The workers' perspective: emotional consequences during a lean manufacturing change based on VSM analysis

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Abstract

Purpose – The purpose of this study is to identify the perception of workers before, during and after the implementation of changes derived from the lean manufacturing (LM) technique called value stream mapping (VSM) analysis and the causes that lead to this perception.

Design/methodology/approach – A qualitative methodological research design was adopted, using individual transcribed and coded interviews as the primary method of data collection.

Findings – At the beginning of the VSM changes, this study found strong denial and resistance emotional responses from workers due to the uncertainty and stress generated. The main cause of this resistance was their lack of understanding of the VSM analysis process presenting technical concepts, due to their educational level and the lack of a pre-existing organisational culture oriented toward continuous improvement. However, in the last stage of change, it is found that the workers accepted the new improvement proposals without resignation, improving their productivity and work performance because they saw and understood the improvements as effective.

Practical implications – This study will enable those responsible for organisations to anticipate the negative reactions that may arise from the organisational changes stemming from the implementation of VSM improvements. In addition, it adds new knowledge bases to the literature on the emotional consequences for employees during LM changes through VSM.

Originality/value – This study provides a qualitative analysis of the perceived emotional impact on workers that participated in LM techniques, in this case, focused on VSM analysis. It is an exploratory study that serves as a foundation for future research in the quantitative field.

Keywords Lean manufacturing, VSM, Workers' perspective, Qualitative research

Paper type Case study

1. Introduction

In recent decades, lean manufacturing (LM) has become a necessary tool for improving production processes and, since its first appearance in what is known as the "Toyota miracle" (Womack and Jones, 1997), it has been implemented in all kinds of companies. The main goal of LM is to improve the performance of production processes and create value by eliminating waste from this process and its continuous improvement (Dal Pont *et al.*, 2008). Due to this waste management benefit, it has piqued the attention of researchers since the mid-1980s, in both academic and industrial settings (Zhang *et al.*, 2017). The literature on LM shows a multitude of techniques for achieving these goals of efficiency in processes. The following are the ones used most: (1) Value Stream Mapping (VSM), (2) Kaizen, (3) Kanban, (4) Single-Minute Exchange of Dies (SMED)/One-Touch Exchange of Dies (OTED) or (5) Push and Pull system. Although it is true that the literature shows examples that these types of techniques

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improve the performance of companies and their production costs (Mouzani and Bouami, 2019), they may not be appropriate for all companies due to different contextual and environmental factors, such as company size and culture (Wiengarten *et al.*, 2015).

This lack of adaptation of LM techniques in practice may also be due to the conflicts that arise in their application with the company's workers. In this sense, in the literature, we find a multitude of papers encouraging future research to be combined with professionals in the workplace to implement improvement processes such as LM techniques in order to analyse their effect on workers (e.g. Chowdary and George, 2012; Hasle, 2014; Marcon *et al.*, 2021). This recommendation is due to the gap of evidence in this area, as LM papers generally focus on technical improvements in production and do not address workers' perceptions of them.

Thus, based on these recommendations, we define our two research aims: (1) to determine the emotional perceptions of workers during implemented LM changes and (2) to identify the causes that lead to these perceptions in workers. To do so, we attended an LM improvement process through the VSM analysis tool at a manufacturing line in a company located in Spain. During the improvement process, we conducted interviews with the workers involved before, during and after the changes. We used the semi-structured interview method and later we transcribed each of the interviews conducted. Furthermore, we conducted a process of coding the interviews using Atlas.ti software, which gave us the co-occurrences between codes, thus obtaining the relationships with the greatest significance from our interviews. This enabled us to conduct an analysis and discussion of the results to identify the main consequences that the VSM process had on workers.

Through the analysis of co-occurrences, our results will serve as a foundation for future research into this context.

1.1 About the company

The company where the case study was conducted is in the province of Barcelona, Spain. Due to the confidentiality of the data shown here, the name of the company will remain anonymous, and we will refer to it as *COMP*.

COMP has been in the sector for over 40 years and is dedicated to the manufacture of equipment for domestic and industrial use. The company has a total of 136 workers. The production team is made up of a total of 20 workers. Its manufacturing process is 100% domestic, and one of its main unique characteristics is that assembly is exclusively manual. There are only two automatic machines that verify possible leaks in the manufactured equipment. COMP has detected that on one of the busiest production lines, the one producing the product called MOS, production times are very long and customer orders are not met on time. Aiming to avoid possible commercial consequences with the MOS product, a process of continuous improvement began in June 2018 that consisted of three steps:

(1) Analysis of the MOS manufacturing process using VSM.

(2) Implementation of improvements in the process after analysing the initial VSM.

(3) Conducting final VSM considering the improvements made to the process.

In each phase, the research team for this study, external to the company, conducted interviews with the workers involved to learn how they experienced the changes. It should be noted that COMP had been introducing the LEAN philosophy in the company for a year prior to the project described in this research, through various training sessions for its staff, but no implementation had been conducted until then. Therefore, the proposed improvement of the MOS line was the first LEAN implementation in the company.

2. Literature review

2.1 Lean manufacturing and VSM: from the workers' perspective

LM is basically used to eliminate waste while putting minimal effort into maximising customer value. Hence, there are three types of waste: (1) Muda, things that are not adding any kind of value; (2) Mura, any operational unevenness; and (3) Muri, conditions that are overburdened and irrational. Hence, employees who are not adding any kind of value to the organisation are considered Muda (Suárez-Barraza and Ramis-Pujol, 2010). The successful transformation, as well as the implementation of lean practices, depends upon the employees of a firm, as they play a crucial role. It is also important for employees to understand the basic culture of LM, and team leaders and managers are the ones who play a crucial role in this perspective (Tortorella *et al.*, 2018).

Within LM, a tool to discriminate value-giving aspects in the process is VSM, which helps understand the flow of raw materials and their statistics along the value chain (Lacerda *et al.*, 2016). VSM analysis is a simple but powerful technique and enables the user to see the waste of resources throughout the process flow (Lovelle, 2001). To conduct it, a process map must be represented with the current stage and the future stage of production. It is a simplified visual blueprint that identifies value and waste throughout the system and encourages a systematic approach to eliminating waste. After identifying these wastes and possibilities for improvement, a mapping of a potential future stage is conducted to verify the advantages over the current situation. For successful and effective implementation of VSM in any organisation, workers must be committed and involved (Andreadis *et al.*, 2017). Furthermore, if the workers play an active role in VSM implementation processes, they tend to be more committed as well as more involved in their workplace (Lacerda *et al.*, 2016).

