Proposal: Lean Model for Continuous Improvement as a Cost Reduction Strategy, ¨SME: SL Service Automotive Mechanical Engineering¨

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Abstract. The current economic situation in Mexico requires companies to adopt the strategies that allow them to acquire competitive capacity, reduce their costs and increase their productivity by managing agile and slender processes all to stay in the market and provide their products and services. To this end, large companies began to adopt manufacturing methods developed in Japan that help competes in the international market, national or local, known as Lean Manufacturing. Everything starts by drawing a diagram of the value chain of the process showing all the activities carried out to obtain the product or service, costs but not value delaying the completion of the same and for that reason should be eliminated. Lean defines these activities as waste, which is presented in the production and service processes, but through the use and application of the Lean tools will allow us to eliminate them. This article proposes an improvement model based on lean manufacturing for the service process of the SME, also taking into account the literature reviewed in the state of the art, which will allow us to reduce its total time of process and as a consequence is the decrease in costs, increase in productivity, increase in profits, all this in order to place it in a competitive state, thus ensuring its permanence in the business. In the beginning, the waste identified in the process is presented to later determine the appropriate Lean tools for its elimination and finally the present VSM (current) and a future (desired) VSM of the process are traced together with a cost-benefit analysis for the implementation of the proposed tools.

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1. Introduction:

Currently, the customer's demand is focused on acquiring products or services of good quality, low cost and reduced delivery times. For this reason, global competitiveness generates a need for companies to seek new strategies to meet the multiple demands of the market, therefore it is mandatory that they focus on improving their internal operating processes. For this reason, we focused our attention on Japan, mainly on the Toyota automotive giant that developed its own production system known as TPS (Toyota Production System) which has as its basic principle "Do more with less".

This system gave rise to the Lean Manufacturing philosophy (adjusted production, the American term "Lean" was introduced by James Womack and Daniel Jones, (1996) in his bestseller "The machine that changed the world", being Toyota the best-managed company in the world, they simplified their success in "Eliminating waste and providing added value to customers." The Japanese philosophy of Lean in our environment is not widespread, only the best managed or world-class companies manage to implement and monitor it, in many cases, the methodology is unknown but has been successfully applied in both productive and service sectors, which is why it is considered a worthy subject of this research work.

According to what has been described, it can be described that the problem addressed in the Small and Medium Enterprises (SME) consists of the following:

1.1. The SME: SL Service

It was inaugurated in January 2016 by the Owner is by profession Automotive Mechanic Engineer and after having served as Service Manager in a Recognized Car Brand and in order to meet the demand present in the south of Tlaxcala. The company starts as a family business, located in a municipality of Tlaxcala, Mexico and has administrative and operational areas. The SME has an approximate area of 600 m2, in addition to starting its operation with a workforce of 12 employees at the end of its first year of creation to make possible the fulfillment of the different labor responsibilities of the Company.

1.1.1. Service Process

The service begins when the client arrives with his unit to the company, continues with the respective mechanical maintenance, goes through the washing and finishes with the delivery to the client and billing. The stages that encompass the process are detailed below:

1. **Reception**: The service starts from the moment the unit arrives at the facilities by the customer or by means of crane service, the owner is questioned about the minors due to the fault and information that can help detect and diagnose the fault quickly, once insurance of the failure is made a budget.
2. **Quotation (Total Price of Service)**: Includes the cost of spare parts and workforce cost. For this, the client is provided with a budget with reactions in which there is a guarantee, and which also guarantee the work. If the client does not accept this budget, 2 more are considered upon request:
   a) If the customer wants spare parts, the quotation is made but it is indicated that in spare parts of his choice the guarantee is not given in the labor of 2 months that is normally offered.
   b) Only in case, the client requires it, a third budget can be generated that would be repair or replacement of use. This option is the least recommended to the client because its security is involved.

- If an agreement with the quote is reached the next step is the purchase of spare parts, otherwise, the client withdraws his unit and the process ends.

3. **Purchase of supplies (Spare parts, oils, lubricants, auto parts, and mechanical parts)**: Once accepted any of the contributions, we proceed to purchase necessary supplies.
4. **Mechanical maintenance of the Unit**: After the diagnosis is made, it is ideal to start the maintenance so that when the supplies arrive, they are replaced. New parts or purchased parts are put into the unit and the parts of the car that had been removed are assembled or assembled. And finally, the necessary tests are carried out to ensure that the service has been carried out successfully.
5. **The Client is informed that his Unit is Ready**: A call is made to the client to indicate that the service was successfully performed.
6. **Cleaning and Vacuuming**: It is offered to all customers as an added value to the service offered. And the customer call starts immediately afterward.
7. **Delivery of the Unit**: The client is shown that the anomaly has been repaired, sometimes a test is carried out if the client requires it, although the service is guaranteed for 2 months.
8. **Service Charge**: When the client gives the approval of his unit, he proceeds to charge the service. If you require an invoice, the corresponding VAT is added.

The guarantee offered 2 months in labor and 30 days in spare parts.

Forms of payment: cash, check, bank transfer, with 3 and 6-month credit card without interest or debt.

Mechanic Services:

The SME offers a variety of services and among the main ones are the following:

Table 1. *Mechanic Services of SL Service*

✓ Motor adjustment	✓ Levels of liquids
✓ Tune up of motor	✓ Alignment and balancing
✓ brake system	✓ Clutch change
✓ Suspension system	✓ Change of distribution bands
✓ Lubrication	
✓ Maintenance to std. and automatic boxes.	✓ Diagnoses by Scanner
	✓ Cooling system

Clients:

The SME has clients from the public, private and private sectors. The units range from patrols sedan-type, Ford f150, managerial units, 3.5-ton trucks and until commercial sedan cars and the like.

Suppliers:

The inputs needed by the SME as spare parts, oils, suspensions, etc., are mostly captured by the Owner and include suppliers from Tlaxcala and from the state of Puebla. The service at home in Motorcycle that give some parts take up to 3 hours to arrive and for this reason is used when the service can wait, otherwise, the Owner is responsible for the collection in their own unit. Below is a list of suppliers from Tlaxcala and Puebla, although when you the part or piece required is not found, it is bought in Mercado Libre:

1. Auto Zone.
2. California Refactionary
3. Mexico Suspensions.
4. Libra Refactionary.
5. Rolcar Refactionary.
6. María Felix Refactionary
7. Direct in Agencies of Apizaco of the different brands: Chevrolet, Nissan, Toyota, Honda, etc.
8. Rectified San Cosme
9. The Union Refactionary.

