, but not an end in itself. This action on the product makes it possible to acquire a potential flow which will be exploited at the desired times to facilitate the management of operations. The main thing for the logistician is the identification of flows and their management which is based on the practice of planning from upstream to downstream.

In the continuation of this research work, we will have a more practical vision of these foundations, while discovering the means of implementation, by devoting ourselves first to the planning of flows.It revolves around a joint planning of logistics flows in correlation with digital transformation during all of the production processes. All of this is supported by an operational forecasting system, in order to discuss the case of container terminals in the Tanger Med smart port.

2. GENERAL CONTEXT OF THE STUDY

The economic development of businesses in general is based on their ability to offer high quality goods and services. The project will deal with how digital transformation could act in favor of the prosperity of these companies; in other words, draw the attention of entrepreneurs to the impact of the digitalization of the economy on the future of businesses, thus the challenges of digitalization for the country's economy, then the stages of the digital transformation of the climate of business, then the priority axes for a successful digital transformation of a company and finally a roadmap on the choice of a digitalization tool which will improve the busines within smart ports. In this context we will directly deal with the elements relating to the planning of flows which are fully digitalized. Seen of crucial importance for improving the functioning of smart ports, as well as for international positioning, this research attempts to target digital transformation within this type of organization. A container terminal is the area of the port where cargo ships dock in berths and containers are loaded and then unloaded for subsequent storage in a buffer zone called a yard. The quay has berths for ships and quay cranes which are used for moving containers. The yard is considered to be the placement area used for the loading, unloading and transshipment of containers.

In the contemporary intermodal transport system, it is about the transition of the container from its source to the end point through multiple modes of transport, such as sea lanes, railways, roads and airways; or a combination of some or all of the means. The container transport chain therefore has many intersection points such as container yard, warehouse, container terminal, mother ship and supply ships etc. that the information circulating in almost all the nodes, which requires the great importance of a very advanced digital system.

3. MATERIALS AND METHODS

The concept of chain of flows corresponds to the overall flow of products, starting from the first of the suppliers to finish with the ultimate customer: the consumer. This integrates what some call the supply chain, but also the demand chain, the expressed or foreseeable needs of customers. This chain is very wide and necessarily open because, on the one hand, suppliers almost always have suppliers and, on the other, we can go far, especially if we go beyond the act of consuming by thinking of recycling flow ...But it is also necessary to take into account local chains, between the different sectors of the same company, each being a client or supplier of another.

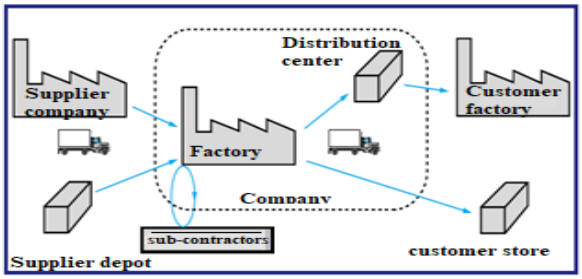

Figure 1: Solar chimney. "Virtual" or extended company

The concept of supply chain allows a look at the activity which is not satisfied to appreciate things within the only perimeter of a factory, for example, but which also takes into account customers and suppliers to find more optimal solutions from the point of view of the entire supply chain: better costs, flexibility, deadlines, quality of service (Figure 1). The transverse flow to all the companies in the sector is sometimes called "pipeline" to clearly highlight the transverse and fluid nature that logistics is trying to approach.

3.1. Logistics flows

We can consider that the concept of management came into play in the early 1950s under the effect of several elements, which, although independent and of different natures, led to an interest in the best possible use of the production system.Nowadays, poor planning, operation and use of demand trading channels results in forecasts not in line with actual operations. This results in a loss of reliability and profitability in achieving satisfaction of customer needs (higher transport costs, losses in production yield ...).Planning for demand flows therefore appears to be a key element in the success of an

optimal logistics flow management system (Rodocanachi et al. 2001). Indeed, it marks the entry point of the logistics chain. It plays an important role in logical operations, that of forecasting the manufacture of products as well as the supply of products with customer requirements (Terrand, 1998).

