

STRATEGIC DIRECTIONS OF STRENGTHENING SUSTAINABLE FOOD SYSTEMS IN HEALTH CRISIS: CASE STUDY OF TUNISIAN NON-GOVERNMENTAL ORGANIZATIONS

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Abstract

Purpose: The objective is to identify the procedure put in place by Tunisian non-governmental organizations (NGO) to strengthen the sustainable food system in health crisis. Indeed, we will study the impact of the strengthening of the food supply chains on international trade. We will start with a presentation of the cause for which the NGO has strengthened its food system. Next, we will study the repercussions of improving the system on the various plans within the lean department while analyzing the results obtained. In a final part we will give recommendations to further improve the quality of the product provided by the engineers.

Design / Methodology / Approach: The Value Stream Mapping (VSM) approach presented in this case study, which allows a NGO to identify its strengths and weaknesses as well as potential for improvement, is derived from COVID-19 experience with NGO in Tunisia. The improvements are made by the Kaizen approach. All the results are discussed from a theoretical, methodological and practical point of view.

Findings: Lean management is a source of improvement in the performance of any NGO, which improves its processes, rationalizes risks and avoids large losses in the period of COVID-19. In summary, sustainable food system is not only a competitive advantage but a strategic necessity in Tunisia.

Research limitations: The results cannot be generalized beyond the study population and similar context in such health crisis.

Practical implications: The study provides operational guidance on how best to reorganize the NGO in Tunisia. Thanks to the reorganizations carried out, we note that all the indicators evolved positively throughout the COVID-19 period.

Originality / Value: The originally found in this case study heaviness in the implementation of the new processes. This study produces new knowledge based on observations, experiments and new approaches to solve problems related to the health crisis.

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Introduction

Since the beginning of the year 2020, the health crisis has caused indescribable disruption in supply chains management around the world (Choi et al. 2020). WHO (2020) argues that it is not easy to strengthen the sustainable food system in the event of a health crisis. Likewise, the crisis reveals deep interconnections between supply chain management in the event of an unforeseen pandemic. Negative results include, among many others, the difficulty of increasing food production capacity and handling conditions in the period of total containment, the rapid response to COVID-19, food hoarding triggering bullwhip effects, as well as the fragility of supply chains contributing to the global economic chaos it faces in the world (Ivanov and Dolgui, 2020). As a result, Tunisian non-governmental organizations (NGO) are facing several problems related to the health crisis. These crises are causing material disruption to the way that charities raise revenue and carry out their activities (Keating and al, 2017). This poses both challenges and opportunities for partners, funders, charities and regulators.

However, pricing requires the NGO to take into account internal factors related to exorbitant handling costs during the total containment period and external factors such as partner attitudes in this period of COVID-19, existence of hygiene regulations and sound structure of the market in which the Tunisian NGO has operated. Similarly, when setting the selling price, the Tunisian NGO must first take into account internal factors linked to its costs: production costs fall into two categories, fixed costs and variable costs, which depend on quantities produced. The NGO cannot consider selling below what it costs the product. It therefore calculates the unit cost of production to which it adds the unit cost of distribution and handling, allowing it to know the unit cost of production of the product. The Tunisian NGO adds its margin and thus determines its selling price. The margin is used to remunerate lenders and to finance the activity of the NGO (Rahayu and al, 2020).

Production costs are linked to the quantities produced: large-scale production reduces the unit cost of production, which is a major advantage for companies with mass production markets. This shows that Tunisian NGO with limited market segments need to redouble their efforts to secure their activity (Yasin and al, 2020). As a result, and faced with high and low market prices for raw materials and increasing personnel costs during the total containment period during the COVID-19, the Tunisian NGO must seek to optimize its production time given the total containment period in order to reduce costs and eliminate waste, which the partner only pays for added value (Thunsrom and al, 2019). Thus, and based on this lean management approach, we have decided to create a project that addresses the problem of waste in Tunisian NGO, and with the objectives of reducing production costs and improving performance indicators in order to strengthen the sustainability of food system in health crisis.