1.1.2. Opportunity Areas

The Small and Medium Enterprises (SMEs) provides automotive mechanics services to all existing brands in the market, with customers from the public, private and private sectors. When performing an analysis of the process you can see a certain amount of spare parts, additives without any inventory as a surplus of previous services that possibly arose from the periodic volume purchase seeking to take advantage of discounts and obtain a decrease in the costs of supplies, in addition there is also

cardboard boxes thrown away, scattered work tools, motor parts or motors throwing oil in parts of the mechanics area that hinder the free transit of the process and increasing the risk of a work accident, as well as units occupying space in the facilities waiting for service since there is no formal procedure to follow for each unit, the activities by the owner are saturated and include: deal with the customer, reception of units, acquisition of spare parts in the state and outside it, which, It is counterproductive because when new units arrive for possible services, these are withdrawn in his absence, it would be good for him to begin delegating responsibilities. Priority is given to the public and private sectors, but they are worked on credit, which sometimes takes from 1 quarter to 1 year to see the payment.

Customers are neglected and represent in our opinion a source of immediate liquidity and can help cushion the credits offered. It is intended that with the use of the philosophy of lean manufacturing as well as the waste identification and tools it comprises, the value chain of the process will be optimized and an improvement in the productivity of the SME will be generated that reduces its costs and increases profits.

GEMBA

It starts knowing the facilities of the company, to become familiar with the process from beginning to end analyzing all the stages, activities and operations of the process from the reception unit until the delivery to the client. That by means of detailed observation and having in mind lean thinking, areas of opportunity are detected:

- A certain quantity of spare parts, additives without any order or inventory as a surplus of previous services that possibly arose from the periodic volume purchase seeking to take advantage of discounts and obtain a decrease in input costs
- There are also cardboard boxes thrown away, scattered work tools, engine parts or engines throwing oil in some areas where mechanical maintenance is performed, impeding the free flow of personnel and the process itself, increasing the risk of accident labor.
- Units (cars, vans) occupying space in the facilities stealing space that hinders being able to provide the service to other customers, which translates into economic losses.
- In addition, there are no formal procedures to follow to provide the service and each technician does it differently according to their experience, which causes the service to be extended in most cases.
- The management and administrative activities on the part of the owner are saturated since they include: dealing with the customer, receiving units, picking up parts in the state and outside it, which is counterproductive as new units arrive for possible services, these are removed in his absence, so it would be good to start delegating responsibilities.
- Customers from 3 sectors are served, which are Public, Private and Private. The first two require credit service and in most services provided the collection of invoices is extended. The service to individuals is the clients that represent the only source of immediate liquidity to and that can contribute to cushioning the offered credits to private and public sectors.
- The cost for Dead Times is not known due to: there is no apparent order in the area of mechanical maintenance and in terms of cleaning it is only done when there is little work, finding the right tools and devices for each job takes time for the present disorder and also due to the distribution of plant that represents long distances to capture them.

All the above mentioned causes the service costs to skyrocket and causes delays in the delivery in the agreed time, generating a negative aspect and discomfort in the client. It is intended that with the use of the philosophy of lean manufacturing as well as the tools it comprises, the value chain of the process will be optimized and an improvement in the productivity of the SME will be generated that reduces its costs and increases profits.

BRAINSTORMING

This technique was used to gather main ideas about the causes that generate a delay in the service which raises the costs of the same and discomfort in the client, the list is as follows:

- Empirical and different mechanical procedures for each mechanic.
- There are no information meetings where feedback is given to the staff.
- There are no incentives.
- Poor motivation.
- The layout of the Plant inadequate.
- The acquisition of spare parts and additives is slow.
- It is not defined who corresponds to certain activities.
- There is no staff training.
- The owner's activities are too many which makes it difficult to focus on the planning of your company.
- The daily activity of the company is done without prior planning.
- Long distances to capture tool which generates downtime.
- No delegation of activities.

2. Literature's Review:

In order to carry out this project, the most recent research and information on the subject were reviewed in order to define how feasible it is proposed in our research. Three epistemological axes are contemplated: Lean manufacturing, Mapping of the Value Chain (reduce Lead Time) and Continuous improvement (Kaizen).

AXIS 1. Lean Manufacturing

The philosophy was exposed for the first time in the book ¨The Machine that Changed the World¨, a study by the Massachusetts Institute of Technology (MIT) that lasted 5 years and required 5 million dollars for its The objective of this development was to study the manufacturing methods of automotive companies on a worldwide scale, highlighting the manufacturing advantages of the best manufacturer in its class: Toyota, the Japanese automotive company, and named its production system (TPS) as Lean Manufacturing Lean uses less of everything in the plant, less human effort, less investment in inventories of materials and tooling, less space and less engineering hours to develop a new product (Womack & Jones, 1992). For 1996 these same authors in their book Lean Thinking describe a 5-step model to achieve a productive Lean process that includes: Be aware of the need for change, Training to teach the technique, identify a crisis for the need of use of the new technique, map the value flow for all product families and find to begin to eliminate the most important waste.

In Mexico, Primitivo, (2002) mentions that thanks to the experience gained in the implementation of Lean Sigma in Mexican companies suggest that two of the main problems to overcome is the cultural change of senior management and the limited recognition that is Give the employees.

In India Lean was initially thought to be applicable to productive processes but due to its approach is extremely relevant for countries whose economies depend on the service sector where only those companies that provide advantageous costs and customer comfort manage to survive in the market. In this context, Lean not only improves organizational efficiency but also improves customer comfort and business profitability (Debashis, 2007).

Spain in the publication "Toyota Way, Lean is more than a set of tools and techniques" claim that it is a philosophy that involves an excellent organizational culture that depends on how the employee thinks and acts within the organization which is considered a key element to reap the benefits of Lean strategies. In a complementary way, they add the eighth type of waste which is: "The creativity of the employees not used" (Diego, Sierra & García, 2009).

Lean is a strategic tool to solve several organizational problems and can gather several change initiatives that are currently in business. The best way to introduce lean in business is through cultural growth (Atkinson, 2010). China in "Improving the way of engineering work using Toyota Way", states that the origin of the concept belongs to the leaders of Toyota for achieving operational excellence and successful business to this day. The success of this company lies in its TPS Toyota Production System in which lies the secret of its high productivity aimed at eliminating waste and ensuring that the right amount of materials was available at the right time for each process (Chien ho ko, WeiChie & Jiun De, 2011).

Likewise, Kihn (2012), refers that nature shows a reality that is totally disorganized and that the order necessary for this will depend on visual planning of all these activities, which will lead to make Lean thinking more intuitive, this planning visual will make the waste visible and can be attacked.

Another of the advances of this topic analyze that nowadays the service sector is growing rapidly and they affirm that there is a strong pressure to turn the service sector into a truly Lean perspective. However, the productivity of this important sector is not on par with the manufacturing sector, many of the Lean techniques and tools applied here are also applied in the services sector, with the purpose of reversing the low efficiency and effectiveness on issues related to cost reduction, increased flexibility, quality improvement (Suárez, Barraza Manuel, Tricia Smith & Su Mi Dahlgaard-Park, 2012).

