

UNIVERSIDAD SAN FRANCISCO DE QUITO USFQ

Colegio de Ciencias e Ingenierías

**Implementación de herramientas Lean & Six Sigma dentro de una
Pyme enfocada a Bienes y Servicios.**

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Ingeniería Industrial

Trabajo de fin de carrera presentado como requisito
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**HOJA DE CALIFICACIÓN
DE TRABAJO DE FIN DE CARRERA**

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Quito, 22 de diciembre de 2020

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RESUMEN

Las Pequeñas y Medianas Empresas (PYMES) tienen un papel importante en la economía ecuatoriana (INEC, 2018). Actualmente aportan más del 90% de la economía del país (Ron, 2017) y el tipo de negocio en el que se concentran más son las empresas de servicios y de comercio (Supercias, 2020). El principal desafío que tienen las PYMES es mantener un constante desarrollo tecnológico e innovador para seguir respondiendo a las exigencias del mercado, teniendo en cuenta que no existe una gestión ilimitada del crédito (Peña, 2019). Por estos motivos, se han puesto en marcha algunas estrategias para mejorar la competitividad y la rentabilidad de las empresas, que están vinculadas al enfoque Lean & Six Sigma (LSS). Las herramientas proporcionadas por LSS han demostrado resultados exitosos en las grandes empresas (Arias, 2020), pero debe haber una metodología bien planificada para lograr resultados en las PYMES. Para el desarrollo del proyecto se propone la implementación de la metodología "DMAIC" en la PYME enfocada en bienes y servicios en el Ecuador llamada "Pro Security Clean". Se encontró que con esta implementación la empresa podría eliminar los procesos que no generan valor, satisfacer las necesidades del cliente y mediante el uso de estas herramientas se puede lograr un cambio de mentalidad y comportamientos en la empresa enfocados a la mejora continua. Se pudo observar que al implementar un plan de 5s la empresa los empleados tienen un mejor desempeño y mediante el uso de un plan de gestión de inventario ABC, señalización y un trolley cart existe un incremento considerable en la cantidad de pedidos que se procesan en las bodegas de Pro Security Clean.

Palabras clave: Lean & Six Sigma, DMAIC, Mejoramiento Continuo, Lean Office, Lean Management, SMEA, Manejo de Procesos, Kaizen, Simulación, 5S.

ABSTRACT

Small and Medium Enterprises (SMEs) have an important role in Ecuador's economy (INEC, 2018). They currently contribute more than a 90% of the country's economy (Ron, 2017) and the type of business in which they are most concentrated are services and trade companies (Supercias, 2020). The main challenge that SMEs have is to maintain a constant technological and innovative development to continue matching market requirements, considering that there is no unlimited credit management (Peña, 2019). For these reasons, certain strategies were implemented to improve the competitiveness and profitability of companies, which are linked to the Lean & Six Sigma (LSS) approach. Tools provided by LSS have demonstrated successful results in large companies (Arias, 2020), but there must be a well-planned methodology to achieve results in SMEs. For the development of the project, it is proposed an implementation of the "DMAIC" methodology in a SME focused on goods and services in Ecuador called "Pro Security Clean". It was found that with this implementation the company was able to reduce and eliminate processes that do not generate value, satisfy customer needs and a change of mentality and employee behavior focused on continuous improvement can be reached. It was observed that by implementing a 5s plan, the company's employees have better performance, and by using an ABC inventory management plan, signage, and a trolley cart, there is a considerable increase in the number of orders that are processed in the Pro Security Clean warehouse.

Key words: Lean & Six Sigma, DMAIC, Continuous Improvement, Lean Office, Lean Management, SMEA, Process Management, Kaizen, Simulation, 5S.

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INTRODUCTION

Globalization starting from the industrial revolution, was the leading cause of international trade (Puerto, 2010). The industries had a transformation when there was an advance in trade agreements, the establishment of means of transport, the growth of demand, and the advancement of production techniques (Puerto, 2010). The term "globalization" is linked to the change in a world economy with a broader degree of integration and interdependence. Its main components are interconnected with the globalization of markets and production (Hill, 2001). This concept has a high impact on companies within a country, mainly in the Small and Medium Enterprises (SMEs), on which our study will focus.

SMEs are small local or regional companies whose purpose is to promote national economic development (Peña, 2019). To be categorized in this segment, they must be companies with no more than 200 employees, and other organizations cannot participate with more than 25% of the company's share (Martinez, 2013). SMEs emerged in the country's economic context to meet the consumption needs of people living in small towns, thus making them less competitive due to lack of technology and capital (Martinez, 2013). For this reason, some characteristics that allow them to be competitive in a globalized world has been demonstrated to be capable of adapting to change and keep innovating. (Peña, 2019). Currently, the challenge that SMEs face due to globalization is the lack of information, the continuous advancement of technology, expensive transportation routes, costs, and existing barriers between countries. (Zetien, 2012).

SMEs in Ecuador are fundamental for the Ecuadorian economy since they represent 95.8% of the business segment (Supercias, 2020). The categorization of these companies is more common to offer services (63%) and trade (26%) (INEC, 2018), putting into account that the company for

the implementation of this project is categorized in goods and services. These companies are necessary for the country since they generate new sources of jobs and competition in the country's productive process, and they contribute directly to the development and transformation of the productive matrix (Ron, 2017). A relevant factor that has helped to increase SMEs' growth in Ecuador in the last decade was the dollarization. Entrepreneurs obtained economic stability, which led to project evolution and growth. There is a constant change in the economic environment, the adaptation of their processes, structure, or management in SMEs to keep competing (Yance, 2017).