The Value Stream Mapping (VSM) approach presented in this case study, which allows a NGO to identify its strengths and weaknesses as well as potential for

improvement, is derived from COVID-19 experience with NGO in Tunisia. At the beginning of the activities, the entire characterization process could take up to four months to collect and analyze the data. This was done on all the products of a NGO participating in the project. The number of interviews was limited to 30 engineers because of the length of the process (Julien and al., 2003). As a result, a three-day intervention approach based on the analysis of a targeted product family through Pareto analysis has been developed and now responds to the term value chain mapping. This approach identifies opportunities for improvement from the results of the process mapping and the overall rate of return estimation based on availability, efficiency and quality indicators.

This paper presents the implementation of the Value Stream Mapping (VSM) project in Tunisian NGO. It is structured as follows:

- Determination of the family of products,
- Drawing of the current state,
- Drawing of the future state,
- Action Plan and Implementation.

The originally found in this case study heaviness in the implementation of the new processes. As a result, 30 engineers have decided to identify sources of waste in individual value chains, that is, for a product or a product family.

The VSM project is based on the continuous improvement of responses from the following guiding questions:

- Q1: Do I know what to do?
- Q2: Do I avoid waste?
- Q3: Am I meeting the deadlines?
- Q4: Are we better today than yesterday?

Literature review

The origin of the lean management dates back to the 1950s, when Ohno launched the design of the Toyota Production System (TPS), a Toyota engineer. In the 80s he launched the "International Motor Vehicle Program" (IMVP), the "Massachusetts Institute of Technology" (MIT), leading to a comparative study of school performance based on their modes of organization (Womack, Jones and Roos, 1990). It is during this research that the concept of "lean manufacturing" appears, thus following others based on the same bases, which are just-in-time or Japanese-style management. However, Langstrand and al. (2009) shows that the characteristics of lean are different depending on the engineers who approach and the companies in which it operates. There are a variety of NGO that have experienced the advantages of applying Lean in their manufacturing area. For instance, Lean management was applied by Boeing to eliminate waste and make its products more cost-competitive. After implementing Lean management, Boeing successfully cuts its defect costs by 75 percent, which resulted in a cost savings of about \$655,000 per aircraft (Jones, 2013).

Moreover, after applying lean management in its manufacturing system the inventory level of DELL dropped by 50% and the time required to produce a PC was reduced (Poppendieck and al., 2003).

These companies are major producers of tangible products and the result of their improvements can be measured by comparing the product cost before and after implementation of the lean management. In order to obtain such benefits in the office settings of the manufacturing, Lean principles are now being applied in NGO to improve their performance and to be competitiveness. Indeed, the price differences between competing products can be such that it becomes difficult to compensate them by differences in value added.

Value stream mapping (VSM) has emerged as a method for researchers and practitioners to identify sources of waste in individual value chains while directing actions to eliminate them or at least reduce their scopes. (Hines and Rich., 1997). However, for many companies the main interest of implementing a Lean methodology remains an approach essentially directed towards the improvement of production methods. The theory developed by Goldratt in the early 1990s aims to increase production capacity and establish benchmarks for effects on total production costs. Together, these three approaches turn into cost-saving attempts by eliminating waste in the production system. To be truly effective, the search for a competitive advantage must also be based on a more integrated approach to the Lean method (Hines et al., 2004). Thus, VSM's strategic approach combines the application of production improvement tools, such as Kanban, and quality control, with the need to meet partner needs (Bekkers and al, 2021). Providing more flexibility, but also acting directly on capacity constraints. Studies in the field have also been conducted by researchers, including Serrano et al. (2006) which highlights the properties and benefits of using the VSM approach as a functional technique aimed at redeveloping the production system from a Lean management, through the analysis of the process, is carried out in two stages. The first step identifies the value-added activities for which the partner is willing to pay and the second step represents the unnecessary activities primarily related to inefficiencies in the process such as foreclosures, material handling, machine outages and overproduction.

The breakdown of these activities into a sequence of elementary operations allows the NGO to better evaluate its sources of competitive advantage. (Porter 1998, San Miguel 1996, and Tapping and al. 2002).