According to Miina (2013), he affirms that there is a deep gap in the way the process of implementation of Lean thinking in organizations is achieved, currently, there is no step-by-step guide for the successful implementation of slender thinking or in any case, it is not clearly defined. However, the author has built a lean thinking implementation process that incorporates important steps for successful implementation: Process quality, Lean acquisition of knowledge, Lean home development, Lean house training, planning of the lean process implementation of the Lean Thought and execution of the plan.

On the other hand, Carlborg, Kindström & Kowalkowski, (2013), suggest 6 Lean principles that through the synergy of the entire organization will give the opportunity to improve their productivity, being invaluable to increase efficiency and customer satisfaction by creating a platform of competitiveness. These principles range from: Define value, Define the value chain, Observe the flow of process elements to optimize it, Pull system to produce only if there is an order, Standardize: Performing procedure for each stage of the process to achieve the desired uniform level and Perfection: the success of Lean to achieve.

Finally, regarding Lean Manufacturing in the article by Pakdil & Leonard (2014), they show that the heart of Lean is its philosophy and the people, which seeks to generate value for the client, society and the economy with the objectives of reducing costs, improve delivery times and improve quality through the elimination of waste. Within TPS identify two pillars: Continuous improvement (Kaizen) and respect for people, under these two pillars 4 groups are categorized: Long-term philosophy, promote the flow of the process, respect between people and partners through respect and development and resolution of problems for continuous improvement.

AXIS 2. Value Stream Mapping (VSM) to Reduce Lead Time.

It is a tool related to production that serves as a pivot and basis for the redesign of production systems under a lean approach. It is a graphics technique that, through the use of standardized icons, integrates logistic flows of materials and information into the same figure. This began to be used in Toyota under the heading of "mapping the flow of materials and information" and was finally developed by Rother and Shook in his book (Rother & Shook, 2003).

VSM aims to map the activities with and without added value necessary to bring a family of products from raw material to finished product, in order to locate opportunities for improvement through guidelines based on concepts of Adjusted Production to subsequently graph a possible state future and launch improvement projects (Womack & Jones, 1996).

The contribution of Lovelle (2001) in "Use of Value Chain Mapping to Reveal the Benefits of Lean Manufacturing" indicates that the mapping of the value chain is a tool that graphically represents the current and future state of the production system, with the purpose of identifying all the activities of the process to visualize those that need to be eliminated and that is within the process unnecessarily only delaying the process.

The fundamental of Lean according to Chen and Meng (2010) is to identify and eliminate waste by dividing the work into 3 parts: Value added; Incidental work: auxiliary activities that do not necessarily add value but are necessary to add value. And activities that add time, effort, costs but not value. They recommend the following methodology to apply VSM in the Lean system:

- Identify family of products.
- Prioritize family of products and select one to implement lean
- Draw the current VSM of the selected product and analyze its process to improve it.
- Draw the future map to which we wish to arrive.
- Implement future state, relying on kaizen.

Mapping the current state of the company's process guides the study to the analysis and identification of the area that needs improvement and must be focused in terms of WIP (Work in Process), lead time (total process time) and cycle time. In addition, the future state is also generated, including the Kaizen short proposed in the current state (Vamsi Krishna Jasti, & Sharma, 2014).

The application of Lean tools, including VSM allows to streamline organizational processes, allowing to improve the flow of media products and finished products, faster delivery of finished products for the client and reduce production costs including in particular storage costs (Wolniak, & Skotnicka-Zasadzien, 2014).

While Rodriguez O. (2014), in turn, recommends 2 methodologies that can be easily implemented to visualize the movement of materials and resources: the first in VSM and the second contemplates the measures of General Equipment Efficiency (EGE).

Another significant advance in VSM describes the implementation of a Lead Time reduction model in a Pull system. The analysis was made to the main production line of the company under the framework of Lean, where the application of the SMED and KANBAN tools is justified to reduce the preparation time of the equipment and the inventory level respectively, main factors of the delay in deliveries. The use of the Value Stream Mapping (VSM) as a diagnostic tool, allowed to identify downtimes and the level of inventory in the process as the main activities that do not add value, which subjected to an analysis turned out to be foci of improvement events. They recommend the development of a maintenance plan to increase the overall efficiency of the equipment (Lozada & Quispe, 2017).

Axis 3. Continuous Improvement

The concept of continuous improvement is key to the concepts of Lean Manufacturing. Continuous improvement is based on a persistent fight against waste. The fundamental pillar to win this battle is teamwork under what has come to be called the Kaizen spirit, the true driver of the success of the Lean system in Japan. Kaizen means "change to improve"; derived from the words KAI-change and ZEN-good. Kaizen is the change in the attitude of people. It is the attitude towards improvement, towards the utilization of the abilities of all the personnel, which advances the system to its success. Logically, this spirit has a way of managing companies that implies a culture of constant change to evolve towards better practices, which is what the denomination of "continuous improvement" refers to.

When starting the review of the literature in the article "Finding kaizen: a theoretical analysis of continuous improvement" shows Kaizen under three perspectives:
The first is management philosophy that is characterized by understanding the management of an organization as the maintenance and improvement of work standards and uses as a link between management and employees the deployment of policies and objectives through Hoshin Kanri. The second TQM (Total Quality Management) which makes use of statistical control techniques, teamwork, customer focus QFD, employee empowerment, benchmarking, quality circles. And the third that has the theoretical Principle of methodologies and improvement techniques, which have the purpose of eliminating the MUDA (waste) among the main ones mentioned: VSM, Redesign of processes, Short Kaizen and Smed (Barraza & Dávila, 2008).

Another contribution defines Continuous Improvement as the key to the Lean culture, which depends entirely on the passionate participation of all employees and their work habits. They add that they can not succeed in deploying Continuous Improvement and Lean

Production without extensive reform of their culture. It also indicates that it will greatly benefit Chinese companies if it is implemented correctly, especially in the current financial crisis. Suggesting the need to change to Japanese improvement practices but previously: change habits and establish a new culture, these are the 2 terms that we need to strive to have throughout the organization and even then the road to continuous improvement is long but the best is start as soon as possible (Chen & Meng, 2010).

In Colombia we find that Kaizen is defined as a program of continuous improvement based on teamwork, the use of the skills and knowledge of the personnel involved, using lean tools to optimize the production process. They also mention 4 Kaizen principles: Negative, and Positive, Approach and Principle restrictions of the facilitator. That must be taken into account for a successful implementation under its methodology also consisting of 4 stages (Atehortua Tapias & Restrepo Correa, 2010):

1. Plan: Define the problem, Study the current situation and Analyze potential causes.
2. Do: Implement the solution.
3. Verify: The results.
4. Act: Standardize the improvement and establish future plans.

The contribution of the authors Espinoza and Heijduk (2010), in the study of "Administrative Model of Continuous Improvement for Small and Medium Mexican Companies", emphasizes 2 fundamental aspects for the implementation: the first is a culture of suitable work that allows them to successfully implement the new methods, as well as a leadership that motivates the owner. In case of missing any in the process leads to slow progress in the implementation and sometimes to failure. They list practices that affect the process of implementing new methods, which should be avoided at all costs and among the main ones we have: not training the personnel, few administrative skills of the owner, almost no involvement of the workers in the design of the work, little follow-up to plans, programs and unsafe working conditions.