3.1.1 Need for productivity

The post-war period led to strong consumer demand when production capacities were limited and could not meet all needs. Industrialists generally have to organize their means of production in order to market as many products as possible.

International trade is considered one of the most essential elements of economic behavior and allows everyone to access the resources and technologies of different countries of the world, it also includes encompasses all transactions involving the operations of purchase and sale. sale of products and services abroad, despite this, the economic literature has not paid much attention to trade. International trade has experienced tremendous growth. Initially, this trade was limited to trade in commodities dominated by primary products. After that, manufactured goods began to take an increasingly important place until they replaced them and became dominant on the stock exchanges. In addition, the services continued to develop rapidly.

Tangier Med is considered to be the most powerful port in the Mediterranean, the choice of this project was for several reasons:

First by its location in an important strategic location, it allows it to be the largest port in the Mediterranean region and the pioneer in Africa, also It is considered a point of contact between Europe and Africa and between the Mediterranean and the Atlantic Ocean, and as it is considered among the 20 most important ports in the world. Second, the port of Tanger Med is one of the major economic projects that has been able to compete with international projects, in a short time it has achieved several successes in ten years, in particular the reception of the largest vessel in the CMA CGM fleet. KERGUELEN (is one of the greenest means of transporting goods in the world), and other important achievements.

Improving the productivity of the direct workforce becomes the priority for business leaders.

3.1.2 The advent of computers

The introduction of large computers capable of processing a large volume of information quickly opens up new horizons. This new technology will induce profound changes in the conduct of operations and allow the emergence of "production management" based on the modeling of the production device.

3.1.3 Production management

Producing more and producing better (cheaper), these are the main objectives sought through this new concept. Produce MORE by new approaches applied in manufacturing (organization of tasks, time measurement, economic series ...) for maximum use of available capacities.

Produce better with the appearance of the first management concepts (economic purchasing quantities, "ABC" classification, planning of activities, scheduling of tasks, etc.).

Flow management therefore continues to evolve according to its content and the scope to be optimized. Renamed successively "industrial management", then "business management", it ends up integrating all the elements necessary for the supply, transformation and distribution of products to cover today the management of the global supply chain (Supply Chain Management).

3.2. Adjusting planning parameters

Whatever the business environment in which the company operates, joint planning of the operations of the various logistics subsystems represents the crucible in which the relevance of most logistics decisions is realized and measured.

Planning allows sequencing of operations over time. It is based on joint planning of distribution and transport, production and supplies. The whole is supported by an operational forecasting system.

To make its efficiency operational planning must tend towards:

- Adjustment of planning parameters,
- Correct evaluation of forecasts,
- A progressive planning system.

This calibration is carried out in relation to the time component and in relation to the logistics families.

3.3. Planning tools

MRP, ERP, JAT, GPA ... so many esoteric acronyms that do not fail to be heard when one is interested in flow management. What is it all about and how do you choose when deciding which approach to take to improve business performance?

3.3.1 The MRP (Material Requirements Planning)

A real revolution in production management, the MRP must be considered as the first reference model. For the first time in industrial history, an information system will be able to exploit the full power of IT and allow a "calculation of the needs" of articles: material, components and other sub-assemblies.

The innovations brought by the MRP and its subsequent evolutions are numerous and will require from the users a deep change in the working methods.

The starting principle is relatively simple since it is a question, from a production master plan, of "calculating" the supply of the necessary components in "quantity, date".