Unfortunately, one of the possible barriers in the implementation of LM techniques is the resistance of employees to adopting new methods and leaving the old ones behind, due to the fact that their competence is in those methods, and because their leaders do not support them or do not provide them with sufficient training (Sim and Rogers, 2009). Bearing this in mind, studies on LM are often restricted to a static perspective that does not take into account the different stages of LM adoption and tend to exclude human resource management practices from research (Chanegrih and Creusier, 2016). As several recent studies show, human resource management in LM processes can significantly moderate its effect on the health of workers (Bertrand and Stimec, 2011). Therefore, knowing how the implementation of LM techniques affects workers remains a critical issue (Longoni *et al.*, 2013).

LM has been positively related to workers (Hasle, 2014), but this relationship has always been addressed at the end of the implementation of the changes. That is why it is necessary to conduct longitudinal research that addresses the effect of LM techniques on workers from their inception to their completion. Because, as the literature shows, changes generally tend to be initially perceived negatively by workers and a series of consequences for the organisation must be considered at the beginning of their implementation (Kiefer, 2005). Therefore, although the literature on LM and VSM shows the importance of considering the human factor as part of the success of the change process, the reality is that there are no studies that focus solely on this perspective, since traditionally they have only been approached from the technical aspect of the process itself (Liker and Hoseus, 2010). Thus, the literature shows that studies are required that enhance the lean practices known as soft practices – i.e. training, educating and promoting human resources – rather than continuing to promote hard lean practices such as methods, systems and procedures used to minimise waste in the production area that have been widely studied (Hernandez-Matias *et al.*, 2019), especially considering that 80% of the effort needed to implement LM is related to changing workers' practices and behaviours (Mann, 2009).

2.2 A negative perspective of change: six emotional stages and organisational justice

As mentioned above, LM improvements revolve around changes implemented in the processes for the improvement of the organisation. However, the literature shows how these changes sometimes generate uncertainty and concern amongst workers (Rubiano *et al.*, 2013). This is due to the negative perception that changes generate in individuals, causing them to transition through different stages: Denial/Anger, Bargaining, Depression, Revising, Deserting and Acceptance (Castillo *et al.*, 2018).

The first emotional stage of change is Denial/Anger, and it is the most personal stress and uncertainty. This causes workers to think that nothing makes sense and to be reluctant to any change. They prefer to remain as they are, even if it is not the most efficient situation rather than face a change. Secondly, we find the emotional stage of Bargaining, where workers try to get out of the initial negative thoughts towards the change and look for positive elements. They try to convince each other that everything will be fine and that they will be able to find a fit in the new situation after the change. The third stage is Depression, when workers have lost all hope of being able to adapt to changes. They feel empty, without motivation or satisfaction from the work they do. In this stage, they tend to isolate themselves and not interact with their peers. The fourth stage is the Revising stage, when workers constantly ask themselves whether to leave the organisation. They wonder what is holding them back and if it is worth putting up with it all. The fifth stage, from which there is no return to any of the previous ones, is Desertion. The worker leaves the organisation because they are not able to accept the changes. And the last stage, Acceptance, which is also one of no return, is the stage when the worker accepts the changes honestly and without resignation. At this stage, there is neither anger nor resentment.

The six emotional stages of change originate, in part, in the perception of organisational justice that workers have towards the change process they are experiencing (Castillo *et al.*, 2018). In this regard, procedural and informational justice are particularly important. The literature considers procedural justice as the equity that the individual perceives in the processes conducted by the organisation (Tyler and Lind, 2002). That is, in any process of change, individuals will evaluate the degree of objectivity in the actions taken and the decisions made (Tyler and Lind, 2002). Regarding informational justice, it refers to the perception that individuals have about the information that the organisation has provided them about the change processes that are conducted (Colquitt *et al.*, 2001). All these perceptions have consequences on workers that translate into resistance as a strategy for dealing with change and can be a problem when it comes to implementing them (Imberman, 2009).

2.3 Resistance and coping strategies of change

Studying workers' perception of change provides change leaders and researchers with tools to predict their possible reactions (Fugate *et al.*, 2008). These reactions are considered coping strategies that generate counterproductive behaviours in the workplace (Bowling and Eschleman, 2010). In relation to this resistance and coping strategies, Skinner *et al.* (2003) presented three adaptive coping processes for dealing with stressful situations that are then broken down into 12 classes of higher-order strategies. The first process of adaptation includes coping strategies that aim to lead the individual to harmony with change: troubleshooting, searching for information, impotence and escape. The second process of adaptation includes strategies where the individual uses social resources to cope with change: self-sufficiency, support of the search, delegation and isolation. The last adaptation process involves strategies where efforts are focused on coordinating desires or preferences toward change: accommodation, bargaining, presentation and opposition.

Thus, considering all the above, it is important to consider the possible reactions workers may have to change, as their reactions can lead the change to fail (Stouten *et al.*, 2018). That is why our research plays an important role in the extension of theory in the literature and in practical implications, as it addresses, for the first time, an LM study, specifically through VSM, focused solely on the workers' perspective, leaving the technical aspects of the improvement in the background.

3. Methodology

3.1 Approach and research design

For our research design, we relied on case studies as a theory generator (Ketokivi and Choi, 2014); that is, through the analysis of case studies, it is possible to derive a theory not identified in the literature. In our case study, the specific analysis of the implications of LM improvements through VSM represented a novelty in the literature and it became the foundation for forming theoretical knowledge in the future with the contributions of other related case studies. So, to achieve our research goals, we chose qualitative research, as the literature shows that when there is not enough evidence in a field of study, a prior exploratory analysis is required through inductive data (Silverman, 2016). In the design of our study methodology, the research team remained outside the case study and did not actively participate in it. The researchers only witness the events and collect empirical data for subsequent analysis (Ketokivi and Choi, 2014) about the case study as a theory generator.

3.2 Method of data collection

To conduct the interviews, we use the semi-structured interview format as, although a previously defined script is used, it is not necessary to follow the defined sequence to formulate the questions, and new questions can be added depending on the interviewee (Rubin and Rubin, 2011). To develop the script, we followed the findings of the literature in this context and especially focused on Castillo *et al.* (2018), who analysed how organisational changes affect workers. The interview script used is available in Appendix.

We did not stipulate any time limit for the interviews, and they were conducted in a private room within the company itself. The interviews were conducted by the researchers (individuals external to the company) so that there was no hierarchical intimidation when answering the questions. All interviews, which enabled us to gain first-hand knowledge of the reality of the interviewees (Kvale, 2011), were recorded with the workers' consent in order to facilitate their subsequent transcription and analysis.

3.3 Sample research

The sample selected for the study was all manufacturing workers: a total of 20 workers. The reason is that, although not everyone works at the same time on the line, they are multi-purpose positions and the changes that are made will affect everyone due to their weekly rotation. The sample used was sufficient for the study context considering the criteria established by Marshall *et al.* (2013), which indicates that for qualitative case-based research, the valid sample size should be between 15 and 30 interviews. On the other hand, other references such as Saunders *et al.* (2018) suggest that the sample size is sufficient when data saturation is reached. In our case, saturation was reached at 15 interviews, by which time 100% of the codes used in this research had been created. Table 1 shows the sociodemographic characteristics of our sample.