On the other hand in the American Union in ¨Using the Standard Work Tools for the Improvement of Processes¨, recommends the application of Kaizen through the use of a series of key tools aimed at the improvement of processes, these tools aim to standardize the work, which he describes as a prescribed sequence of balanced activities to achieve the level of programmed production. Some of the recommended tools are Takt Time, Verification Sheet, Cycle Time Bar Graph, Spaghetti Diagram, STD Work Diagram, 6-S Audit Format combined with Standard Work (Labach, 2011).

Additionally, the book "Process Management" presents a comprehensive vision of process management, contributing to 2 stages. In the first, it gathers all the knowledge expressed in many methods, techniques, and tools that represent how to work in process management, essential to incorporate it and develop it in the organization. In the second, it incorporates motivation with a series of vital attitudes for the practices to take root, pointing towards the will of the people: professionalism, customer orientation, the vision of processes instead of areas, the leadership that is necessary to achieve. When the will and technique come together magic arises and you can begin to see wealth (Carrasco, 2013).

Finally in the article ¨Study of the Implementation of Continuous Improvement in SMEs in Spain¨ notes that the basis of continuous improvement is self-assessment, knowing the starting situation of the company to be able to evolve, detect areas for improvement, to create the project of improvement that will bring financial and human quality benefits. The continuous improvement of processes tries to improve the different phases or processes that take place in the production of our product or service, intervening from the beginning until it reaches the client. The success or failure in the implementation of a process of continuous improvement will depend on the will of the managers or owners, in this case of the SMEs, beginning their implementation with their own learning and improvement. If in the implementation of the proposed plan it is necessary to make an investment, it is preferable that it covers human resources initially, improving motivation and training, (Canales, & Soler, 2015).

The following lists show the principal contributions taken from the literature´s review and that we should consider to develop our model to propose:

Table 2. *Main contributions of the literature´s review to create our own model*

Aportation	Description
Leadership	Carried out by the Owner, Manager, Directors and Administrative Staff
Change of Culture	Constant training in Lean Tools, Detection, and Elimination of Waste
Management Commitment	There must be participation and motivation always. Any improvement without management support will fail.
Customer focus	Without them, the company does not exist.
Change of habits	Throughout the organization, you must start with Pilot areas through the implementation of 5's.
Use of Lean Principles, Tools, and Techniques	Kaizen, VSM, TPM, Smed, 5'S, Std Work, Takt Time
Kaizen	Minimal incremental daily improvements have great long-term potential. Everyone's participation is essential.
Suggestion systems	Obtaining solutions to visible and non-visible problems.

8th waste	Little recognition to employees and no use of the creativity of the staff.
Use of technology	Software for process management and control.

3. LEAN Manufacturing's Tools & Waste:

3.1. LEAN Tools

1. Mapping of the Value Chain.
2. 5'S
3. Standard Work
4. Single Tooling Change (SMED)
5. TPM
6. Kaizen
7. Takt Time
8. Kanban
9. Just in Time

3.2. The 7 Waste + 1 Considered In LEAN

They were defined by Taiichi Ohno within the Toyota Production System as follows:

1. Overproduction: It refers to produce more than the amount required by the customer, to manufacture products before they are needed, that is to produce faster than what is required.
2. Over inventory. It is the excess of raw material, work in process or finished product and its indefinite storage which generates a negative impact on the company translated into storage, transportation, handling or obsolescence costs, being able to suffer damages, hidden quality errors and others. Stock wastage is the result of having more stocks than is needed to meet immediate demand, so if material accumulates before and after the process indicates that the production flow is not continuous.
3. Over-processing. It is the consequence of subjecting the product to unnecessary processes that do not generate value to the client and for which it is not willing to pay.
4. Defective Products. Are those products that are outside the specifications of the client and therefore do not add value to it. These mean a great loss of productivity since it includes extra work because of not having correctly executed a process. They generate direct costs of non-quality, consumption of raw materials, labor, reprocesses as well as dissatisfaction on the part of the client.
5. Transportation. It is the unnecessary transfer of raw materials, equipment, machinery and people that do not add value to the product. These unnecessary distances must be eliminated since it generates a cost, increases delivery times and risks of damage.
6. Waiting Times. The time that is lost when an operator waits for his machine to finish the job or operation, or otherwise when the machine stops waiting for the worker to adjust or even for both worker and machine to wait for work orders, materials or tools. The most common causes are unbalanced processes (one process goes faster than the next).
7. Unnecessary movements. It refers to unnecessary movements of people or equipment within the area of a process. It is the result of a badly designed layout that forces the worker to make movements that force the normal displacements to have an inadequate position placing at risk the health of the worker and generating an unproductive environment. It should seek to reorganize work stations and staff to achieve a better layout and optimize space and movement.
8. Do not take advantage of the Talent, Capacity, and Creativity of the people. In addition to the first 7, it is considered mute to waste human talent, not using the capacity of the staff for the needs of the position or the improvement of processes. The ideas of the members of the organization should be taken advantage of to detect possible changes, the non-involvement of the personnel generates demotivation in the employees, waste of resources and distrust in the improvement systems.

4. Existing Improvement Models for The Development of The Own:

See table 3.

5. The Proposed LEAN Model

Considering the obviously TPS Models, Philosophy Lean Manufacturing, as well as the models of Anahuac University and Mantilla & Sánchez, we proceed to design the construction of our model, which is the main objective of this research work. Important elements obtained in the state of the art are also included. See Figure 1.

6. Outline of The Application Model

6.1. Define

What was described in the section of 4.2 Opportunity Areas of the SME in question was obtained through the Japanese Gemba Technique together with those obtained with the Brainstorming technique developed with experts from the process: Owner, Mechanics, mechanic assistants and administrative personnel. It allowed us to define the main factors that delay the service and so we can focus on working to minimize them, always seeking to achieve the main objective of this work, which is to reduce the total time of the process to reduce the cost of the service and increase productivity.

Main causes that delay the service:

1. *Lack of Short-Term Planning*. The Owner performs all management and administrative, some of them are: payment and issuance of invoices, input collection, customer service, distribution of work, external service to engines, grinding discs, grinding heads, alignment, rolling and the rest of activities of the

business and as well as the staff are carried out according to what is required without any previous planning.

2. *Appropriate late diagnosis*. For lack of training or experience in the staff. While in an agency service to correctly detect a fault, it takes an hour and 2 to repair it.