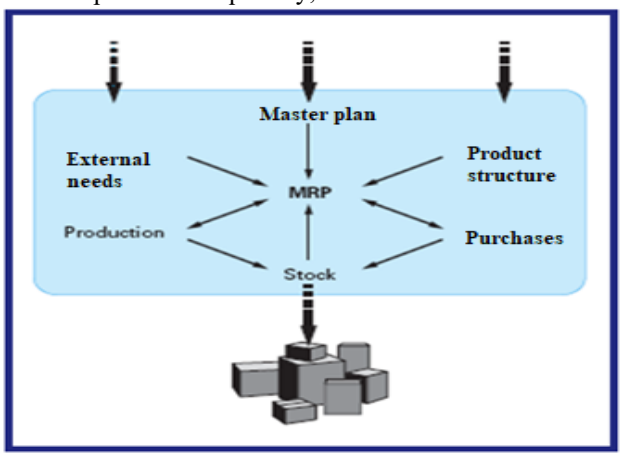

Figure 2: MRP Logistics

This calculation (MRP) is based on the following basic data:

- The master plan, representation of the forecast production plan generally expressed in terms of finished products and deduced from commercial forecasts.
- External "independent" needs, that is to say not arising from the breakdown of the production plan.
- The product structure, description of the products to be manufactured through the tree of relationships between product - assemblies - elementary components.
- The modeling of the production system described through parameters (available stocks, manufacturing cycles, supply, security, batch sizes, yields, transport time ...).
- This data is processed to determine the "net requirements" (gross requirements - available stocks - orders in progress) and to deduce the supply recommendations to be made to satisfy them. The recommendations, after analysis, are transformed into purchase orders or production orders which, upon receipt, will be cleared and will supply the available stock.

Among the key features of the MRP model is the relationship between "planning" and "execution".

The planning materialized by the results of the needs calculation aims to position over time, for each item of the product structure, the needs arising from a consumption forecast.

Execution, for its part, aims, day after day, to scrutinize on its work horizon the potential needs positioned by "planning" to convert them into purchase or manufacturing orders.

If we refer to the characteristics set out, it seems obvious that the immediate effect of the MRP is to strengthen Taylor's organization of work. Whether it is the integration of data, the uniqueness of information, the centralization of the calculation of needs, the definition of product structures, everything leads to creating in the company, specialized activities grouped into powerful functional organizations.

The future developments and the optimizations they bring about will amplify the movement through an increasing complexity of tasks and an increasingly advanced specialization which, gradually, will lead to the creation of two worlds in the company, the white-collar workers. (who decide) and blue-collar workers (who execute).

The largest companies, most of them American, are gradually adopting this model, which still today underpins the philosophy of the most modern computer-aided production management (CAPM). On this basis, two major developments will emerge, the MRP 2 and the ERP.

3.3.2 The MRP2 (Manufacturing Resource Planning)

To describe this evolution, it is first of all to decode MRP 2. Beyond the number "2" indicating a logical continuation to the MRP, the definition of the acronym evolves to concern now the "planning of manufacturing resources". Thus, the calculation of needs is no longer limited to the sole processing of "articles" but is also interested in the "capacities" of the company through the

calculation of costs associated with the forecast production plan. While the first version of the MRP supposed to work at infinite capacity, this new approach introduces a feedback loop on the production program by analyzing the material and load needs it induces. From an open system, the MRP thus evolves towards a regulated system.

In addition, taking advantage of the computing power now offered by computers and new techniques available in the field of databases, the MRP extends its borders to organizations bordering on production (commercial, purchasing, finance) and at the same time develops new logic functions.

It is the appearance of the so-called "integrated" management system which presents for the first time various logical functions processed in a coherent whole, with unique data, assigned to an owner and shared between the different modules of the system. Management.

From production management (MRP), the model extends to industrial management (MRP2).

3.3.3 The ERP (Enterprise Resource Planning)

Although appearing in this place as an evolution of the MRP logic, this new version appeared in fact much later (in the early 1990s). Consequently, beyond the MRP 2 logic which it perpetuates, this new model proposes to also respond to the concerns of the end of the 20th century which have greatly evolved since the appearance of the first concepts of production management.