The value stream is defined by a NGO's internal processes or activities to design, manufacture, market, deliver and service. The value stream can be studied from the concept until the start of production or the order until receipt.

Value is defined as the service or product delivered to the partner at the right price, at the right time and as defined by the partner. There are two types of values; value added and non-value added.

Value-added refers to any activity that adds value to the product, that is, the activities for which the partner is willing to pay (Thunsrom, 2020).

Non-value added represents unnecessary activities that do not add market or functional value to the product, that is, waste. Thus, the value stream breaks down business activity into a sequence of basic operations and identifies sources of potential competitive advantages. It shows the activities (main and support) required for the proper functioning of a business. It should be noted that support activities should not be removed but they can be reviewed to ensure their optimal and effective integration.

Methodology

The main concepts used by the methodology described later highlight a family of products. According to Julien and al. (2003), a product family is a grouping of products that share similar processes and / or equipment. Indeed, the methodology used is based on the following steps:

- Follow the path of manufacturing a product from the partner to the supplier.
- Visually and accurately, represent each process throughout the flow of material and information.
- Ask the key questions and draw the new value chain

This section briefly presents industrial engineering tools commonly used in the value chain mapping process.

Flowchart

A flow chart presents a series of manipulation made on a product according to a series of standardized symbols. The table below shows the six symbols used to represent an operation, delay, inspection, transportation and storage.

From these symbols, a complete process can be represented either by an assembly diagram or a process diagram. This step is important because it allows to visualize the flow of the product and incidentally the sources of waste in the chain.

Matrix From-To

This matrix is used to evaluate a development taking into account the distance between departments or machines and the intensity of exchange between them. The multiplication of the distance by the intensity makes it possible to obtain a score for the development. This tool highlights transportation issues in a development.

Seven statistical tools of quality

The 7 statistical tools of quality are Pareto analysis, cause-effect diagram, diagrams and graphs, the analysis sheet, the histogram or the sheet diagram, the scatter plot and the control charts. The usefulness of these tools is to make it possible to analyze a problematic situation or process in order to take action to better control or improve it.

The Pareto analysis, commonly used, is very useful because it allows to define the priorities of action. There are several variants of Pareto, in terms of cost, frequency, ... In general, the finding of the analysis is that around 80% of problems are related to 20% of causes.

Costs of quality

For many years, there has been little effort to measure the costs of the quality function. Several organizations began in the 1950s to formally assess quality costs. One of these pioneers, Juran, estimated more than 30% of the cost of quality in business. Quality costs include prevention costs, evaluation costs, internal failure costs and external failure costs.

It is not uncommon for an NGO not to know the true costs of quality. Indeed, during several mappings, the entrepreneurs know at most the percentage of return of partners and sometimes the rejection rate to different operations. It is very common that the cost of rework is not calculated.

Results

The objective of this section is to present the results of this study and establish findings by different NGO in Tunisia.

Determination of the product family

For this case, the study will focus on a family of products that undergo the same treatments.

The ABC method (Pareto, 1896)

It proposes to distinguish three classes A, B and C, which are distributed as follows:

- Class A: elements representing 80% of observed effect.
- Class B: items representing the following 15%.
- Class C: the elements representing the remaining 5%.

In the case of researching the family of products to be studied, the observed effect will be "sales" and the items will be "Products of the enterprise". Once the classification is established, the choice will be made among the products of Class A. If there are too many products in the A-Class, then a second selection may become necessary. To do this, it is advisable to draw up a table as Table 1, summarizing which equipment is used for the different products of class A. This amounts to creating a matrix products / equipments Composed of "0" and "1".

This type of matrix sometimes reveals obviously the product families. This is not the case for Table 1. It will be able to be reorganized thanks to a mathematical tool: the Analysis in Principal Components in order to group the close products in terms of use of equipment.