This project's chosen company is "Pro Security Clean" (PSC), which was founded in 2010 and has maintained a continuous development. PSC is a distributor of chemical and biosafety products, cleaning implements, and personal protection equipment. The company's office is located in Quito, and it is categorized as a Stratum II SME since it has at least ten employees (Supercias, 2020). Its business model focuses on goods and services. Currently, the company manages an inventory of 1000 products, 50 of which are registered trademarks. Trademarked products are produced locally as an outsourced model, and the rest is imported or acquired from local suppliers. The sales channels that the company manages are direct and electronic. As for the electronic channel, the products' marketing is managed through social networks or online sales channels, and the direct channel is through the customer's contact with the company or vice versa (PSC, 2020). For the project, the company's commercial process was chosen. The main objective is to implement Lean & Six Sigma tools to optimize or eliminate processes that do not generate any value and achieve a continuous improvement plan that meets the customer's expectations.

The implementation of LSS tools in PSC was chosen because they are based on process optimization, waste reduction, general cost reduction, and continuous improvement. These tools aim to comply with customer requirements at a lower cost and in less time (Torres, 2017). LSS is

considered as the evolution of the classic theories of continuous improvement and quality control. This philosophy takes the main elements of the precursor theories and structures them to create an improved approach that is more effective in obtaining results (Felizzola, 2014). Other aspects that LSS is based on are:

- Intensive use of data analysis and statistical tools;
- Ability to measure results through a financial and functional aspect;
- The effectiveness through its implementation creates a significant management and people commitment to meet objectives;
- Organizational change focused on excellence.

It should be mentioned that there are many benefits for implementing the DMAIC methodology for this project as cost reduction and elimination of waste in processes.

With the above background, the project's general objective will be to implement LSS tools in a goods and services company to reduce waste and increase operational efficiency. There are also other objectives to reach, such as:

- To generate a plan of continuous improvement that will be focused in the medium and long term;
- To diagnose the real situation of the company to look for improvement alternatives;
- To propose a business model based on LSS tools to support the growth of the company.

THEME DEVELOPMENT

Literature Review

The Lean Six Sigma methodology was born from the combination of Six Sigma principles with the concept of Lean Manufacturing. In the beginning, these new ideas were applied in

manufacturing companies like Motorola. However, with the continuous advance of time, it is now known that it is a methodology that fits into a company's process.

Six Sigma

Six Sigma is a methodology that focuses on process improvement; Bill Smith created this methodology in the 80s at Motorola (George, 2003). The implementation of this methodology tries to reduce the variability in the processes of a company. It also seeks to reduce or, if possible, eliminate the defects or failures that exist when a service or product is delivered to a customer (Guerrero, 2019).

The goal on which Six Sigma is based is to be able to reach a level of 3.4 defects per million opportunities (DPMO), having as a definition of defect any event in which a service or product does not meet the main expected requirements of a customer. It is necessary to determine this level to review how many standard deviations fit within the specification limits defined for the objective in the chosen process (Arias, 2019).

Lean

Lean has a fundamental pillar at the beginning of the 20th century in the United States. F. Taylor and Henry Ford were the pioneers in introducing several techniques that sought to optimize the mass production processes in the manufacture of automobiles (Barsalou, 2013). These techniques were taken to a degree of excellence by the Japanese, where we find one of the most relevant figures Sakichi Toyoda, founder of Toyota Motor Company (Touron, 2016).

Lean is a way of organizing work focused on the optimization of the productive system seeking to eliminate waste; it also focuses on continuous improvement within the organization and the identification and correction of activities that do not generate any value to the process (Shah, 2002). The principal goal-focused of Lean Manufacturing is to minimize all the losses generated

at the time of carrying out a manufacturing process so that only the essential resources for the process are used. So it will be possible to achieve a clear improvement in quality, cost reduction, and product manufacturing time (Touron, 2016).

Lean & Six Sigma for Services

There is a link between Lean and Six Sigma to have a greater scope in solving the problems that exist within a company (Purdue, 2020). The Lean methodology chosen for the project's development focuses mainly on services because Pro Security Clean is listed in this area. One reason for using this methodology is because of "*the huge opportunity that offers. Empirical data have shown that the cost of services is up to 30-80 % waste. The processes are riddled with activities that add no value from the customer's perspective*" (George, 2003). Service departments do not have much history of using data. The need for data management is almost non-existent, and service company employees are not very accustomed to handling this type of information compared to those working in manufacturing companies. It does not impede implementing data for analysis within service companies. LSS for Service helps understand how companies can start managing data and analyzing it with specific simple statistical tools that bring benefits such as reduced costs and process delays (George, 2003).

There is a structure of LSS for Service:

- I. ***Using LSS for strategic advantage in Service: LLS is an essential tool for driving shareholder value, and all that entails*** (George, 2003).
- II. ***Deploying LLS in Service Organizations: It include insights from corporate leaders who have already implemented it, accelerating the process*** (George, 2003).

III. Improving services: It includes the steps of using effectively DMAIC on existing processes and one on using Design for LSS to invent new processes or services (George, 2003).

The approach will be based on the third option because the project will follow a plan of continuous improvement. Focused on the implementation of a DMAIC, in the chosen goods and services company, where the processes that are managed in the commercial will be analyzed, focusing on the elimination of any type of waste and as next steps be able to offer improvements established in a medium to long term to eliminate costs. Using a project charter will officially initiate a project or a phase of it. It formally authorizes the existence of a project and provides a reference source for the future. This tool gives direction and purpose to the project's management from start to finish (Simplilearn, 2020).

The objectives of a project charter are:

- It must explain the needs of the business to choose which project to undertake.
- It must capture high-level information for project planning.