3.4 Data management

Finally, a total of 3,300 min of recording were obtained for the three time periods: before, during and after the changes derived from VSM analysis, resulting in an average of 165 min

Sample	$n = 20$
Gender	
Female	55%
Male	45%
Age	
18 to 35	25%
36 to 54	65%
55 to 65	10%
Education level	
Elementary school	100%
Work experience at company	
1–3 years	5%
4–5 years	20%
Over 10 years	75%

Table 1. Sociodemographic characteristics

per interviewee. Once all the interviews had been compiled, they were transcribed using Transcriber software and a double review process was conducted to ensure their quality and suitability compared to the recordings. The transcriptions were then encoded using Atlas.ti software, following the contributions and recommendations in the literature (Linneberg and Korsgaard, 2019). To code the aspects related to the emotions and perceptions of workers when faced with organisational changes derived from VSM analysis, we relied on the literature. As a result of this coding, we obtained a total of 38 codes. After double-checking, the codes were reduced to a total of 33 (see Table 2). It is important to bear in mind that the codes used in our research are the result of the analysis of the interviews conducted. Thus, they were not conceived before, but during the reading of the interviews, so that in no case was the analysis conducted with a preconceived vision of the results.

3.5 Method for data analysis

To obtain the results through coding, we used the co-occurrence analysis tool within the Atlas.ti software. This specific software for qualitative research calculates the value of co-occurrence by means of which the relationships between the concepts and the repetitiveness of the codes used are found (Friese, 2019). To this end, the software uses the C-coefficient, which varies between 0 and 1 using the following formula:

$$C = \frac{nij}{(ni + nj) - nij} \tag{1}$$

Codes related to the event time frame	Before, during and after
Codes related to the consequences of change	Denial/anger, depression, revising, acceptance, bargaining, resistance, commitment, conviction, disappointment, hope, stress, frustration, uncertainty, insurrection, fear, collaboration, rejection, resignation, happiness, tiredness and decrease
Codes related to organizational justice	Informational and procedural
Codes related to job performance	Motivation, performance, satisfaction, productivity and concentration
Cause-related codes	Difficulty understanding, disbelief, complexity, goodwill, future vision

Table 2. The final Code Book for our research

Equation (1) shows the co-occurrence between any pair of codes (*ni*, *nj*) and the co-occurrence for the combined pair of codes (*nij*) provides the coefficient *C* (Garcia, 2005). This coefficient is like a statistical correlation coefficient, without obtaining in this case a *p*-value. Therefore, the closer the value of *C* is to 1, the stronger the relationship between the two codes analysed (Friese, 2019).

To do this, we used the following criteria to classify the relationships between codes, taking into account the value of the coefficient *C*: (1) less than 0.10, we considered the relationship between codes was weak; (2) between 0.11 and 0.25, we considered the relationship between codes was moderate; (3) between 0.26 and 0.49, we considered the relationship between codes was strong; and (4) between 0.50 and 1, we considered the relationship between codes was very strong. As shown in Section 6, we presented a series of propositions that were formulated only considering those relationships between codes that were above 0.50 and, therefore, demonstrated a strong relationship between codes.

4. Improvement of a production process through VSM analysis: a case study

Before presenting the results of the qualitative research conducted to meet our research objectives, we present the case study of the improvement process through the VSM. In this section, we specify the aspects related to the process to be improved, how the changes affected the daily tasks of the workers as well as the role that each one carried out in the production line. Due to the weekly rotation of manufacturing workers, all workers were directly affected by the changes.

4.1 Description of the process to improve

The manufacturing line that COMP wanted to improve was the one that makes its product called MOS. Before making any improvements, the line was divided into three stations. The first station is pre-assembly and it is assigned to a worker who oversees conducting the first part of the MOS manufacturing. Specifically, in this initial pre-assembly, the final product is left at 25% completion. The second process is assembly and it has another worker assigned to it. In this process, the most important part of the assembly is completed in which the rest of the components are assembled. In this assembly, the product is finished and saved for the final check to detect possible leaks (leak check). The product is 90% complete. The last process is a leak check and it is carried out using an automated leak detection machine. The worker assigned to control this station is the same one that performs the assembly in the previous station. In this same line of verification, once everything has been verified to be correct, the product is packaged and palletised for the warehouse. It should be noted that the line workers rotate weekly, so all manufacturing workers go through each one.

Figure 1 shows the first VSM conducted in the manufacturing process of the MOS product, and it should be noted that an analysis was conducted on how many times a leak appeared in the product in the third station and, therefore, the estimated rework had to be carried out in about 12 min more. The result was that it was estimated that 20% of the time, the product had to be processed due to leakage, which increased the time at station three.

Through the VSM analysis, COMP observed a considerable difference in cycle time, which was highly dependent on the rework that must be performed in the event of a product leak detected during station three verification. The total standard cycle time of the process (Station 1, 2 and 3) without rework at station three was a total of 44 min. Whereas if rework must be performed in Station 3, the total cycle time of the process increased to 56 min. As mentioned above, rework at Station 3 was performed 20% of the time, which represents a final average increase of the standard process of 2.4 min. Thus, the average total cycle time is considered to be 46.4 min (44 min from the standard cycle plus 2.4 min for reprocessing).