Table 1: Example of product / equipment matrix for grouping products into families

		Product							
		A	B	C	D	E	F	G	H
Equipment	1	1	0	1	0	0	1	0	1
	2	1	0	0	0	0	1	0	0
	3	0	1	0	0	0	0	0	1
	4	1	0	1	0	0	1	0	0
	5	0	0	0	1	0	0	1	0
	6	0	1	0	0	1	0	0	1
	7	0	0	0	0	1	0	0	1
	8	1	0	1	0	0	1	0	0
	9	0	0	0	1	0	0	1	0
	10	0	1	0	0	0	0	1	0

Principal Component Analysis (PCA)

This method is based on the calculation of the correlation coefficients between the series of values of two variables in order to determine whether they are dependent on each other. To do this, it is necessary to calculate the variance of each series (the value that characterizes the dispersion of a distribution) and the covariance between the two series (a value that characterizes the dispersion of one distribution over another).

The correlation coefficient r is a value between -1 and 1 which reflects the degree of linearity between two sets of data that is to what extent two variables "vary together". The closer the coefficient is to the extreme values -1 and 1, the stronger the correlation between the variables. A correlation equal to 0 means that the variables are linearly independent.

In the context of family product formation, this is tantamount to saying that:

- "r approaches 1", the more products use the same equipment (positive correlation).
- "r is close to 0"; there is no link between products in terms of equipment use.
- "r is close to -1", less equipment useful to one of the products, is the same for the other (negative correlation).

We will therefore only distinguish the coefficients close to 1, which lead to the conclusion that the products belong to the same family, and those not close to 1, which correspond to different family products (Husson & al., 2009).

Application of the PCA for the determination of product families

Using Table 1, it becomes possible to calculate the correlation coefficient between products and place them in Table 2.

A	A11	B	C	D	E	F	G	H
A	1							
B	-0.53452	1						
C	0.801784	-0.42857	1					
D	-0.40825	-0.32733	-0.32733	1				
E	-0.40825	0.218218	-0.32733	-0.25	1			
F	1	-0.53452	0.801784	-0.40825	-0.40825	1		
G	-0.53452	0.047619	-0.42857	0.763763	-0.32733	-0.53452	1	
H	-0.25	0.356348	-0.08909	-0.40825	0.612372	-0.25	-0.53452	1

Table 2: Product Correlation Coefficients

For greater understanding and as an example, here is how the value entered in the turquoise blue box of Table 2, corresponding to the correlation coefficient between Products D and G, was obtained.

First, calculate the variances and covariance for products D and G, the values of which are given in Table 3:

		Product	
		D	G
Equipment	1	0	0
	2	0	0
	3	0	0
	4	0	0
	5	1	1
	6	0	0
	7	0	0
	8	0	0
	9	1	1
	10	0	1
Variance		0.16	0.21
Covariance		0.14	

Table 3: Calculation of variances and covariance for products D and G

The calculation of the correlation coefficient follows:

$$r_{dg} = \frac{S_{dg}}{\sqrt{S_{dd}} \times \sqrt{S_{gg}}} = \frac{0.14}{\sqrt{0.16} \times \sqrt{0.21}} = \mathbf{0.763763}$$

The color code in Table 2 (green, violet, turquoise blue) corresponds to the families identified. After grouping the products of the same color in Table 4 (obtained by changing the order of rows and columns in Table 1), it becomes more evident that they are part of the same family.

Three families of products have been identified with this method:

- Family 1: A, F and C
- Family 2: H, E and B
- Family 3: G and D

This is only a categorization by way of indication, the final choice of the product family to be studied is made by the project team and may be different from the result of the CPA.

		Product							
		A	F	C	H	E	B	G	D
Equipment	2	1	1	0	0	0	0	0	0
	4	1	1	1	0	0	0	0	0
	8	1	1	1	0	0	0	0	0
	1	1	1	1	1	0	0	0	0
	7	0	0	0	1	1	0	0	0
	6	0	0	0	1	1	1	0	0
	3	0	0	0	1	0	1	0	0
	10	0	0	0	0	0	1	1	0
	5	0	0	0	0	0	0	1	1
	9	0	0	0	0	0	0	1	1

Table 4: Reorganization of the product / equipment matrix in Table 1

Drawing of the current state

In order to develop a reworked map of the value chain of a product or a family of products, one must first know the current situation. This part is devoted to the drawing of the VSM card in its current version.