The development of LSS implementation in a company focused on providing a service, after defining the leader and the team that will be part of the project. All the details were specified. It was possible to define which roles and responsibilities each participant of the project would take and the objectives that wanted to be fulfilled. It could be done in a practical way using a project charter with the background, reasons, and goal statement of the project (Dora, 2015). At the time of making the project charter, it is possible to identify the CTQs that meet the needs and requirements of the client for the realization of the current work some CTQs that were identified were: speed of delivery of products, product quality, and efficiency in the sales service provided. In Issa's work, the different CTQs were also identified in the project charter, being these the

priorities of the business, which is related to a parameter that is fundamental for the client (Issa, 2020).

A Gantt diagram was used to project and plan the activities to be carried out in the stages of LSS (Arias, 2020). This tool has two main advantages; it is easy to carry out, and the visualization of the activities that are going to be carried out is very pleasant, managing to control and follow up on the progress in each of the project's planned stages. The diagram's objective is to define the schedule within a specific time to comply with it (Arias, 2020).

In literature, Process Mapping tends to be used to identify weaknesses and strengths in the company's departments and who is responsible for the task/activity (Hessing, 2020). It will help identify any re-processes and reduce defects and process cycle times to increase productivity. The components within a process map are inputs, outputs, and the steps in the process. While making the company's process, mapping was essential to understand what activities are carried out in the commercial area. The departments managed in Pro Security Clean are the commercial department, accounting & finance, warehouses, and the company's general manager. After analyzing several sources, it can be concluded that carrying out a process mapping in a company project is fundamental since we can understand what is being done and what activities are not generating any value. BPMN will be used for the process mapping of Pro Security Clean to handle an internationally standardized language. This language is easy to be understood by all employees of the company. In similar studies that performed a process mapping, it is evidenced that it can communicate visually how the processes flow in companies. The study conducted by Morales in 2019 shows that the maps were fully understood by people involved in the project (Morales, 2019), and thus give us a complete opening for the use of this language

Lean Six Sigma follows a Kaizen concept that means improvement, but a more specific definition is "continuous improvement" in the work environment, whole life, or even social life (Imai, 2020). Five fundamental principles of Kaizen must its tools and behavior follow. The principles are:

- Know your customer;
- Let it Flow;
- Go to Gemba;
- Empower People;
- Be transparent.

It has been evidenced after a bibliographic review that implementing the Kaizen concept associated with LSS projects has had a great benefit. In Arevalo's study, realized in 2015, the Kaizen concept was implemented in customer service support in a service company. In contrast, this project has as main objective the formation of kaizen teams that carry out activities of analysis, development, and implementation of improvements in different situations, which increased the response rate of the clients' calls (Arevalo, 2015). In conclusion, it was possible to confirm that Kaizen's application to companies related to services has several benefits.

One tool used in Kaizen is the 5s concept because it is characterized by producing a change that generates several benefits in the place of implementation, which improves the conditions to be able to perform new business management techniques (Dorbessan, 2006).

The name 5s comes from the five Japanese words that characterize it:

- Seiri (Separate): Keep only the necessary to perform tasks;
- Seiton (Sort): Maintain tools and equipment for easy use;
- Seiso (Clean): Keeping workplaces, equipment, and tools clean
- Seiketsu (Standardize): Maintain and improve the achievements that have been made;

- Seiketsuke (Self-Discipline): Ability to meet the standards that have been set.

One project focused on establishing a trained team that understands the importance and guidelines of this methodology. Some objectives were established and related to the workstation's organization, adequate archiving of documents, or correct handling of labels. In conclusion, the percentage of error was lowered to 1.07% (Arévalo, 2015).

Also, the VSM tool can be adapted to companies that perform services. It is known that this diagram is mainly used in manufacturing companies. A study conducted shows that the results are valid for this type of company since applying a VSM allowed the integration of improvement techniques in the organization that is commonly seen in manufacturing processes. Taking into account that this tool is visual and helps to understand in depth the flow of information that exists in the value chain (Fernandez, 2013).

METHODOLOGY

There is more than one type of methodology used in Lean & Six Sigma projects. Some of them are PDCA (Plan-Do-Check-Act) created by Deming and DMAIC, which will be chosen to realize this project. This methodology was chosen because it is one of the most practical ways to implement Lean Six Sigma projects (Lopez, 2020). The chosen methodology seeks to eliminate or reduce waste in the processes, costs associated with this, and thus be able to have more significant customer satisfaction.

By having the six-sigma methodology through the use of the DMAIC cycle, we can improve the quality by focusing on reducing the wastes and the variability in the processes (Morales, 2019). Also, DMAIC is a data management strategy that seeks to improve processes, being a structured method focused on problem-solving (Lopez, 2020).

DMAIC follows a step-by-step strategy for its application. This methodology is part of Six Sigma, where the main goal is to execute projects focused on improvement.

- Define (What is essential)

In this phase, the objectives of the project and the critical requirements of the client are defined.

The processes will be documented by mapping them, and the best way to eliminate the problems should be found by building an effective team.

- Measure (How is it being done)

The current performance of the process will be measured to determine "what" is being measured.

Also, in this phase, the measurement system to be chosen is developed and validated to determine the process's current performance.

- Analyze (What is doing wrong)

In this phase, we will seek to analyze and determine the root cause of defects or problems in the chosen process, understanding the reason for such variation and identifying the potential causes.

The next step is going to focus on identifying the improvement actions to be taken in the process.

As the hypotheses of the solutions for the root cause are developed and tested.

- Improve (What should be done)

The potential solutions to be taken are developed and quantified. In turn, the process is improved and optimized through assessments and the selection of a final solution. Afterward, it is verified if the chosen solution is the correct one following an approval plan

- Control (Control the improvements implemented within the process)

In this last stage, the team implements the solution presented, guaranteeing that the improvement plan will be maintained. It must be ensured that in a scenario where new problems arise, they can be identified quickly (García, 2018).