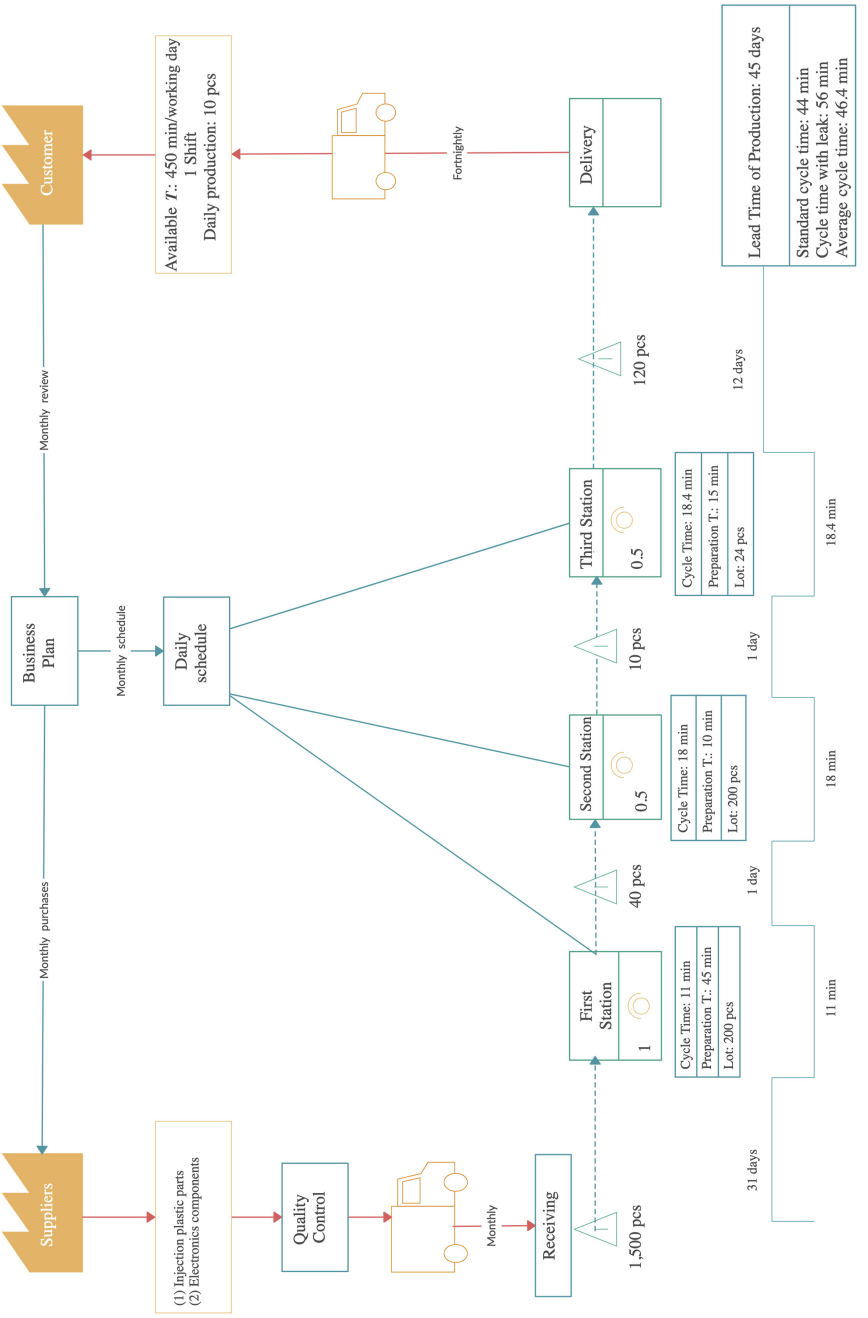


Figure 1.
First VSM carried out in the manufacturing process of the MOS product

COMP also noted that part of the leak detection process at Station 3 is performed automatically, with the worker monitoring the process for 5 min. During this time, the worker was unproductive because they were not performing any task other than being in front of the machine observing the process. In addition, they observed that a bottleneck occurred at Station 2 because the assigned worker's time was shared with Station 3. This caused the worker at Station 1 to accumulate pre-assembled material on their line until the workers at Station 2 completed the final packaging of the product. From the 99th minute of work, up to three pre-assembled products can accumulate at the end of Station 1. This causes Station 1 to request more material for the assembly of its equipment, even though the assembly on the other two lines has not yet been completed. Thus, the total production time was 45 days with a total processing time of 46.4 min. Although with the knowledge of data on the process cycle time it may seem irrational to have only one worker for two Stations (2 and 3), we must consider that COMP had never performed a LEAN study, so all this was not taken into account to this date.

Considering all the information presented above, COMP set the following objectives for the improvement of the process detailed in Figure 1:

(1) The new process must plan purchases of raw materials further in advance.

(2) The new process should reduce the cycle time of manufacturing the MOS product.

(3) The new process should ensure the reduction of delivery times for the MOS product to customers.

4.2 Continuous improvement process

COMP gave the manufacturing department the responsibility of coordinating the process improvement of the MOS product manufacturing line. Thus, internally, this department created a working group that was divided as follows: the factory manager as responsible for the project, an industrial engineer in the organisation as responsible for collecting data onsite on the manufacturing lines and a line manager to monitor how improvements were implemented in the factory, as well as to act as a point of contact in individual meetings with workers. These three people made up the team known internally as LEANMOS, but the rest of the manufacturing workers also participated in the process through the collective and group meetings that were organised.

To take into consideration the workers' views on the changes to be implemented, the line manager met with each of them, individually and collectively, to explain the improvement proposals and gather their opinions. The collective meetings were also attended by the factory manager and the organisational engineer to learn first-hand the workers' opinions about the changes. After these meetings, the LEANMOS team met to gather all the opinions and try to implement them in the improvement process. Periodically, they explained to the employees how their proposals had been implemented and, in case of non-implementation, the reasons were explained: economic, personnel, process or organisational reasons. In the collective meetings, the LEANMOS team always showed all workers the progress of the VSM analysis by displaying the resulting graphical representation on a monitor. The graphical representation also included technical information about the process such as takt time, lead time, cycle time, among others. Based on this graphical representation, workers proposed improvements or gave their opinion. After these meetings, the researchers interviewed the workers to collect all the information without the presence of a supervisor. Researchers only conducted individual interviews, not group interviews, for data collection.

In addition, to facilitate the process to follow for continuous improvement, LEANMOS based themselves on the recommendations of Rother and Shook (2003): (1) know the takt time of the manufacturing line, (2) rethink the supply chain and the customer dispatch chain,

(3) rethink the current pull model for that push, (4) identify the weaknesses of the current process in which the continuous flow of material is difficult, (5) implement a Kanban system, (6) rethink whether it is necessary to continue with batch manufacturing, (7) rethinking flow movements in the future process and (8) clearly identify current weaknesses and how they should be addressed in the future process.

4.3 Results on the production line after improvement through VSM

Regarding the supply of goods, the main weakness was in the delivery times by suppliers due to the order release system by COMP. After implementing a Kanban card system and a new annual purchase forecast, suppliers had more information to anticipate the shipment of raw materials. On the other hand, changes were made to the personnel involved in Stations 2 and 3, incorporating an additional person on the line so that there would always be a fixed person at each station, an improvement that, together with the change in the verification process of the pre-assembled product, remedied the weaknesses in the flow of materials. Figure 2 shows the new VSM of the process proposed by the LEANMOS team after implementing the entire improvement process and considering all workers' views and input. As in the original process, leak detections occur 20% of the time. Therefore, considering the standard cycle time of the new process, which is 44 min, and the management time when there is a leak, which is 46 min, the average cycle time considered is 44.4 min. Thus, based on the above information, the changes made to the MOS product manufacturing line have resulted in a reduction in delivery and shipment times to the customer:

(1) Raw material shipments from suppliers have gone from monthly (31 days after order shipment) to biweekly orders.

(2) Average MOS production cycle time has gone from 46.4 min to 44.4 min (down 2 min).

(3) Daily MOS production has increased from 10 units to 40 units.

(4) With the new process, the target of shipping 120 units per week, divided into two deliveries of 60 each, is met.