First Phase of Design

The VSM is part of a chain-of-value improvement approach. This implies a clear definition of the value of the product (s), in the eyes of the partner (Kumar & al., 2016).

Second phase of the drawing: Manufacturing Processes

Then, the two icons used in the VSM are the manufacturing processes, also called Case Processes, and Stocks. Process boxes represent operations where the raw material is processed. In order to limit their number on the drawing, the connected steps or the workstations belonging to a single process are represented by a single icon. On the other hand, if an operation is cut off from the next (geographically or temporally) and intermediate stocks accumulate between the two or are moved in batches, then two process boxes are needed. This differentiation also depends on the purpose of the study, if the objective is to understand in detail an operation, then it will be necessary to use a process box for each of its steps. Placed end to end, the process boxes constitute the material flow, which is placed in the lower half of the design of the VSM, from left to right in the direction of the treatment of the materials and not according to the physical layout of the places. Between each process box is a stock icon, below which are entered the number of items found there and their type. There is also one at the beginning of the chain: it schematizes the materials coming directly from the supplier. The NGO presents a flow of linear material, but this is not always the case. Some value chains are made up of several streams that come together later.

Below each process box is a data box that summarizes important information about the process represented. Here are some examples of information that may be listed:

- The cycle time (TC)
- Value added time (VAT)
- The turnaround time (DE)
- The time of change of manufacture
- The number CPC (each piece each [hour, day, week ...])
- The number of different products
- Voluntary working time available (Chapman and al, 2020)
- Usable time
- The rate of scrapping

Third phase of the drawing

After focusing on the partner and then on the manufacturing process, the third step concerns suppliers. The representation of the frequency and mode of delivery is the intermediary between the supplier (s) and the first step of the process, as well as between the last step and the partner(s). A wide arrow indicates a delivery between two factories, and a truck (or an aircraft, a boat ...) which mode of delivery is used.

Fourth Drawing Phase: Information Flows

At this stage of construction of the VSM card, only material flows have been drawn. The fourth phase aims to represent information flows. To do this, we need to introduce new icons essential to the understanding of the drawing: a straight line represents a flow of physical information (on paper in general), while the lightning corresponds to an electronic information flow. A frame placed in the middle of an information flow is used to describe this flow (giving an exchange frequency for example). There is another type of connection that it is important to characterize: the movement of materials between the manufacturing processes. Two configurations are possible to organize production: either the products are pushed by the supplier process or they are driven by the partner process. The pulsed flow system is based on forecast downstream process requirements. By definition, these forecasts do not correspond to reality and therefore the production of each process is never perfectly in line with those of others. Each behaves like an "isolated islet" which tries to manage its timing and its production rate individually. In this type of organization, intermediate stocks appear. They allow the upstream process to continue functioning even if its products have not yet been used by the downstream process. That's why this system is called pushed flow: each process produces at its own pace and when it is finished, it pushes the parts to the next process. The flow-based organization is quite different: it is the downstream process that asks the upstream process to produce. The quantity of voluntary work in progress is thus reduced, and the reactivity of the macro-production process increased (Chapman and al, 2020).

Timeline

The diagram obtained is divided into two parts: the upper part is devoted to the information flow, while the lower part contains the data relating to the flow of materials. This is a representation of the operations of the manufacturing process more visual and easy to understand than the plant layout of the plant. There is, however, one final step in the

mapping of the value chain: the representation of the time line. This line is drawn under the production process boxes and the stock icons (lower part of the drawing) and is intended to calculate the Lead Time. Below each case processes are copied the corresponding turnaround times. For stock icons, the times used are those passed by each of the items in these stocks. Delays are expressed in days and are calculated by dividing the quantity of parts stored by the number of products required daily by the end partner. The addition of turnaround times and storage times gives a fairly accurate estimate of the Lead Time (in most cases, the time spent by a part in the manufacturing process is negligible compared to the storage period). The sum of the processing times for the manufacturing process corresponds to the processing time applied to each of the parts. Under such conditions, the processing time corresponds to the green time (value added time), while the red time (non-value added time) is equal to the difference between the Lead Time and the processing time. For strings composed of multiple parallel streams, the longest path will be used to determine the global time (Lead Time and processing time).