Lean & Six Sigma has an approach based on improving a service or product to create their products in a better way and mainly to achieve a lower response time and reduce costs (Pyzdek, 2003). It should be mentioned that the control phase will not be carried out within the project, but it will be sought to establish a future control plan so that the organization can keep the improvement proposals working. The following is a breakdown of each of the phases of the DMAIC methodology, mentioning the tools and objectives to improve the processes within the commercial area of Pro Security Clean of Ecuador.

PROJECT DEVELOPMENT

Define. –

In this stage, the scope to understand the current situation within the commercial process and to be able to know which are the contributions and key relationship with the rest of departments in Pro Security Clean.

The definition and technical analysis of the problem must be initialized based on the objectives set for the realization of this Lean Six Sigma implementation project, therefore it is important to choose tools that can solve it, such as Pareto diagrams, the creation of a project charter, process mapping, and a joint analysis (Morales, 2019).

A project charter was the first tool used since it formally authorizes the existence of a project and provides a reference source for the future, where the definition of the project is documented and through it can identify the direction to follow and the purpose in the management of the project from start to finish. It was followed by the Gantt chart's realization to document a report of the activities that were done, time, and level of compliance of these as agreed with general management.

It was identified that the company has three departments: commercial, accounting & finance, and general management. In the commercial department are currently different ways of classifying customers, and each of the options follows a different protocol that seeks to meet all requirements in each situation following a series of steps already established by the company's general management. The department in charge of accounting & finance is always present in the commercial process because each client registration and invoicing must be done according to the country's laws. For these reasons, there must be a constant and well-established flow of information between all departments.

For the process mapping, the software Bizagi with the BPMN 2.0 language was used since it is standardized worldwide. Through the involvement of those responsible for the company's different activities, the process mapping will be carried out. It will also be proposed a work team directly linked to general management for establishing direct information channels to obtain results that have a more significant explanation of the process (OMG, 2011).

Currently, the company does not have management indicators focused on the analysis of customer satisfaction, compliance with product delivery on time, and compliance with sales goals.

Measure. –

In this phase of the DMAIC, the scope is to collect the maximum amount of data associated with the commercial area's possible problem. The correct selection of the sample will be established based on the bibliography. The capacity of the process and the objectives established in this stage must be determined. These objectives will describe the process in detail to understand the key points and the functionality of the process. It will also be necessary to establish certain types of metrics to verify the performance of the process.

Using the SIPOC tool helps us to manage the transition of stages visually, representing and analyzing the company's flow to understand the impact of the value chain. Following the map of the value chain, we proceed to describe each activity.

1. After receiving and registering a purchase order, the commercial department proceeds to categorize the client. Currently, four types of clients are handled: if it is a new client for the company, if it is a passive client, active or considered not "effective" to make the sale.
2. The accounting and finance department is responsible for checking the status of the client. If it is accepted, the order is sent to a warehouse manager to prepare it.
3. After receiving a purchase order sent by the credit and finance department, the warehouse manager proceeds to verify the stock of products. If there is no stock, the order is placed with the suppliers. Then, the order is invoiced, and a delivery route plan is prepared. The dispatch of the products the company has established must be done in a minimum time of 48 hours. If this delivery time is not fulfilled, the commercial department is responsible for monitoring what happened with the order and provide a solution to the customer by contacting him directly.
4. After the order is delivered to the client, the commercial department proceeds to perform an after-sales service.

The company currently does not have an efficient system to control the acquired and later sold products. It is required to implement a system that can enter the number of products in the warehouse, informing when the products are about to be sold out. Thus, affecting the company's profitability can directly reduce customer satisfaction since purchase orders can be generated without detecting whether there is stock.

Having an objective to measure the current situation of the CTQ's ideal sample size must be determined. It focuses on fulfilling the specifications of error, level of confidence, and the population's size that is part of the data analysis to infer the current situation in the commercial area processes. We will analyze the number of orders within the year 2020 from January to the middle of October, considering that it is a finite population.

The formula to determine the sample size established by proportions for a finite population will be used, which is described below:

$$n = \frac{N \times Z_{\alpha}^2 \times p_o \times d_o}{d^2 \times (N - 1) + (Z_{\alpha}^2 \times p_o \times q_o)}$$

Equation 1. Proportions for a finite population

Where N is the sample size, Z is the deviation from the mean value that is accepted depending on the level of confidence is wanted to be achieved. Considering a standard normal distribution usually has values between 90 and 95%, in this case, it will be taken a value of 95% since it is a value usually used in projects of this type (getting a value of 1.96). D is the maximum accepted error. P is the proportion of the characteristic expected to be found in the population; it will use a p of 0.5 because based on the literature. It was determined that this value is adequate when we do not have complete knowledge of the population; this project aims to maximize the sample size. Q is the value of the difference of $1 - p$ (Guerrero, León. 2020).

For this project, N 's value will be the sum of all the orders that existed in the time previously established. A 95% confidence interval will be used since the exact value of p is not known.

By replacing these values:

$$n = \frac{2000 \times 1.96^2 \times 0.5 \times 0.05}{0.05^2 \times (2000 - 1) + (1.96^2 \times 0.5 \times 0.5)}$$

$$n \approx 33$$

Thirty-three random orders will evaluate within the period described above. Each order comes with a quantity N of products; they can be of the same type or different types. Currently, the orders that have more demand are those related to biosecurity and protection, such as antiseptic alcohol, alcohol gel, masks, visors, and others. An analysis can be done with the company's general manager to determine what kind of problems were discovered in these orders. With the information found, a Pareto and Ishikawa analysis to determine the company's causes of problems will be performed. With this, the next step is to create a mitigation and control plan to maintain it.

To follow a 5s implementation plan and to control each of its stages, a survey was carried out consisting of 20 questions related to each of these stages, this survey is presented in annexes. The Likert scale was used. All the surveys were answered online by the general manager.