Table 3. *Review of some existing improvement models*

Model/Year	Author	Methodology or Tools used
Toyota Production System (1954)	Taichi Ohno	PDVC Cycle & 5 Why
The Lean Aircraft Initiative" (1993)	Formed by Aeronautics Industry, USA Air Force and Massachusetts Institute of Technology (MIT)	1. Adopt lean paradigm, 2. Prepare 3. Define value 4. Identify value stream 5. Design production system 6. Implement flow 7. Implement total system pull 8. Strive for perfection
Management of continuous Improvement (2013)	Dr. Mariusz Bednarek	1.Implementation preparation 2. Analysis 3.Pilot implementation commencement 4. Lean expansion implementation 5. Measurement and improvement
4P Toyota Way (2004)	Jeffrey K. Liker	1. Philosophy 2. Process 3. People and Partners 4. Problem Solving
Lean Six Sigma Deployment (2002)	Michael George	1. Define 2. Measure 3. Analysis 4. Improve 5. Control
Lean Six Sigma Deployment (2005)	Pivotal Consultant Resources	1. Diagnosis and orientation 2. Planning 3. Deploy 4. Integrate
Design for Lean Six Sigma (2008)	Jugulum Rajesh & Phillip Samuel	1. Define 2. Measure 3. Analysis 4. Design 5. Verify
Lean Six Sigma SIS (2008)	SIS Consultant	1. Commitment 2. Planning 3. Development 4. Integration 5. Lift
Continuous Improvement through Lean Philosophy (2009)	Anahuac University Mexico	1. Stabilize 2. Standardize 3. Simplify 4. Extend
Lean Six Sigma Logistic (2012)	Mantilla / Sanchez	1.Begining 2. Development 3.Results 4. Objectives

Source: Espinoza and Heijduk (2010) and Yarasca & Aylin (2016).

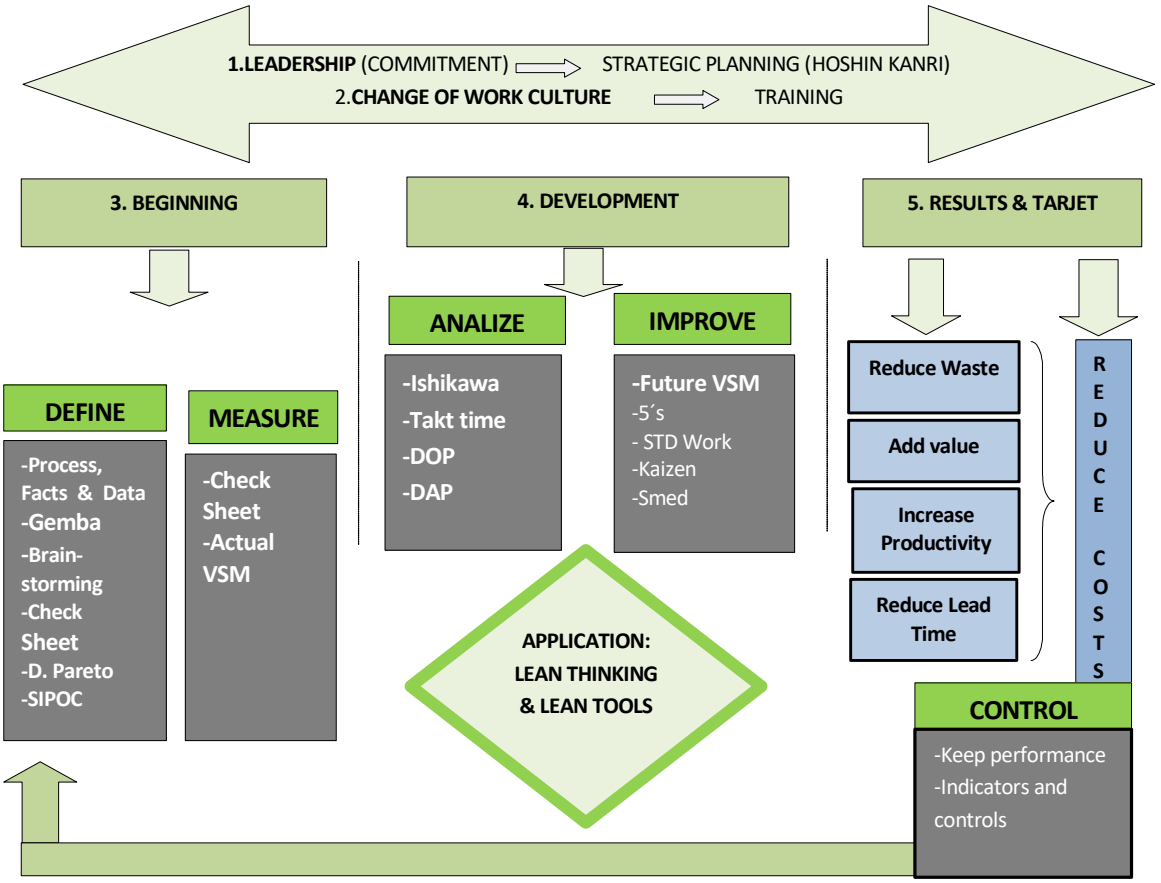


Figure 1. Proposed Lean Model.
Source: Own elaboration

3. *Dead Times*. By not having an order in the Tool and devices, and efficient plant distribution. You must determine the cost $ that represents the SME per unit of time (cost per minute or hour).
4. *New Models*. Sometimes it turns out that for something as simple as changing a bulb you must be an expert since it involves disassembling many parts.
5. *Mechanical Procedures without Standardization*. Each mechanic performs his own procedure according to his experience, including unnecessary activities that lengthen the maintenance time of the unit.
6. *Acquisition of supplies (spare parts, oils, and additives).* The catchment in refactionaries of Tlaxcala and Puebla and directly in Spare parts of Agencies of the different marks in the locality of Apizaco is realized. In Tlaxcala, there is delivery to the client in some refactionaries but in addition to taking too much to the delivery, they have deficiencies in variety. All this is done by the owner.
7. *Emergency Services.* When this happens, the acquisition of inputs is neglected, and the services

provided within the workshop are delayed because the vehicle is serviced directly at the fault site.

6.1.2. Check Sheet

Through this tool, the frequency of the 7 causes was monitored and that increase the total time of service (lead time). The Service was provided to 57 units in the 5 weeks monitored during the first month at the beginning of the project, belonging to clients of the 3 types that the SME owns: private and public. See table 4

According to the Pareto chart above, we can see the 3 most frequent causes that generate service delay:

1. Mechanical Procedures without Standardization.
2. Dead Times by disorder.
3. Lack of Planning

Being the Mechanical Procedures the main cause of service delays. Now that we have this information the next step is to select the SME the most representative service to be treated to improve it. SL SERVICE serves 3 types of clients, then how to know which service of the different clients that is the most significant of the company and that analyzing it positively impacts the same. Figure 3 helped us to select the most representative service of the year 2018 taking account sales, costs and utilities all expressed in MXN:

Table 4. *Causes that delay the service*

Causes	Week 1	Week 2	Week 3	Week 4	Week 5	Frequency	Percent
Lack of Planning	8	9	11	7	9	44	20.5%
Appropriate Late Diagnosis	2	3	2	2	1	10	5%
Dead Times	10	9	12	11	10	52	24%
New Models	3	2	1	1	0	7	3%
Mechanical Procedures Without Std	12	11	13	11	10	57	26.5%
Acquisition of Supplies	6	5	7	6	8	32	15%
Emergency Services	3	2	3	3	2	13	6%
Units Per Week	**12**	**11**	**13**	**11**	**10**	**57**	**100 %**

The data of the verification sheet above are presented below graphically for a better interpretation:

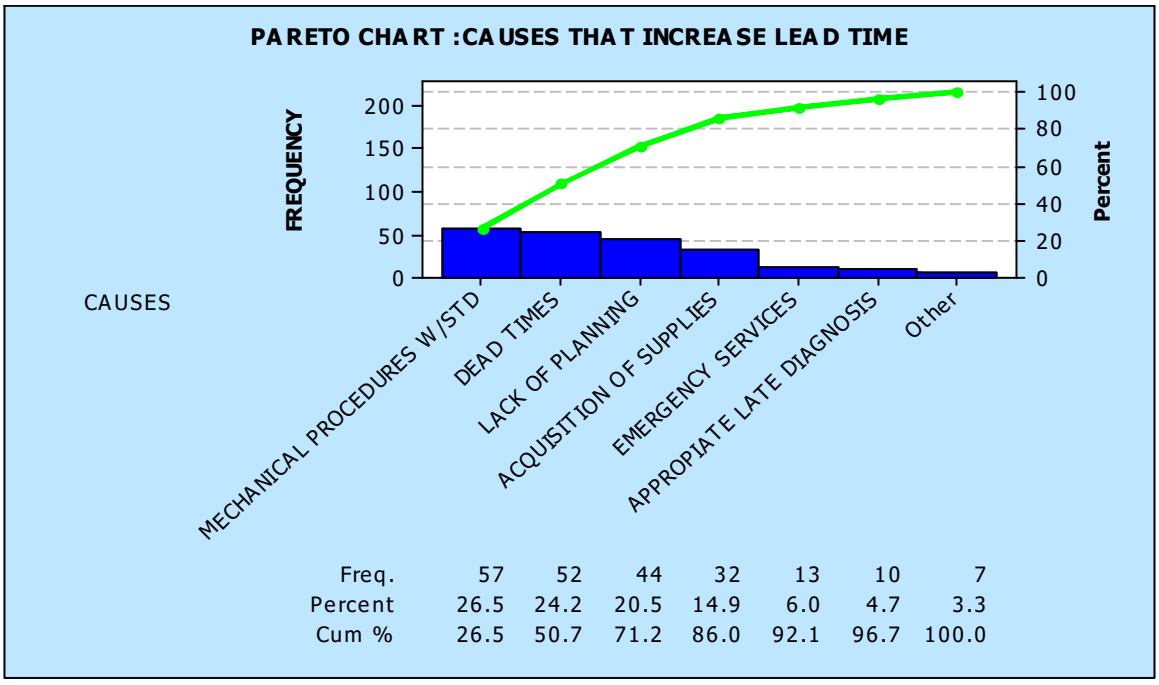


Figure 2. *Pareto Chart*

SL Service

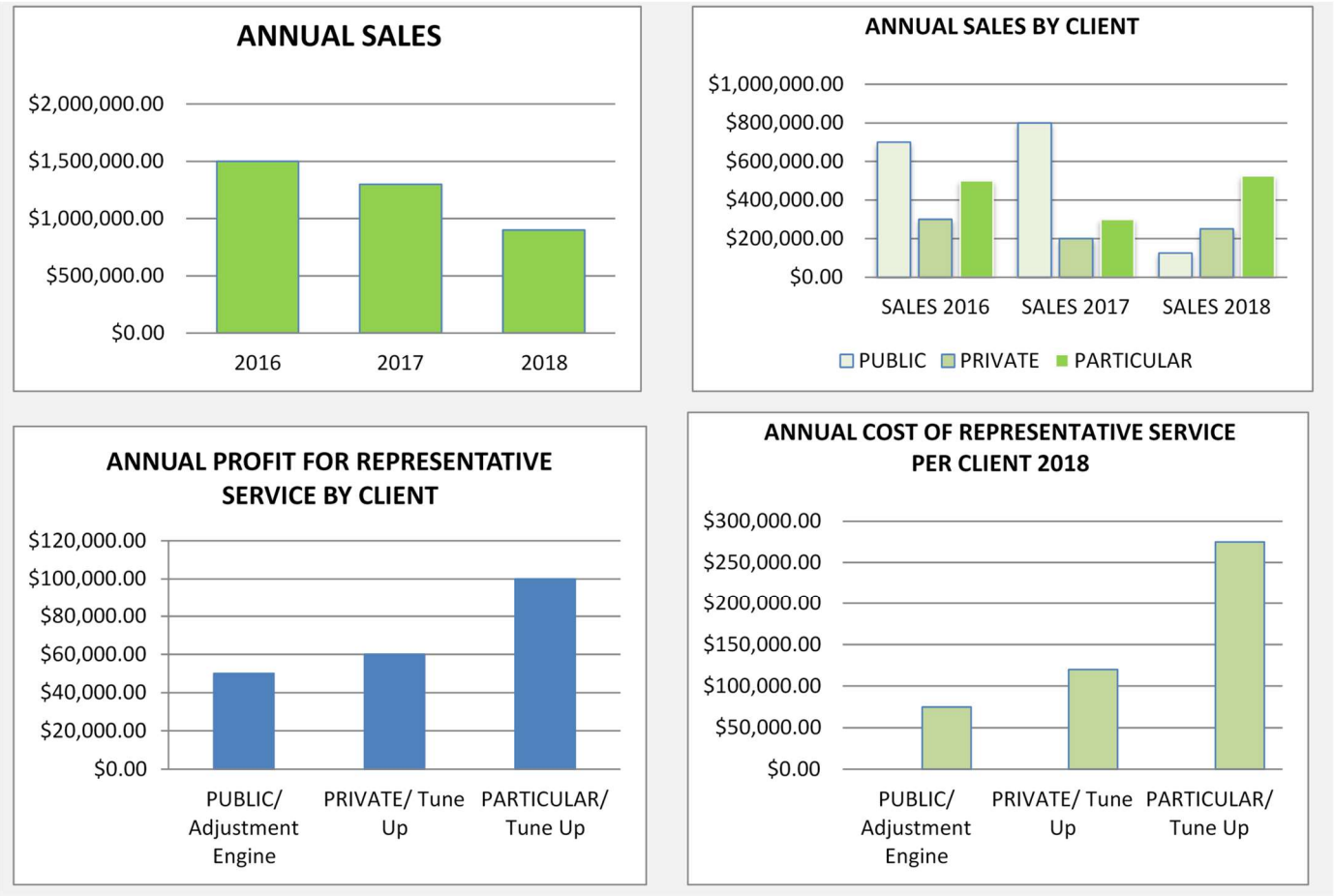


Figure 3. SL Service Graphics: Sales, Profit and Cost.