As its name suggests, ERP presents itself above all as the management system of the enterprise as a whole. Thus, after the integration of organizations touching the first circle of production (MRP 2), the ERP extends its coverage to all functions of the company, from research to the strategic conduct of operations through the management of human resources and distribution logistics.

In addition, in order not to stay away from new trends, the ERP introduces some variations and some complements to primitive logics. Thus, new logical functions are developed to support just-in-time (JAT) manufacturing operations or even approach the field of extended enterprise with the notion of "Supply Chain".

Last but not least, ERP is refocusing on planning at the expense of execution. As cryptic as this last remark is, it is important to note that it represents a fundamental change from the original concepts where execution is closely linked to planning and entirely dependent on it.

In summary, ERP can be considered as a global model, which maintains overall coherence through enhanced planning, while proposing diversified execution solutions (JAT, timing, synchronous flows ...) or even going so far as to accept external execution applications.

3.3.4 The DRP (Distribution Resource Planning)

It is the direct transposition of the MRP applied to the field of product distribution. In fact, the DRP, considered as a MRP with only one level of nomenclature, is used to determine the supply orders of the various depots marking out the flow of product flow between the manufacturing plant and the customers.

Thus, considering as an example a distribution chain made up of a manufacturing plant, a national warehouse and regional depots, the role of the DRP is to deal with the needs of each of the links, in a dependent manner. From the delivery forecasts to the various customers, the regional warehouses make their needs known to the national warehouse which, after consolidation, transmits its own forecasts to the production plant which will consider this information as the main input (forecast of the request) to its own calculation of needs.

The D.R.P. is the link between physical distribution and production planning. Close to its market through its warehouses, the D.R.P. provides a coordinating role, comparable to that of the M.R.P. for production, but located upstream.

From the calculations provided, the warehouse can manage its transport and stocks, determine its vehicle needs and determine its replenishments.

Extracts from the book "D.R.P, the engine of E.C.R." by André J. MARTIN, distribution A.S.L.O.G. :

- The winning companies of the 21st century will have established customer / supplier partnership agreements and radically different ways of working.
- Three ingredients are necessary for the acceleration of the flow of information and materials through the logistics chain, it is necessary:
- systems that accelerate information flows (D.R.P. and M.R.P. 2),
- techniques that tend the material flows: J.A.T. and Q.T. (total quality),

- tools that facilitate both the rapid flow of information and materials (E.D.I. to establish the D.R.P./M.R.P.-2 link; the barcode for traceability).

Planning and scheduling systems such as distribution resource planning (D.R.P) and production resource management (M.R.P.-2) generate and maintain valid schedules throughout the chain. The schedules do not only reflect the accuracy of the needs of the business, but they also incorporate permanent changes, while remaining realistic. The JAT and QT approaches make it possible to tend the physical flows and to tackle any form of waste (too long fixed assets in stock, too long changeover times, too large manufacturing lot sizes, too high safety stocks) resulting in improved quality and lower costs. Finally, the E.D.I. and barcodes are tools to facilitate the flow of information and materials.

3.3.5 Shared supply management (GPA)

The GPA, applicable in principle to all links of the global supply chain, consists in delegating to its supplier the responsibility of managing the availability of the products it supplies within a predetermined framework:

- partnership contract with service level objectives;
- procedure for approving delivery proposals;
- sharing of information previously deemed sensitive (stocks);
- adequate data flow and transmitted with suitable means and pace.

The technique used is certainly DRP type stock management, but the fact that supplier and customer stocks are managed, in supply, by the same person leads to a certain number of improvements. GPA thus optimizes the distribution of quantities, eliminates "jolts" between stocks, and takes advantage of the fact that the supplier, generally having fewer items to control, can exercise more rigorous management.