Data collection was carried out during two stages, half of October and half of November 2020, taking it as a test plan. Two of the four vendors were evaluated. A total of 64 entries were obtained, where showed an increase to the previous month. The evaluation covers two points: the workers' evaluation, for example, exact assignment of roles, knowledge of procedures, and others. The second point is based on the workplace's control following questions such as order, control of personal elements, cleaning kit in the workplace, and others.

Analyze. –

In this phase, it will be possible to recognize the primary sources of variation, the cause of the problems, and determine the path to follow in the commercial process of Pro Security Clean del Ecuador. From the sample of 33 orders, three orders presented problems of different nature with the products or processes. About 10% of incidents are handled in the company's orders; this

value was the same that the one that was provided by the company's general manager before this study was carried out.

After making one brainstorming and diagraming, it can be presented in an organized way all the causes of a particular effect, achieving a better visualization of the current problems that exist in the company and what are the possible actions for improvement.

According to with the brainstorming presented in annexes “*Pro Security Clean Brainstorming*”, we can say that as a result, we have that the variables that have a more significant impact on the commercial process being related to a low internal and external customer satisfaction of Pro Security Clean (PSC) are related to Inventory Management, Product Quality, Missing Products, Service Quality, Commercial Process, and Information Management.

The Pareto diagram analysis will help to identify the irregularities that may exist within the company, to identify which are the points of improvement, and to define which would be the action plan to follow to attack the problem that affects the company. This diagram represents the rule related to 80/20, that is, in most cases, 80% of the problems are produced by 20% of the causes. With this tool, it was possible to assign an order of priorities to make decisions. It turned out to be a benefit for the study since it allows to focus the company's objectives to a path of continuous improvement, optimize in a better way the efforts, and focus on the aspects that have a more significant impact.

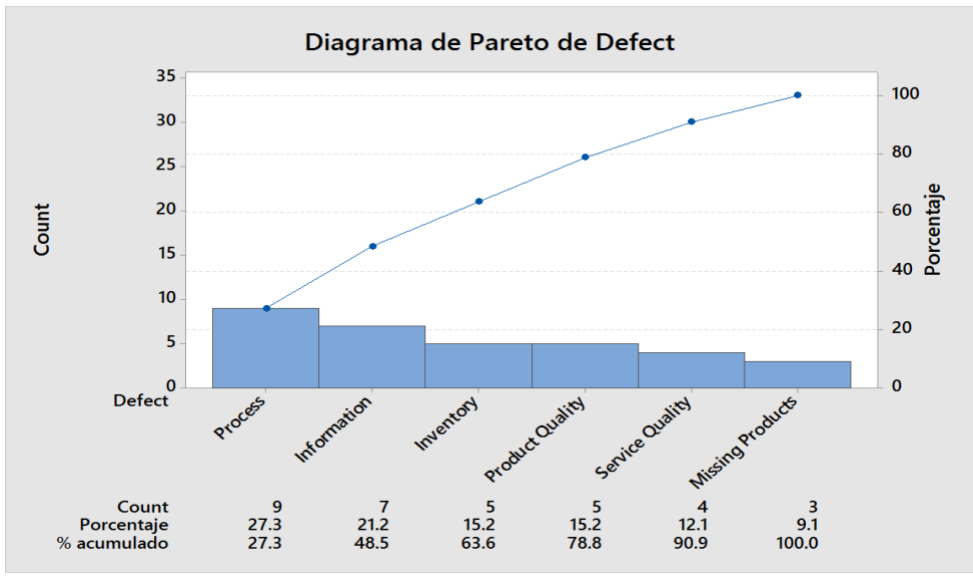


Figure 1. Pro Security Clean Pareto

After obtaining the Pareto diagram, the problem that has more incidents is related to the commercial process. The causes of this problem are related to Necessities Identification, Suppliers agreements, Transportation (Local-Provinces), and Inventory Management; therefore, we proceeded to make another Ishikawa diagram to have a better explanation.