The selected service is Tune Up of Sedan Autos of Particular Clients because compared to the other services offered by the SME to different customers this recorded the highest demand and profits in 2018. Sedan cars were selected as they are the most frequent in the SME Tune up. The next step is to measure the performance of the Tune Up service through tracing of Actual Value Stream Mapping:

6.2. Measure:

See figure 4.

6.3. Analyze:

When analyzing the Lead Time of the service we can notice that it is in 236 min, and according to the Labor Guide for Real-Time Pro developed by Dowell / Systems, we have that the ideal time for a Tune-Up in a body type Sedan is 140 minutes, which compared with companies such as Bosch Service, Nissan and Toyota show the same time. Dowell & Systems indicate in their Labor Guide that if our Lead Time in this service exceeds this time, it generates excessive costs and annoyance in the client. Dowell & Systems are experts in times of automotive mechanical services in the USA.

6.3.1. Takt Time:

We will analyze the service by calculating the Current Takt Time, which refers to the production rate that must be followed according to the time available based on a certain demand. The formula is Takt Time = Available Time / Demand.

The Takt Time formula is TT = Available Time / Demand, to make the calculation consider the following premises:

- ✓ There are 46 available work hours weekly, which annually represent 2208 hours that are equivalent to 132,480 minutes.
- ✓ Monthly there is an average demand of 50 units for mechanic service, which annually represents 600 units. Providing a Tune-Up service to a Type Sedan

unit represents a sale of $ 1500 and a gain of 26.66% on the sale.

✓ Now for the Takt Time Current the formula is applied as such, but for the calculation of the Future or desired Takt Time it is contemplated to lower the Lead Time to 140 minutes which is the time handled by Toyota, Bosch Service and the labor guide for real-time pro, for this it was necessary to clear the demand of the original formula to obtain the number of services that we can perform with a Lead Time of 140 minutes, where D = Time Available / Takt time

Now for the purposes of analysis and calculation, suppose that the number of services refers to Tune Up to customers since there is a variety of mechanical services. The approach we want to show is that if the model methodology is applied to the key services of each client, it will be possible to reduce the Lead Time considerably and, consequently, productivity will be improved, and cost reduction will become eminent. Consider the following information Mexican Pesos (MXN).

Figure 4. *Actual VSM*

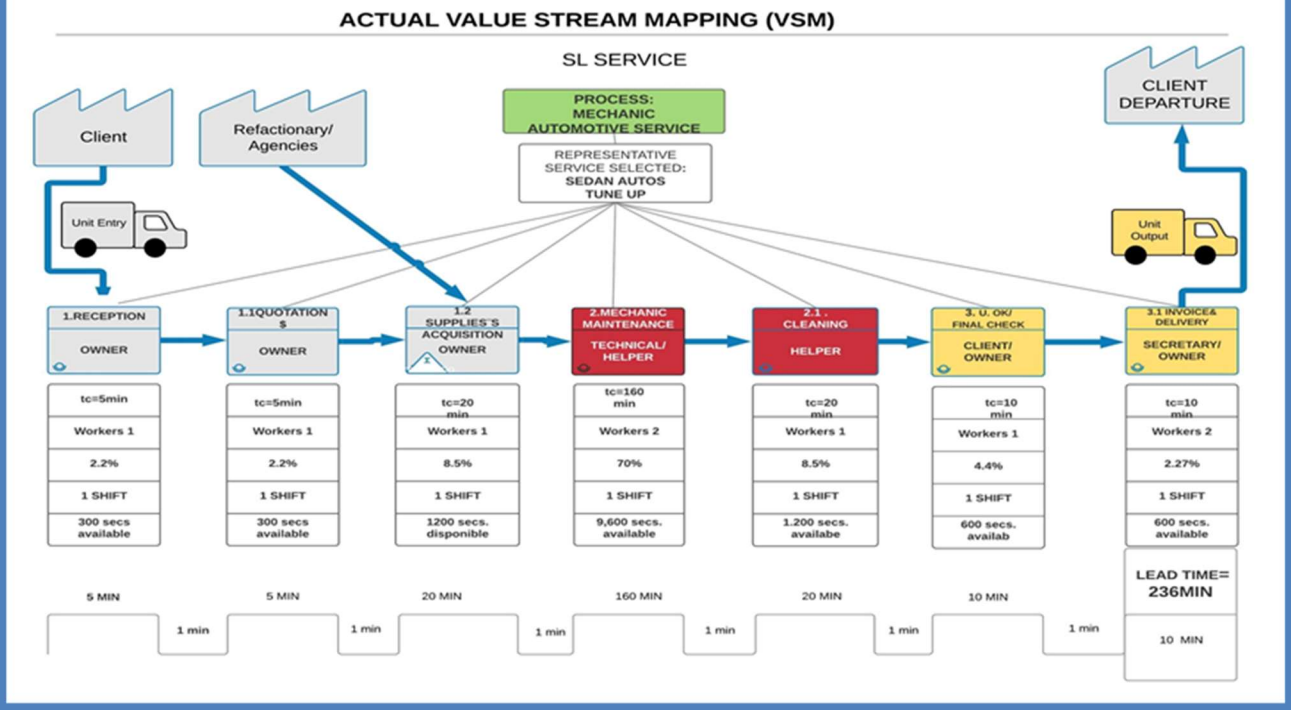


Table 5. *Takt Time*

CONCEPT	TT	Annual Available Time	Annual Demand	Annual sales	Annual Income
TT Current	221min.	132,480 mins.	600 units	$900,000	$240,000
TT Future	140 mins.	132,480 mins.	946 units	$1,419,000	$378,000
	-81mins = 40.6 %		+346 units = 57,6%	+ $519,000 = 57.6%	+ $138,000= 57.6%

The Actual Lead Time of the Up Service is 236 minutes versus 221 minutes of Takt time. This TT indicates in theory that every 221 minutes 1 tuning service is performed but in practice, but in the practice, it takes 236 minutes to do it. Which indicates that we are above the Takt Time and also the desired Lead Time (140 mins.)

By identifying the waste and applying the Lean tools, it is projected to achieve a gradual reduction of 40% of the Total Lead Time from 236 minutes to 140. By reducing the service to 140 minutes with the same annual available time, 346 units could be served. which represents an increase of 57.6% in demand?

The challenge is to achieve this and to be able to do so it is necessary to identify waste by mapping all the activities or operations that are carried out in the process. It must be gradual starting with small goals from 5% up to 40%.