VSM

The mapping of the current state is now complete. This exercise has aroused a number of questions and observations concerning the areas of overproduction. The work carried out until now will have been in vain if the map of the current state is not analyzed and reworked, in order to construct the drawing of the future state.

The third part of the VSM approach is a transition stage: its purpose is to analyze the current state in order to reflect on the future state. To do this, a new mode of operation of the production of products called production at the right (Benson, & al., 2016).

The NGO works with 2 teams that each work 8 hours a day (with 30 minutes of break). The partner request is 600 rings per day. The Takt Time of the production activity is 90 seconds. This is tantamount to saying that if the NGO wants to respond to partner demand, hardware must exit its production line every 90 seconds.

This implies that the cycle times of each manufacturing process correspond to the Takt Time, or at least do not exceed it. This adaptation of production requires:

- an effective response to problems leading to systematic delays.
- the elimination of causes of unexpected stoppages.
- redefining the manufacturing steps.

In the drawing of the future state, if a continuous flow is established between two processes, then their execution times will accumulate and the two process boxes will merge to form only one. But be careful, in accordance with Foundation # 1, the overall cycle time must be less than the Takt Time (Shepherd and al, 2019). The entire value chain must not necessarily be in continuous flow. When situations such as those described above arise, there are two alternatives: flow drawn with storage depots or the FIFO corridor (Bernier and al., 2007). By definition, if a continuous flow is unthinkable, this implies that two discontinuous streams are kept at some point in the value chain. The link between these two processes can be managed through storage depots. In order to avoid recreating a situation of overproduction and product accumulation in stocks, it is

preferable to control the process downstream rather than attempting to schedule production with estimates of partner needs.

The introduction of a Kanban system is then necessary. Kanban is a flow management mode created by Toyota that is based on labels (Mitchell, & al., 2014). The principle is very simple: Process removes what it needs from the storage repository at the time it needs it, and then the procurement process starts production of items that have just been removed from the repository to replace them. The labels are the vector of information ensuring the organization of the production. They are placed on each of the elements that have just been produced. When the partner takes one of these items from the warehouse it removes the label from it and stores it in a summary table. The supplier regularly consults this table and knows what has been consumed and what he must produce again, the labels then become production orders. Geographically, the storage depot is preferentially located next to the procurement process. This situation accentuates the view that the downstream process is a partner who comes to withdraw its products from the depot, and in doing so, triggers production at the supplier. Continuous flow and pulled flow are perfectly complementary in production management. By interposing the two it becomes possible to control the flow through the Kanban labels and to limit the storage areas and the number of work in progress. The manufacturing process thus gains in reactivity and speed, and programming based on estimates becomes unnecessary. The FIFO corridor (First In, First Out). The drawn stream is a good alternative to continuous flow when it is impossible, but it cannot be applied effectively in all cases. For example, it is difficult to have a storage depot that contains all the elements of the procurement process when the number of versions is large, or where the size of the parts is large. The same applies if the parts are made to measure (therefore unique), costly or have a limited shelf life. The FIFO corridor is a solution adapted to the scenarios described above. It is established between two discontinuous processes to make the connection. Its principle is simple: when a part leaves the upstream process, it enters the FIFO corridor and places itself at the top of the line. If the maximum capacity of the FIFO corridor is 1, then production is described as One Piece Flow operation. This is a good alternative when continuous flow is impossible because there is only one part between two discontinuous manufacturing processes: when the product leaves the upstream process it is transported to the downstream process which, as soon as it is available, will treat it. There is an unavoidable rule in the designation of the programming point represented by the regulating process: there can be no storage and / or flow zone drawn downstream of the regulating process. This is why the choice is often based on the process just after the last stock in the value chain. Case A applies to a production entirely based on drawn streams, the last manufacturing process therefore constitutes the programming point. For Case B, the regulatory process is mostly in the upstream part of the value chain, as is often the case for custom manufacturing. The more upstream the regulating process is, the more the reactivity of the production chain decreases. This is the main disadvantage with the use of FIFO corridors. It is up to the program to schedule the production, that is to say to fix a rhythm of manufacture, rather than to issue a list of batches to be produced during the day or in the week without worrying when it will be done. This action is all the easier because the regulating process constitutes the only trigger zone for production. The