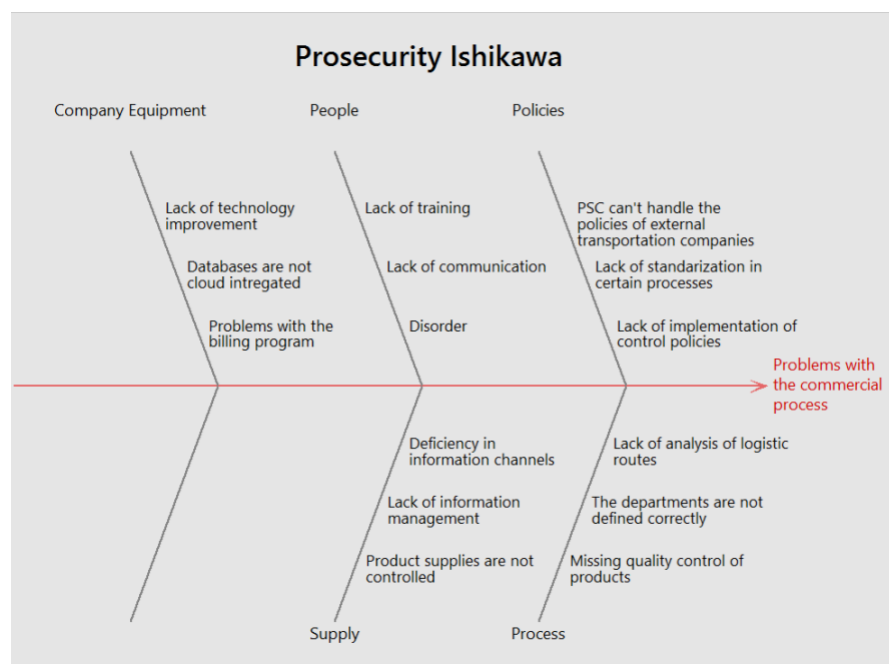


Figure 2. Pro Security Clean Ishikawa

It is essential to mention that most of the company problems are directly related to the lack of technological implementation and impossibility to control the deliveries to different provinces. As for the first problem mentioned, the company does not handle any ERP where the information of areas involved can be shared. At the moment, it only has software that serves for invoicing and accounting registration, but the rest of the information management is done manually, mainly in excel sheets. Neither does it manage a database. There is a communication gap between the process members; there is a lack of control in the deliveries. Most of them are managed by an outsourced company. Pro Security Clean (PSC) currently does not have its service for province deliveries. In the orders that are generated with these characteristics, there are delays according to the estimated date. Also, it is not possible to control the logistic management of the routes for the deliveries. Another factor that must be taken into account that generates problems is related to the products' quality. As mentioned before, PSC does not manufacture its products either, they are imported, or an outsourced company manufactures them.

Two value stream mapping graphs (VSM) were graphed; one focuses on the commercial process, i.e., from the arrival of the order, the sale of the products to the customer's delivery. The second one has the objective of representing the post-sale service that carries out with the client. An adaptation was made since this tool is mainly used for companies located in the manufacturing area. The goal of this procedure was to identify waste such as waiting, movements, processing, among others, in order to display them. This information flow is mapped to be able to understand it. Both VSMS are in the annexes, but it is of great importance to analyze the cycle time (CT), value-added activities (VA), not value-added activities (NVA), and the lead time (LT).

C/T = 75 min
VA CT = 19.5 min
NVA CT = 11.5 min
Lead Time = 1360 min

Figure 3. Pro Security Clean Process 1 VSM

The first VSM has a cycle time of 75 minutes, which is measured starting from the reception of the order to the delivery's preparation. The VSM has a VA 19.5-minute value; in this classification, we can find activities such as information transfer, creation of accounting documents, or delivery checklist verification. While the NVA has a value of 11.5 minutes, finding activities such as printing documents, completing information manually, and unnecessary waiting times. It is fundamental to mention that the time allocation was provided directly by the company's general manager; due to the current conditions, it was impossible to measure the times on site.

VSM SERVICIOS	
CT	60 min
NVA	20 min

Figure 4. Pro Security Clean Process 2 VSM

In the second VSM, the cycle time value was 60 minutes, counting from the time the after-sales service order arrives at the commercial advisor (following a First In First Out system) until it is completed. A 20-minute NVA time was also identified. The leading cause being the unnecessary waits that customers must have tied to manual data collection and the lack of management of an automated system that shares the information directly with the rest of the areas.

Because the person in charge must first accept the service request, the service cannot start without the acceptance check.

Improvement. –

The study's focus is guided in proposing the implementation of the Lean & Six Sigma methodology to the commercial process of Pro Security Clean (PSC). Therefore, this stage will indicate the steps that will be proposed to the company to achieve an improvement of its processes. The purpose of following the improvement phase of the DMAIC is to be able to detail with high precision the actions that the company is going to take to be able to have a better performance, reduce times and unnecessary costs that directly affect the financial situation within PSC. A continuous improvement plan will be provided, taking into account a cost-benefit analysis, simulation of an efficient environment in the processes, implementing a tool for KPIs control, and improvements to follow. Bearing in mind that the company being an SME has limited economic resources.

A simulation was carried out in the Flexsim software of the warehouse organization process and the order dispatch procedure. Due to the country's current situation, it was not possible to take the dimensions of the office. However, through the company's general manager's guidance, a simulation was made according to the information and validation provided by Pro Security Clean (PSC). Simultaneously, we proceeded to list some assumptions to have a good analysis of the possible improvements that PSC can implement.

1. Orders arrive every day at any time of the day, but it will be one run in this case.
2. Each type of color represents a different product stored in the company's warehouse showroom.

3. The size of the place where the simulation occurs is not taken into account, but the operator's average speed is established in both situations (before and after).
4. The assignment of orders in the dispatch process is done randomly.
5. The simulation time of the organization process in the warehouse has a value of 3600 seconds, while in the dispatch process, a time of 2700 seconds was assigned.

The simulation results found are:

Organization process. –

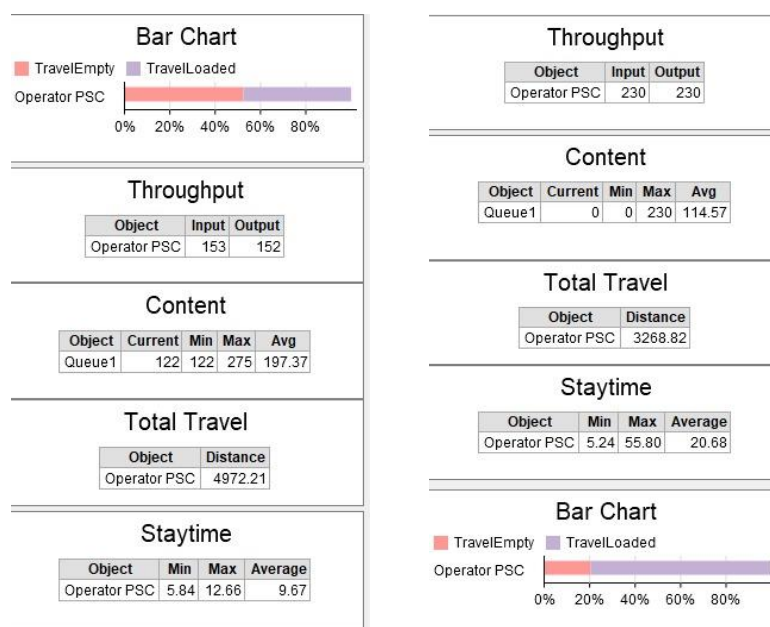


Figure 5. Before implementation & After implementation #1

The As-Is Organization Process reflects that the operator has a throughput of 153 products received and 152 products placed into the racks. The total movement distance of the operator before the Lean implementation is 4972 meters. Compared with the To-Be model, the throughput is 230 received products and 230 racked products, the total distance traveled is 3258 meters.