4.4 Major changes in workers' tasks after the VSM upgrade

After implementing the changes following the VSM analysis, the main modifications that the MOS line personnel workstations underwent were:

(1) One of the biggest time increases at Station 3 was due to rework when the verification machine detected a leak. As mentioned above, leaks can only occur on pre-assembled components (Station 1), so to avoid this rework, it was decided to incorporate the leak detection test at Station 1. The leak detection test is much faster if performed only on pre-assembled equipment than on all assembled equipment. In addition, in the event of a leak, the process to replace defective parts takes less than a minute, since no rework has to be performed on a fully assembled product. Thus, the Station 3 worker alternates between Station 1 and Station 3 leak checks. Therefore, personnel who were used to checking only for leaks at Station 3 now must combine their tasks between Stations 1 and 3. This also eliminates unproductive time in front of the leakage machine and, therefore, keeps workers from halting their work rhythm.

(2) Adding an additional worker to the MOS line so that there was always a worker at Stations 2 and 3 eliminates the bottleneck and allows for better material flow between Stations 1 and 2. This means that the Station 1 worker does not accumulate pre-assembled equipment and, therefore, cannot afford to slow down as the other two stations will require their work to continue.

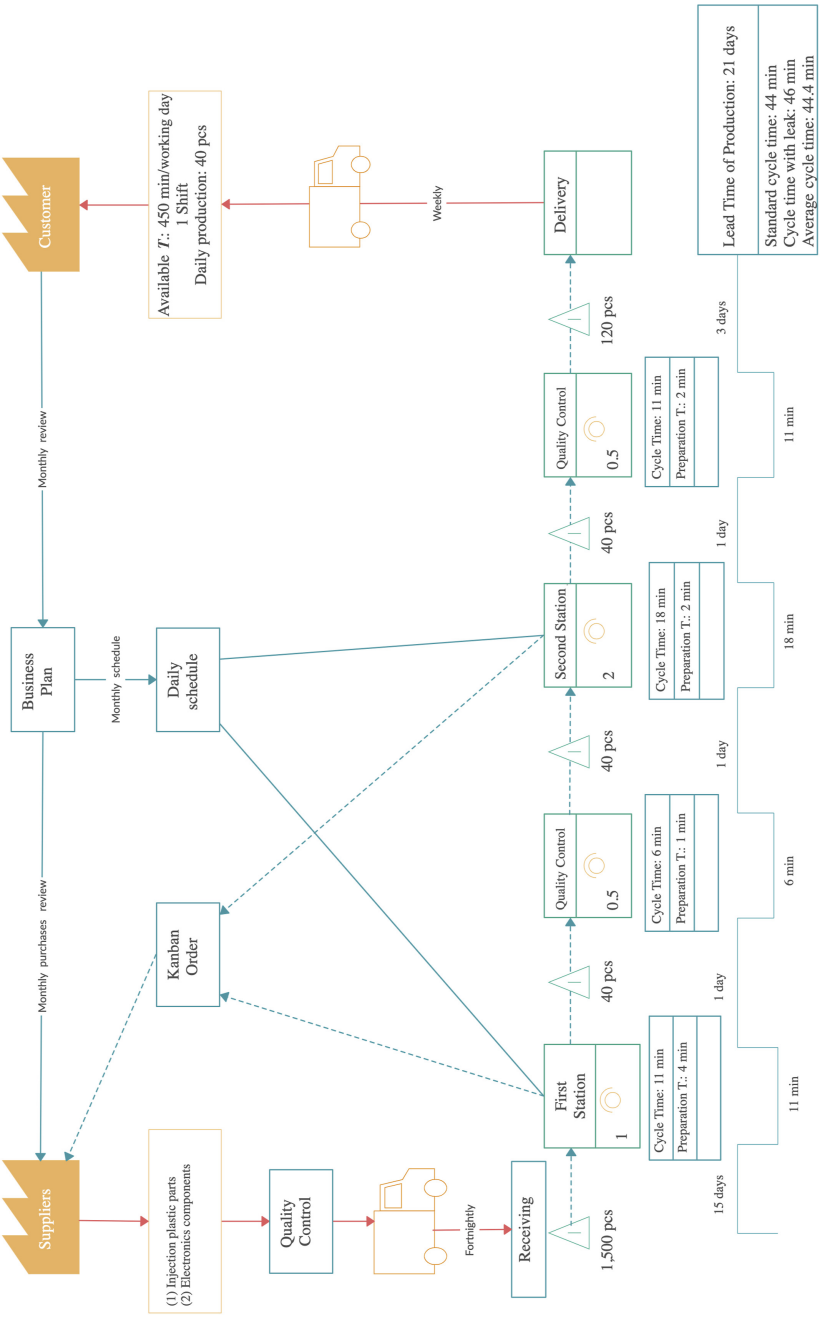


Figure 2.
The new VSM of the process proposed by the LEANMOS team

(3) With the implementation of Kanban cards, workers were no longer in control of deciding when it is time to place an order. This meant that they have more of a monitoring and control role rather than a management and decision-making role.

5. Results of qualitative research

As specified in the methodology of our research, the interviews were encoded using Atlas.ti software, thus obtaining a 33 × 33 matrix with the C coefficients for each pair of codes. For the representation of the table, the following numbering of the codes was used: (1) Acceptance, (2) Before, (3) Tiredness, (4) Collaboration, (5) Commitment, (6) Concentration, (7) Conviction, (8) Disappointment, (9) Depression, (10) Performance, (11) After, (12) Decline, (13) During, (14) Hope, (15) Stress, (16) Happiness, (17) Frustration, (18) Uncertainty, (19) Informational, (20) Insurrection, (21) Fear, (22) Motivation, (23) Denial/Anger, (24) Bargaining, (25) Procedural, (26) Productivity, (27) Rejection, (28) Resignation, (29) Resistance, (30) Revising, (31) Satisfaction, (32) Difficulty understanding and (33) Complexity (Table 3).