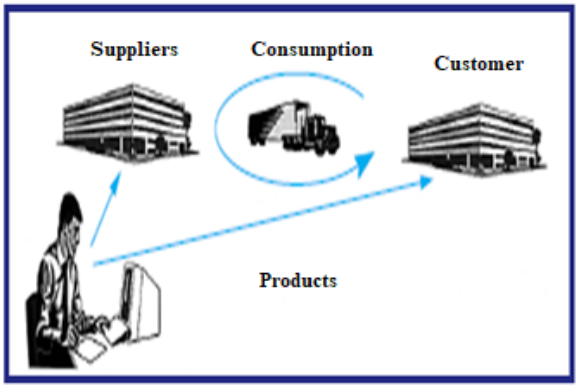

Figure 3: Shared Supply management

This new generation of businesses can take advantage of the evolution of e-commerce from a simple model of information transfer to a true "network commerce" based on an interconnected network of marketplaces and supplier and client companies. However, this will require far more radical reconfigurations in the supply chain as the level of integration between the players is high and the volume of trade and on-line transactions is potentially high. In the years to come, competition between companies will be determined more by competition between networks of companies, i.e. between real teams, capable of bringing about change and influencing market development (proactivity).

4. RESULTS AND DISCUSSION

This section may each be divided by subheadings or may further divided into next heads as shown below.

Given the importance of international trade in goods, port logistics is one of the main links in the logistics chain. But just like the last kilometer for logistics, port logistics facilities are a key element in globalization.

In Morocco, the concern for openness towards port operators was reflected in the preamble to Law 15-02: "it has become essential to provide the port sector with a legislative and regulatory framework adapted to future developments, in harmony with the treaties and the various agreements to which Morocco subscribes, capable of encouraging private initiatives and putting port operators and operators in a competitive situation ".

The port of Tangier Med is considered mainly as a transshipment hub in the west of the Mediterranean. Being at the crossroads of maritime routes, it operates on all types of East-West and

North-South traffic and is not limited to serving the African market only.

Thanks to its strategic position on the strait, the port of Tangier Med offers broad connectivity and is ideal for ship-owners and the various flows of goods. This geographical position has enabled the port, from its opening, to increase each year the number of maritime services to directly and regularly serve the East-West and North-South routes and to offer a competitive transport time from the goods, especially for containers from Asia and the rest of the world.

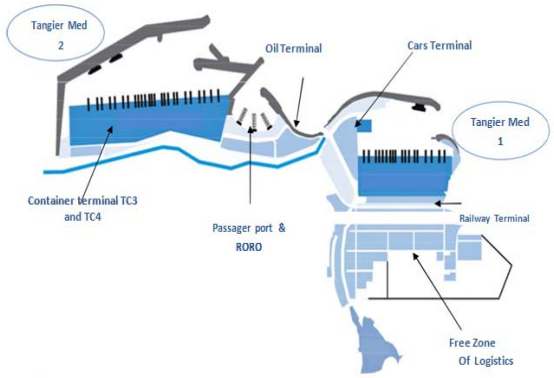

Figure 4: Tangier Med Smart port structure

The importance of the flow of information) arguing that the unified flow of information is essential to ensure well-organized advancements. He further explained that extremely variable supply chains, with rapid response to customer needs, require specific information flow for monitoring, scheduling and regulating activities.

4.1 Tangier Med port terminals

4.1.1 TC1 : APM Terminals Tangier

The first container terminal (TC1) is operated, under a 30-year concession granted in 2005 to APM Terminals Tangier, a subsidiary of the APM Terminals group, one of the world leaders in the management of container terminals, and " AKWA Group, leader in Morocco in the distribution of fuels, gases and fluids.

Terminal TC1 is equipped with 8 Super Post Panamax quay gantries (61T lifting capacity), 28 wheeled gantries, 27 Kalmar type trucks, 37 ATT type trucks, 34 40 'chassis as well as container storage gantries refrigerated. Plus 2 Reach Stacker and 5 Empty Handler. TC1's investment in superstructure and equipment amounted to more than € 140 million.