The To-Be plan proposes implementing a Kanban board in both processes, where the most critical communications, KPIs results, and safety measures can be placed. The use of a trolley to

load more products and order or extract them from the racks in a more effective way. Implementation of visual signs and an inventory control sheet on the racks. It is also proposed to manage the company's documents in a more orderly way, using a specific area where they can be filed, and finally implement the 5s methodology in the workstations to maximize the efficiency of the people involved with the business process.

Order Preparation & Dispatch Process. –

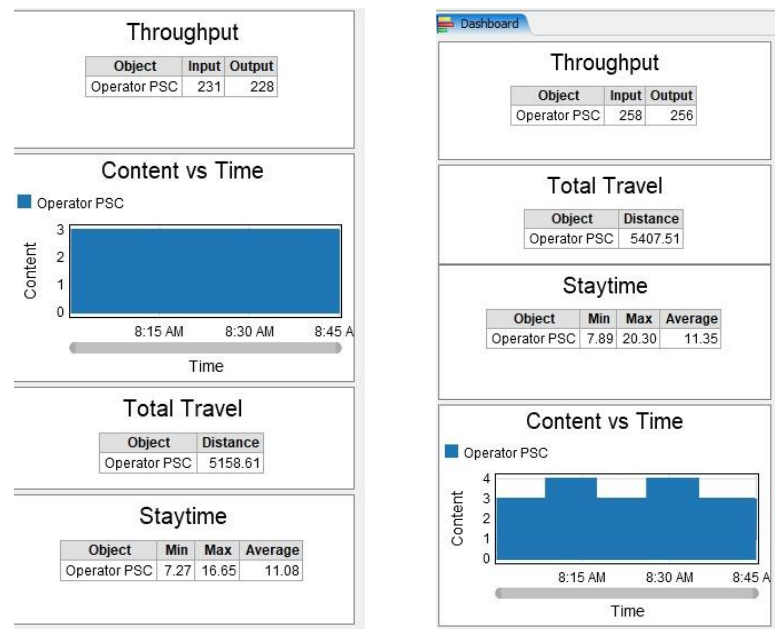


Figure 6. Before implementation & After implementation #2

The As-Is Organization Process reflects that the operator has a throughput of 231 orders received and 228 products dispatched. The total movement distance of the operator is 5158 meters. The To-Be model shows a different result, the throughput is of 258 received orders and 256 dispatched products, the total distance traveled is 5407 meters.

An increase in the number of products placed on the racks or dispatched could be observed in both processes. In the first process, there is a 50% increase, while in the second process, the

total distance traveled increased, but there is also an 11% increase in products dispatched. Therefore, there is a considerable increase in productivity in the Pro Security Clean warehouse.

By realizing the 5s implementation control document, different dashboards could be extracted. It is possible to observe in percentages if there is an increase or decrease of certain aspects mentioned before, to be evaluated. The document also presents an analysis of some KPIs that evaluate if there is an increase in sales, proper handling of products in inventory, the number of complaints about defective products, and others. We also proceeded to analyze the fulfillment of the 5s master plan by the company's commercial advisor. In the future, we seek to add to the rest of the commercial team since currently, only two of them were part of the analysis.

The results of the analysis are:

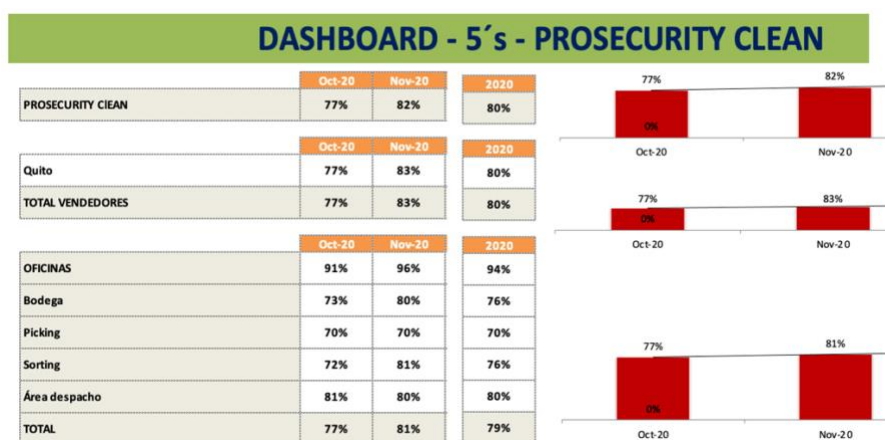


Figure 7. Pro Security Clean 5s Dashboard

There was an increase in the results compared to the previous month, from 77% to 82%, considering that the data collection took place from the middle of October to the first 15 days of November. The only area that presented a reduction in its rating was the dispatch area since the pilot plan for implementation could have influenced the procedures carried out by those in charge of this process. The aim is to stabilize the control of this plan by handling a monthly analysis of results. Therefore, the next results will be contrasted at the end of December 2020. However, with

the analysis of the values, it was demonstrated that using these tools has a positive result when implemented in Pro Security Clean.

A kaizen events plan implemented following its primary function, since this methodology helps us make improvements in the organization, which involves all the people within it to make improvements, without involving large amounts of capital investment. Three kaizen events were identified for the first VSM and two kaizen events for the second VSM that will be applied within the Pro Security Clean company, both of which can be observed better in the annexes. These events have been chosen because they present failures, delays, and in general, they are not fulfilling an objective that the company wants to achieve, delivering orders to customers on time. The processes that have been identified to apply this methodology are in the following templates. Opportunities for improvement exist in the proposal to PSC, whose objective is to reach managers and specific tentative dates of the application, which are at the discretion of the company's staff.