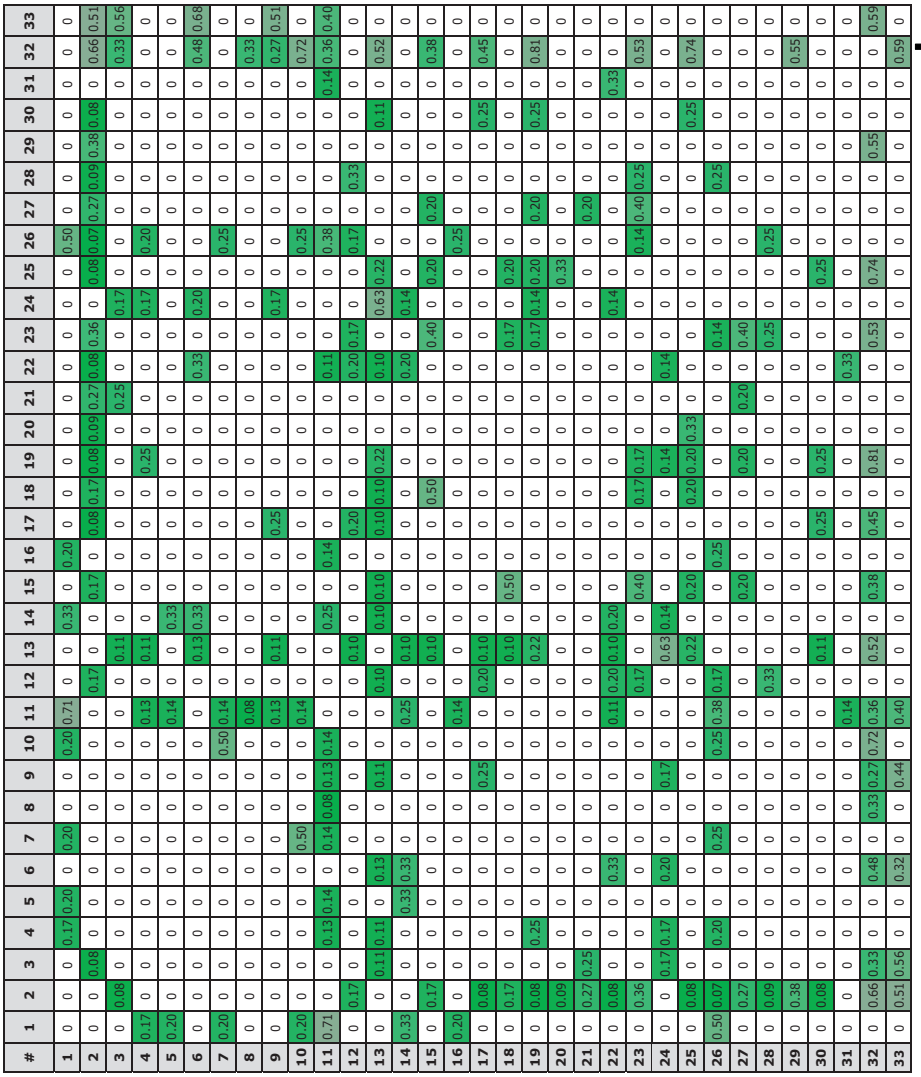
Before turning to the analysis and discussion of our research, we would like to highlight the strongest relationships ($C \geq 0.50$) in our results. Regarding the emotions experienced due to the implementation of in-line improvements, we found that the post-change phase was closely related to Acceptance of the change (0.71). And it seemed that this Acceptance was in turn related to an increase in worker Productivity (0.50). Likewise, the During changes phase was related to Bargaining (0.63). Finally, Conviction was strongly related to Performance (0.50) and Uncertainty to Stress (0.50). As for the causes of these emotions, which we will discuss in-depth in the following section, we would like to highlight that in the Before and During implementation phases, there was a Difficulty understanding the VSM system used (0.66 and 0.52 respectively), which caused low Performance (0.72) and the feeling that the information that was provided was not sufficient to make a decision (0.81). Furthermore, this difficulty of understanding by considering the VSM tool too Complex (0.59) was related to Denial/Anger (0.53) of the way in which the improvement process was managed (0.74), thus causing Resistance to change (0.55). Similarly, workers' sense of Complexity of the VSM system was related to the Before and During the implementation phases of the changes (0.51 and 0.56, respectively) and to workers' Difficulty understanding it (0.59).

6. Analysis and discussion

In this section, we conducted an in-depth analysis and discussion of the results obtained to fulfil our research aim: to identify the emotions provoked in the workers of a case study by the implementation of LM improvements through VSM and the reasons that lead to these emotions.

6.1 Worker emotions before, during and after implementation derived from VSM analysis

As far as the before implementing the changes phase was concerned, one of the common points in the interviews conducted with all the workers was their fear of the process of change that could be derived from the VSM analysis before such changes were made (0.27). This fear contrasted and was related to one of the emotional stages of change when it is perceived as negative, which is the stage of Denial/Anger (0.36). At this stage, the individual does not accept what is happening and rebels against change, resisting it in its beginnings (Castillo *et al.*, 2018). This coincided with our results, where we find that in the phase prior to implementing the changes, there was rejection (0.27) and resistance (0.38). As a result of this attitude towards the new proposals for change, we found some workers who were not very motivated (0.08) and were stressed (0.17). The literature shows how these stressful situations



#	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33
1	0	0	0	0.17	0.20	0	0.20	0	0	0.20	0.71	0	0	0.33	0	0.20	0	0	0	0	0	0	0	0	0	0.50	0	0	0	0	0	0	0
2	0	0	0.08	0	0	0	0	0	0	0	0	0.17	0.33	0	0.17	0	0.08	0.17	0.08	0.09	0.27	0.08	0.17	0	0.08	0.07	0.27	0.09	0.38	0.08	0.17	0.66	0.51
3	0	0.08	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.08	0	0.33	0.56
4	0.17	0	0	0	0	0	0	0	0	0	0.13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.20	0	0	0	0	0	0	0
5	0.20	0	0	0	0	0	0	0	0	0	0.14	0	0	0.33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0	0	0	0.13	0.33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.48	0.68
7	0.20	0	0	0	0	0	0	0	0	0.50	0.14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.25	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0.08	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.33	0
9	0	0	0	0	0	0	0	0	0	0	0.13	0	0.11	0	0	0	0.25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.27	0.51
10	0.20	0	0	0	0	0	0	0	0	0	0.14	0	0	0	0	0.14	0	0	0	0	0	0	0	0	0	0.25	0	0	0	0	0	0.72	0
11	0.71	0	0	0.13	0	0	0.14	0.08	0.13	0.14	0	0	0	0.25	0	0	0	0	0	0	0	0	0	0	0	0.38	0	0	0	0	0.14	0.36	0.40
12	0	0.17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13	0	0	0.11	0	0	0.13	0	0	0.11	0	0	0.10	0	0.10	0.10	0	0	0	0.22	0	0	0.10	0.63	0.22	0	0	0	0	0	0	0	0.52	0
14	0.33	0	0	0	0.33	0.33	0	0	0	0	0	0	0.10	0	0	0	0	0	0	0	0	0.20	0	0	0	0.14	0	0	0	0	0	0	0
15	0	0.17	0	0	0	0	0	0	0	0	0.25	0	0.10	0	0	0	0	0	0.50	0	0	0	0.40	0	0	0.20	0	0	0	0	0	0.38	0
16	0.20	0	0	0	0	0	0	0	0	0	0.14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17	0	0.08	0	0	0	0	0	0	0.25	0	0	0.20	0.10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.45	0
18	0	0.17	0	0	0	0	0	0	0	0	0	0	0.10	0	0.50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19	0	0.08	0	0.25	0	0	0	0	0	0	0	0	0.22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.25	0	0.81	0
20	0	0.09	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21	0	0.27	0.25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22	0	0.08	0	0	0	0.33	0	0	0	0	0.11	0	0.10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.53	0
23	0	0.36	0	0	0	0	0	0	0	0	0.20	0.17	0	0.20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24	0	0	0.17	0.17	0	0.20	0	0	0	0	0	0	0.63	0.14	0.20	0	0	0	0	0	0	0.14	0	0	0	0.14	0	0	0	0	0	0	0
25	0	0.08	0	0	0	0	0	0	0	0	0	0	0.22	0	0.20	0	0	0	0.20	0	0.33	0	0	0	0	0	0	0	0.25	0	0	0.74	0
26	0.50	0.07	0.20	0	0	0	0	0	0	0.25	0.38	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.25	0	0	0.33	0	0
27	0	0.27	0	0	0	0	0	0	0	0	0	0	0	0.20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
28	0	0.09	0	0	0	0	0	0	0	0	0.33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29	0	0.38	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30	0	0.08	0	0	0	0	0	0	0	0	0	0	0.11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31	0	0	0	0	0	0	0	0	0	0	0.14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
32	0	0.66	0.33	0	0	0.48	0	0.33	0.27	0.72	0.36	0	0.52	0	0.38	0	0.45	0	0.81	0	0	0	0.53	0	0.74	0	0	0.55	0	0	0	0.59	0
33	0	0.51	0.56	0	0	0.32	0	0	0.44	0	0.40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.59	0	0