Dredging works carried out at the end of September 2012 on the quay of the TC1 container terminal brought the draft to -18m. This achievement enabled the terminal to receive from 2013 triple class E vessels from Maersk line.TC1 has been performing since 2008 on productivity levels of high international standard (30+ movements / hour / gantry) with non-stop operations in 24h / 365d, allowing TC1 to ensure an annual processing capacity level equal to or greater than 1.3 Mil TEU.

4.1.2 TC2 : EUROGATE Tangier

The second container terminal (TC2) is operated under a 30-year concession granted in 2006 to the EUROGATE TANGER consortium, Contship Italia, the leading European port operator and leader, and to the shipping companies MSC and CMA-CGM, 2nd and 3rd container carriers in the world respectively.

In addition to a draft of -18m, allowing the terminal to receive CMA CGM Marco Polo generation ships, the second TC2 container terminal is equipped with 8 Super Post Panamax type gantry cranes (61T lifting capacity) , 21 gantry cranes, 36 trucks, 36 40 'chassis as well as refrigerated container storage cranes. Plus 4 Reach Stacker, 1 Empty Handler, and a mobile crane. The investment in TC2 superstructure and equipment amounted to more than 140 million euros.

TC2 performs on productivity levels of international standard ensuring operations in 24h / 365d. The nominal capacity of the terminal is around 1.3 Mil TEU.

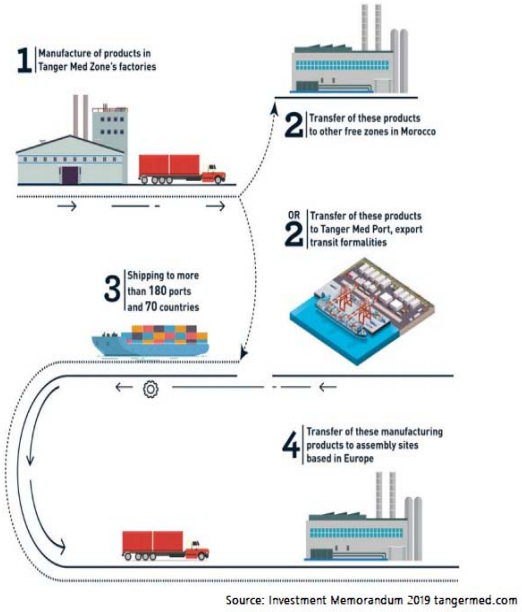

Figure 5: Product manufacturing process in Tanger Med

The manufacture of products goes through a process before distribution:

- Manufacture of products in factories in the Tanger Med area.
- Transfer of these products to other free zones in Morocco.
- Or Transfer of these products to the port of Tanger Med, export transit formalities.
- Delivery to more than 180 ports and 77 countries.
- Transfer of these manufactured products to assembly sites based in Europe.

The logistics free zone managed by MEDHUB is located in the heart of the port of Tanger Med.

It includes a customs post with a site of 200 hectares with a continuous extension of more than 50 hectares, and 3 billion euros of investments for logistics activities, 400,000 square meters of logistics warehouses and a logistics platform for regional distribution in more than 40 trading countries.

There are also warehouses of 400 m² to 20,000 m² and a clear height of 8 meters to 11 meters, dedicated to the logistics of ready-to-use stores and advanced stores.

And also value-added logistics services: selection, warehousing, common packaging, labeling, assembly and quality control. Although this region is based on distribution in other free zones of Morocco.

4.2 Evolution of the containerized fleet: result of the extension and digital transformation of logistics flow planning in container terminals

The Tangier Med port is increasingly playing a major role in trade between the Kingdom and the rest of the world, and is accentuating its role as a maritime hub for the continent. Regarding container traffic, the port reached its maximum capacity:

The uncertainty linked to the amplification of the variation in demand, as the wave propagates in the container terminals of the Tangier med port, has caused stocks at the organizational interfaces and between the terminals and its upstream and / or downstream third parties. The procrastination by stocks had masked the reliability of the equipment and the good involvement of the port authorities in recent years.