manufacturing launch pace chosen is the unit of time in which the chain will operate, it is called no production. A production order will be issued at each production step. For example, it can be defined as the cycle time of the regulating process, or the time required to produce a packaging unit with which the partner wishes to be delivered (unit, carton, pallet, etc.). This smoothing of volumes helps to avoid passing on the vagaries of demand on production. The pace of work is preserved, the efficiency of the chain is increased and the workflow is predictable. Smoothing of the type of products requested. It is more convenient to produce many parts of the same type as a result, then reconfigure the hardware and start a new series of parts different from the previous ones. However, this encourages the creation of stocks which, because of the whiplash effect, are all the more important when the storage area is located upstream in the production line. Lean Manufacturing thinks rather to produce regularly and in small quantities each type of products. This reduction in batch sizes reduces inventory and gives the NGO greater flexibility and responsiveness. The major disadvantage of this type of organization is an increase in the number of changes of manufacture, but it can become negligible if efforts are made to reduce the time required to reconfigure equipment. In our case, the daily partner demand is 30 pieces and it takes 30 minutes to produce one, then the production time will be 15 hours per day. Let's say that the opening time is 16 hours a day, this leaves 1 hour of "free". If the unit time for a manufacturing change is 20 minutes, then it will be possible to make 3 changes per day, thus producing 3 batches of different parts. The fourth and last part is devoted to the redesign of the VSM card. This phase of representing the future state of the value chain enters the Improve stage of the DMAIC process (Zhen He, & al., 2014). The objective of Lean Manufacturing is to identify and eliminate sources of non-value added. Some waste is linked to the technology used, the plant layout in the plant, or the design of the products. These themes are not explored in the drawing of the future state, but they can be studied further by other methods than the VSM.

Study limitations

In the context of health crisis, considering that one of the phases consists of a systematic procedure, carried out through lean management, the sources are limited to the consultation bases selected by the researcher, which may interfere in the quality of data and case studied during the main phases. It is also worth noting the difficulty in generalizing the empirical findings, since COVID-19 period had as a source of data the development of a 30 engineers' behaviors. Even if composed of specialists in the area under discussion, the findings may not represent common sense.

Conclusion

The study provides operational guidance on how best to reorganize the NGO in Tunisia. Thanks to the reorganizations carried out, we note that all the indicators evolved positively throughout the COVID-19 period.

Lead Time increased from 65.3 days to 12.2 days. The difference between the two comes from stocks that have been reduced or eliminated. The ratio of processing time on Lead Time was 1.5%, it was multiplied by more than five and is now 8.2%.

It is important to note that the processing time (green time) has not been modified, the reshuffle that has been carried out has only concerned the stocks, that is to say the wastes (red time).

Further improvements can be made to this new functioning. For example, stocks of raw materials could be managed by Kanbans, and thus be reduced again. A study could also be carried out on the 40% of the production time used for other products, in order to determine whether a continuous flow can be established between these two processes.

The strengthening of its sustainable food system positively affects the performance of the NGO and therefore hung the price of "the best Tunisian NGO" in the field of international trade for two years.

It was likely that the NGO's partners were afraid of this health crisis, but all the engineers: lean department and other departments did everything they could to allay the concern of their partners.

The food security policy represents a label of sector development in Tunisia which separates the NGO from its competitors, and which is exploited by the NGO's partners with their foreign associates. Consequently, the volume of transactions processed has increased.

In conclusion, lean management is a source of improvement in the performance of any NGO, which improves its processes, rationalizes risks and avoids large losses in the period of COVID-19. In summary, sustainable food system is not only a competitive advantage but a strategic necessity in Tunisia.

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