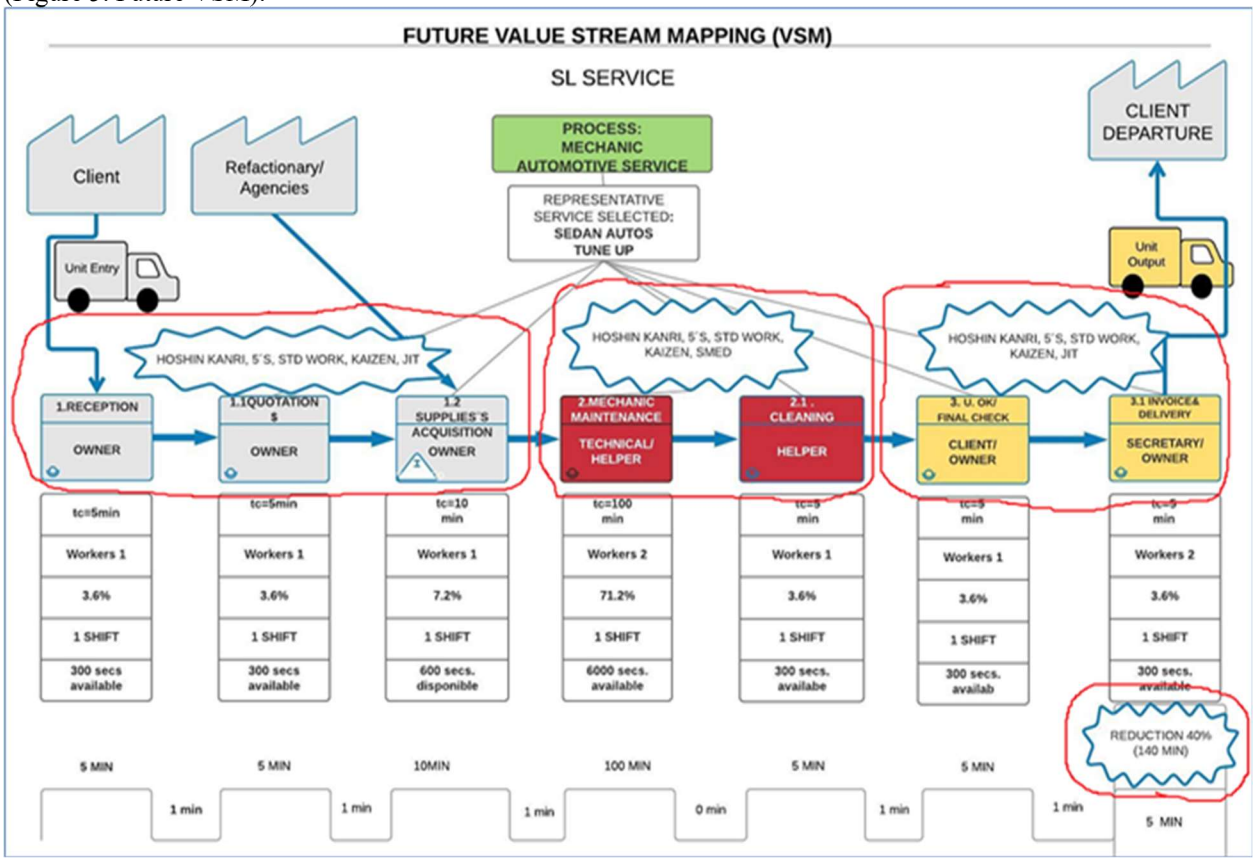
The Future TT would mean increasing sales by 57.6% which translates into an increase in profits of $ 138,000 per year. Consider that the profit margin of the Tune-Up service to Private customers is the lowest compared to the other clients' key services:

Table 6. Representative Service per Client

Clients	Representative Service	Unit Sale	Income
Particular	Tune Up	$1500	$400
Private	Tune Up	$3,000	$1,000
Public	Adjustment Engine	$25,000	$10,000

Imagine the potential that would be had to start standardizing the key services of each client to postpone doing it with all the services offered by the SME. There would be a reduction in Lead Time, which would lead us to increase profits, improve productivity and deliver on time units which would guarantee SL Service, satisfied customers.

6.4. IMPROVE: The future VSM of the process shows the reduction from 236 minutes to 140 minutes of Lead Time, indicating the time per stage s and indicates the Lean tools proposed to reduce the Lead Time of the process (Figure 5. Future VSM):



We can see that the Lean tools to apply to reduce the Lead Time are: Hoshin Kanri, 5's, Smed, Just in time and Std work.

As you can see in the Future VSM we have the proposed Lean tools to reduce the total time of the tuning service and the following list of actions to improve the process is also recommended:

- Hoshin Kanri deployment program to support the owner in the planning of SME activities
- Continuous training in Lean Manufacturing Philosophy to all staff
- Starting with 5¨L Pilot Area and gradually to all areas of the SME
- In the beginning, standardize the key services of each client and gradually standardize them in their entirety
- Always consider the ideas, creativity, and capacity of all staff to improve the process
- Implement a suggestion mailbox system for continuous improvement for internal staff, suppliers, and customers.
- Actions to motivate staff such as diplomas or worker of the month.

6.5. Control

The following actions are proposed to maintain performance and guarantee the achievement of objectives:

- Establishment of Indicators and Controls in the Process
- Publicize the results
- Delegate activities
- Ensure continuous support from the Owner
- Problem response plan
- Development of process manual
- Standardize all services in full.

7. Conclusions

The application of the proposed Lean Model to the mechanical service process allowed us to identify the main opportunity areas of the SME, as they are:

Informal mechanics procedures: what led us to suggest the Lean tool: Standard Work tool. Start with the key processes of each client and gradually standardize in full the services.

Dead times by disorder: Implement 5's starting with a Pilot area, which is suggested to be the area of mechanical maintenance and little by little to all areas.

Lack of planning: Hoshin Kanri is suggested for strategic planning as a Lean tool to help the Owner in the activities that he develops in his Company, for which a deployment program will be developed as a guide and support of the same.

In Tracing the Current VSM we realize that Lead time is through the clouds precisely at 68.5% up compared to Nissan, Toyota, Bosch, and Labor Guide that are in 140 minutes. This comparison indicates that the Pyme SL Service has to improve its service times, beginning with the basis of any improvement project such as the 5'S, then continue with the standardization of all its mechanical services and as a good start to start with the key services of each client. The future VSM shows us 140 minutes of Lead Time which is the challenge to achieve, set small short-term goals maybe 2.5% weekly until you reach the desired goal. We have to analyze all the o activities of the process through operations and analysis diagrams to find the repetitive activities and the ones that cause waste to be able to optimize the value chain of the process and leave those that add value.

The Owner represents one of the crucial parts of the improvement project because it is required to be aware of the change since the success or failure will depend on their level of commitment. The change and adoption of a Lean work culture through constant staff training and being opening to change in improvement projects is a commitment that all staff must assume and be responsible for.

The most important element in the process that we must not forget and consider for the improvement of it is to use the capacity, creativity, and talent of the staff. It is common for improvement projects to forget this element when Taichi Ohno himself commented that instead of the Toyota Production System he would have preferred to call it the Thinking Production System since the success of the system depends on the personnel.

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