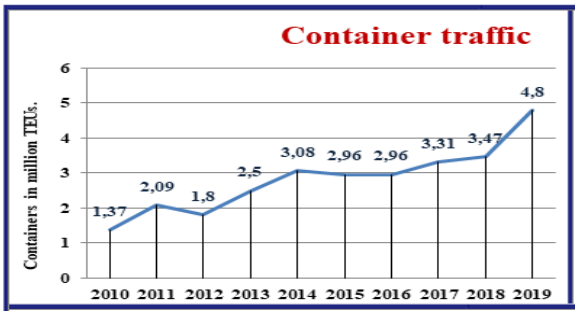

Figure 6: Tangier Med container terminal traffic

Over the years Tanger Med has experienced different levels of controller traffic processing.

Precisely an evolution of 0.72 million TEU was recorded in 2011 (2.09 million TEU) compared to 1.37 million TEU in 2010.

In 2012 Tanger Med recorded a 13% decrease in containers handled (1.8 Million TEU), but the following years noted increases of 2.5 Million TEU in 2013 and 3.08 million TEU in 2014.

In 2015 and 2016 the number of containers was almost stable after a decrease of 0.12 million TEU, 2.96 Million TEU was recorded for the two years, and to estimate a 3.31 million TEU.

A very significant increase is recorded in Tanger Med with a total of more than 5,771,221 TEU * containers were handled within the Tanger Med port complex in 2020, i.e. a significant increase of + 20% compared to 2019.

This traffic now confirms Tanger Med's position as the leading container port in the Mediterranean Zone.

The container terminals of the Tangier Med port must therefore evolve towards a transversal

organization. Its reorganization by flow and process will translate the transition to a dynamic vision of the planning of logistics flows through the control and acceleration of the flow of container passage through these terminals. Therefore, the planning of logistics flows in container terminals plays a decisive role in the evolution of container terminal traffic.

A large enough port requires resources of the same size, it is an investment that the state wanted to make, but it was worth it as well as a very advanced information system. Since its implementation in 2007, the port of Tanger Med has contributed a lot to the regional and national economy.
This port platform has made a decisive contribution to better commercial logistics for import and export, and it has positive effects on the economy. He attracted major investors and encouraged large companies like Renault to set up in northern Morocco to export their cars, as they were looking for an efficient logistics solution aligned with international digital systems.

Increasing competitiveness is often seen as an important factor for all contemporary organizations. In the current scenario, it is essential to meet and exceed quality standards. Thus, the digital transformation responds appropriately to this organizational need, the analysis and rapid processing of logistics data is particularly important to improve the competitiveness of the organization. Through the high-performance data analysis process, organizations are able to identify "best-in-class" performance standards against which they can compare their own organizational performance and then strategies to achieve that standardized level of performance. in their product delivery process.

5. CONCLUSION

Through this research work, we were able to identify the necessary processes and elements, as well as the difficulties of planning flows in container terminals since it is not a question of automating but, on the contrary, of mastering, evaluating , anticipate the decisions and actions to be taken.
The study of flow planning in the container terminals of the Tangier Med port allowed us to analyze the operation of the handling subsystems and the organization of shore operations. These have an impact on Tangier Med's role in global maritime logistics, something that first affects the quality of services to shippers, port operators, ship operators and owners, and other stakeholders, on the other hand the overall performance of handling companies (APM & EUROGATE).

6. FUTURE SCOPE

As part of this study, we were able to conclude that digital transformation plays a crucial role in the planning of flows, especially for the container terminals of the Tanger Med smart port. In this sense, we invite them to continue on this path in order to to conduct studies on the impact of digitalization and digital transformation on the world economy in the era of covid containment 19 and also studies on the close relationship between flow planning and improving trade based on economitric models from an emerging economy such as Morocco. In order to improve our work, we are trying in the future stages to make use of business intelligence and Blockchain.

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