Table 3.
Results of co-occurrence by Atlas.ti

lead to resistance and coping with the changes experienced (Lazarus, 2006) and this was precisely what those responsible for the LEANMOS team found with the manufacturing workers. The resistance was motivated in large part by the uncertainty that workers felt about the changes (0.17), as suggested in the literature Lazarus (2006). We found workers who were not collaborating (0.00) and were not committed to the new project (0.00), sometimes showing fatigue (0.08), frustration (0.08) and low productivity (0.07) due to the situation. In terms of the quality of communication of the process conducted, our results showed a low relationship with informational justice (0.08) and with procedural justice (0.08).

Proposition. The uncertainty generated in the initial phase before implementing the VSM analysis changes generate emotional stress for the workers involved (0.50).

If we focus on the During the implementation of the changes phase, the interviews conducted with the workers revealed a strong presence of the emotional stage of Bargaining (0.63). This stage was related to a positive increase in informational justice (0.22), so it was considered that on this occasion the company, represented by LEANMOS, was being more transparent by providing information on the change process. The same happened with the perception of procedural justice (0.22), which also increased compared to the phase before making the changes. In this phase, the workers were beginning to visualise some of the proposals, and this reduced their Uncertainty (0.10) compared to the previous phase. Reducing Uncertainty also reduced Stress (0.10) and, therefore, Resistance to change (0.00) disappeared (Lazarus, 2006).

During the implementation of changes, the workers showed Hope (0.10), more Concentration (0.13) and more Collaboration (0.11). A strong relationship was also observed between the Bargaining stage that they were in the During the changes phase and the emotional stage of Depression (0.11). This coincided with the results of Castillo *et al.* (2018) stating that if individuals are in the Bargaining stage and do not observe the expected results, they tend to go into the Depression stage. Another noteworthy aspect of the results was the occurrence of the emotional stage Revising (0.11) as it coincides with the research of Castillo *et al.* (2018). In this stage, workers consider leaving the company because they are not comfortable with the situation, but in our study, the relationship was weak (0.11) and their attachment could not be generalised. This weak relationship appeared because in one case, the LEANMOS team had to deal with a worker who threatened to leave the company if they did not return to the previous situation. This worker later changed their position, especially when improvements were observed in the line.

Proposition. During the implementation of the changes derived from the VSM analysis, workers were most likely in the Bargaining stage (0.63), in which they tried to find positive elements to face the changes.

As far as the After the changes phase is concerned, from the interviews conducted, it was extracted that the majority of workers were in the emotional stage of Acceptance (0.71). In this stage, the worker feels neither resignation (0.00) nor rejection towards change (0.00) (Castillo *et al.*, 2018). In addition, after the changes, an increase in productivity (0.38) was observed, not only derived from the improvements implemented in-line but also due to the increase in worker satisfaction (0.14). These results also agreed with the existing literature in which it has been concluded that a pleasant work environment favours the satisfaction of workers and increases productivity (Budie *et al.*, 2019).

Proposition. After implementing the changes derived from the VSM analysis and following the resistance initially shown, the workers end up accepting the changes (0.71).

Through this emotional stage of Acceptance, our results showed that there was an increase in collaboration amongst workers (0.13), commitment to the project (0.14) and conviction (0.07) that the changes that have been made had been the correct ones. This conviction had a strong relationship with each individual's job performance (0.50). This was also in line with the definition of Castillo *et al.* (2018) for this stage, and the LEANMOS team was able to verify that in the form of a greater ease in speaking with and making requests of workers.

Proposition. Workers' acceptance of the novel changes derived from the VSM analysis and the firm belief that they have been implemented correctly favour an increase in their productivity (0.50).

6.2 Causes for workers' emotions during the VSM analysis process

As noted in the previous section, the perception, at the beginning of the process, of the changes to be implemented, was generally negative. Although it was true that at the end of the process, once the changes had been fully implemented and improvements began to be observed, workers' perception improved positively, and during the whole of the previous process, they generated rejection and resistance. This led us to ask the following question: what generated this negative perception during the VSM improvement process?

After analysing our results and reading the interviews, we identified two main causes for the negative perception of the process conducted before and during the changes: difficulty in understanding (0.66/0.52) and complexity in the chosen method (0.51/0.56). Both causes had a very strong co-occurrence (0.59) and were the common factor in all the interviews conducted. Workers indicated that the graphical representation of the process to be improved through VSM, despite being accompanied by an explanation using technical information, prevented them from understanding the proposed changes on their own, which made them distrustful. While it is true that the literature points out that the difficulty in applying the VSM method is related to the complexity of the systems analysed (Nawcki *et al.*, 2020), our study identified that the difficulty also lies in the involved workers' understanding of the VSM method. Respondents mainly associated this complexity in understanding VSM charts and information with their Denial/Anger at change (0.53). This lack of understanding also generated distrust of the information provided by the LEANMOS team and affected the concept of informational justice (0.81). This type of justice refers to whether the workers consider the explanations and information provided by the company to be transparent, which is difficult to determine given that the workers did not fully understand the VSM system (Hadi *et al.*, 2020). At the same time, this situation of difficulty of understanding generated an aversion towards the process, which influenced workers' perception of procedural justice (0.74). Like informational justice, procedural justice refers to whether the change process is perceived as fair and transparent, without any deception (Tschentscher, 2019). COMP workers indicated difficulty in knowing whether this was the case due to not being able to understand the explanations given by the LEANMOS team on their own. One of the causes that we considered for the lack of understanding and comprehension of the VSM process by the workers may have been due to their level of education; in the case study sample, 100% of the workers had only received primary school education. While it was true that the workers were trained on LM, some of the more technical concepts such as cycle time, takt time, etc., which are dealt with in the VSM tool, could have been difficult for the workers to understand.

While it is true that the literature shows examples where the level of education of workers has an impact on the organisation (e.g. Bakan *et al.*, 2011), there is no evidence that addresses the relationship between the level of education of workers and barriers to implementing LM in a company. Therefore, we can only report the difficulties in comprehension and understanding associated with the VSM tool based on the results of our study and not generalise for the rest of the LM techniques.

Proposition. Because of its format of presenting information graphically and with operational abbreviations, the VSM tool proved to be difficult to understand (0.66) because of its technical complexity (0.51) for workers. This led to resistance to change before and during the implementation process (0.55) that only improved when results began to be seen.

7. Conclusions, limitations and future research

Previous research on LM has focused on the technical barriers that its implementation has in production processes. However, there is a lack of research into how the implementation of LM techniques affects the workers involved. This study fills a research gap by exploring not only the emotional perceptions of the workers during the implementation of LM improvements but also the causes that led to them. To do so, the study employed an inductive analysis through a real case at a Spanish company in which interviews were conducted with the workers involved in the process where LM was implemented, specifically using the VSM tool.

7.1 Theoretical implications

Regarding the perceptions originated by the LM changes using the VSM tool, the results of the study showed that during the first phase, workers experienced high levels of uncertainty and stress, causing an initial resistance to the proposed changes and that workers were in Denial/Anger in the initial stage, as put forward by Lazarus (2006) or Castillo *et al.* (2018). Also, during the implementation of VSM, workers found themselves in a stage of Bargaining, which helped them to look for positive elements to steady themselves on, to try to cope with the situation experienced. Finally, in terms of workers' perceptions, the results showed that there was acceptance of the changes, increasing productivity and work performance, to the benefit of the organisation (Budie *et al.*, 2019).

However, the most important contribution to the theory of our study lies in the root causes of the emotions identified during the implementation of LM using VSM. The nature of the use of VSM lies in the process of visually mapping the information and material flow of a process, thus preparing a future status map with improved methods and performance (Jones *et al.*, 2011). Thus, VSM, to summarise this information uses graphs, figures and technical concepts that, in our case study, triggered a lack of understanding in workers due to the complexity of the system. While it is true that the workers were trained on LM and specifically on VSM, their lack of basic knowledge of concepts such as material flow and process cycles, among others, complicated their understanding. After careful analysis of the characteristics of the case study, we considered that the fact that all workers only had primary level schooling was relevant, and, indeed, it may have had a further impact on the lack of understanding of the improvement process. In addition, the literature shows that improvement processes by VSM have a smooth and successful involvement when the organisation has a proactive and continuous improvement-based innovative culture (Loyd *et al.*, 2020). In our case study, COMP was conducting an LM improvement project for the first time, so its innovative culture was not yet ingrained. This fact may also explain the difficulties encountered in the implementation of VSM in our case study.

Hence, while the literature to date has only addressed the technical difficulties of implementing improvements with VSM (Dal Forno *et al.*, 2014), our study identifies barriers related to the workers involved in the process.

7.2 Practical implications

The results of our study indicated that the process conducted by the case study company was not as successful as expected for its workers in the early phases of the deployment of line

improvement using VSM. The lack of understanding of VSM's graphical representation of the process to be improved was a trigger for the most negative reactions to the changes to be implemented. As a lesson for future organisational leaders with VSM implementation projects, we recommend that they avoid as much as possible using VSM graphical representations directly to explain improvements to workers. We consider that the VSM graphical representation should be a tool used by LM managers but that when explaining it to workers, it should be adapted without using technical elements or language that could make it difficult for them to understand. Thus, the knowledge provided by our study should enable those responsible for implementing VSM-based LM measures to reduce their impact on the emotional health of workers by fostering communication and understanding through organisational support (Ng and Feldman, 2012).

7.3 Limitations and direction for future research

Although the results of this study identified the causes of resistance to change when faced with a VSM improvement process, it is important to consider its limitations. For instance, in our study, the negative effect ratio of changes and basic education is high because all workers were in the same situation. Therefore, it would be necessary for future research to conduct this study with a more heterogeneous sample in terms of the educational level of the workers. Another limitation lies in the way of working involved in the company we analysed as a case study, with all manual processes and no automation. This fact may be significant as the worker's dedication to the process to be improved is greater and future research should consider the need to explore the findings of our study in more automated production environments. Thus, the size of the case study company (136 total workers; 20 workers in-line) must also be considered. The results we show cannot be generalised for larger companies such as multinationals. We recommend further research extending the studies to larger companies. Another limitation of our study lies in COMP's [lack of pre-existing] continuous improvement culture, which was not well ingrained. Future research should replicate our study in companies that implement VSM and have a more experienced continuous improvement culture to see workers' perceptions in those cases (Loyd *et al.*, 2020). In addition, another research limitation is that our conclusions are based on a single case study. It would be necessary to examine different cases and cross-analyse them to see if our findings coincide with other improvement processes through VSM and extract, if necessary, new conclusions.

Finally, for future research, we consider that the findings from our research should be used to conduct broader quantitative research, collecting a greater sample of interviewees to measure the impact on workers before, during and after the implementation of the changes. Other future research may address a qualitative study like ours but with another LM technique. For example, the impact derived from changes in the philosophy of the 5s may have on workers, but conducting the study before, during and after the changes (Dogan *et al.*, 2014). Also, as future research, the implications of not all manufacturing workers being directly affected by the changes could be analysed. In our case study, all workers rotated weekly and worked in the line affected by the changes, but future research can address how it affects emotionally if there is one part of the team affected and another not by the changes. In relation to this, some contributions could be implemented such as those of Castillo *et al.* (2021) who propose a simulation model to see how workers evolve emotionally depending on their emotional stage in which some workers are affected by the changes and others are not.

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Appendix

Interview script

How do you feel and what do you believe right now about the changes that are going to take place?

Do you feel that you have been or are being informed about the changes at all times?

What is your behaviour in relation to changes?

How do you feel about your co-workers an what is your behaviour with them?

How do you feel with your supervisors about the change what is your behaviour with supervisors regarding the change?

Do you use any element to help you internalise the changes?

Are you motivated? Why?

Do you feel productive?

Do you have the opportunity to express your opinion and feelings during the change?

Have you had influence on the results of the changes to be made?

Do you consider that the decision-making regarding the changes has been free of bias?

Do you consider that the information on which the organisation relies for the changes is accurate and correct?

Have you been able to complain about any aspect that you did not like about the changes?

Do you believe that your supervisor is treating you correctly regarding the changes?

Do you consider that at any time your supervisor has made inappropriate comments regarding the change process?

Do you consider that your supervisor has been kind and courteous to you regarding the change process?

Do you consider that your supervisor has provided you with all the information regarding the change process?

Do you accept the line changes?

About the author

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