Kaizen events are presented in the annexes "*Pro Security Clean Process Kaizen Proposal*".

Considering that the ABC inventory management system, which consists of dividing the products into three classes, based on its demand value, and in this way, the area managers can focus on those representing a better monetary value for the company.

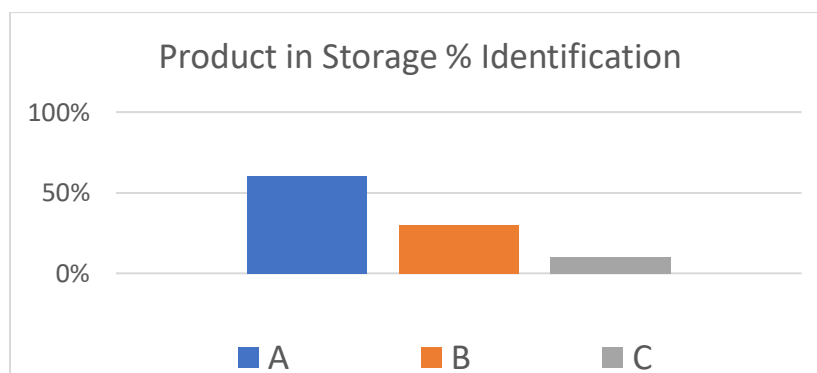


Figure 8. Pro Security Clean Process ABC Inventory Management

The improvement team analyzed the demand of the company to determine which products had a higher level of consumption (A), a medium level of consumption (B), and a low level of consumption (C). The identification shows that high consumption items represent 60%, medium consumption items 30%, and low consumption items 10% of the inventory. It is established that category A should have closer control, better demand studies should be carried out, Pro Security Clean should negotiate better terms of purchase contracts, and a continuous inventory system should be managed. While for products rated as B or C only by maintaining observation at their levels, they can be controlled. It is proposed that Pro Security Clean should use this type of management model in order to be able to satisfy customer demand.

Finally, to have a result of the impact on the implementation of the proposed improvement, a cost-benefit analysis was carried out. In this way, it can be seen if it is convenient for Pro Security Clean to consider the proposal. The prices were evaluated according to those provided in the Ecuadorian market.

Year	Cost	
2021	ERP & Installation	\$ 5,500.00
	Trolley Cart	\$ 100.00
	ERP Support	\$ 200.00
	Miscellaneous	\$ 150.00
TOTAL	\$ 5,950.00	

Year	Benefit	
2021	+10% Sales Incrementation (annual)	\$ 8,000.00
TOTAL	\$ 8,000.00	

B/C	
TOTAL	1.34

Figure 9. Pro Security Clean Cost-Benefit Analysis

After collecting the necessary information, the economic analysis was carried out, which seeks to establish a relationship between the two and verify the measure's feasibility. The total costs are 5950 USD, while the expected benefit is 8000 USD. The relationship gives a total of

1.34, which is a value greater than 1, so the implementation would benefit PSC. It should be taken into consideration that there are benefits about an economic increase in the company and an increase in the operability and efficiency of the people within the commercial process. A better level of service to the clients will be seen, a good percentage of manual activities will be reduced, they will be able to automate them. The exchange of information will be safer and faster.

CONCLUSIONS

In conclusion, it was possible to understand the commercial process of Pro Security Clean and raise possible actions of improvement for the company; after performing the analysis cost-benefit, it was possible to observe that it will directly benefit the company. The company is willing to invest in the proposed improvements to handle the information better, reduce manual processes, and more optimal control of the inventory that is handled within the company's showroom. A benefit that also counts the company is that due to manage fair agreements with companies that manufacture their products, has the option to store products in these without any additional cost.

In the simulation of the as-is and to-be processes, it can be seen that with the implementation of signaling in offices and the racks and using a trolley cart despite being a solution considered as "simple." There is an increase in the number of processed products because the warehouse operator can take more products and organize them better in both processes. The simulation reflected an operational increase of 50% in the first process and 11% in the second process.

In the analysis of which are the products that have a greater consumption? We proceeded to divide them into three classes (A, B & C), where class A had 60% consumption, B 30%, and C 10%, thus managing an ABC inventory management, where the products that have a more

significant amount of consumption are those that management can focus more. With this organization, the company will be able to focus on meeting demand more precisely.

The implementation of the 5s plan in the company, it can be seen that after the analysis that consisted of the last 15 days of October and the first 15 days of November, there is an increase of 5% total between all the phases that this tool includes (classification, order, etc.). Also, analyzing the results obtained with the realization of the surveys to see the salesmen's fulfillment, it is appreciated that the increase was 6%. Therefore, the implementation testing phase of the 5s plan showed positive results for the company.

An adaptation of the VSM diagram had to be made for a service company because it is used primarily in manufacturing companies. According to the VSM tool, we were able to identify five possible kaizens, 3 for the commercial process, and 2 for the after-sales service provided. With these improvements, it is expected to reduce the time of the activities that do not generate any value for the company and also to have greater efficiency in the execution of the process. The lead time that was calculated reflects a value of 22 hours—being a time within the company's plan in terms of deliveries of their products. Pro Security Clean defined a maximum delivery time of 48 hours, but this can be reduced by working on improving logistics routes and better delivery management.

Finally, the improvement plan of Pro Security Clean is focused on the medium to long term. Considering that an SME needs fast, effective, and not so high-cost solutions because it does not have an extensive investment portfolio to this type of plan as in a large company. It is essential to encourage good communication between all departments to achieve a change in corporate culture to one that is focused on continuous improvement. In this way, the company will be able to meet its objectives and grow in the market.

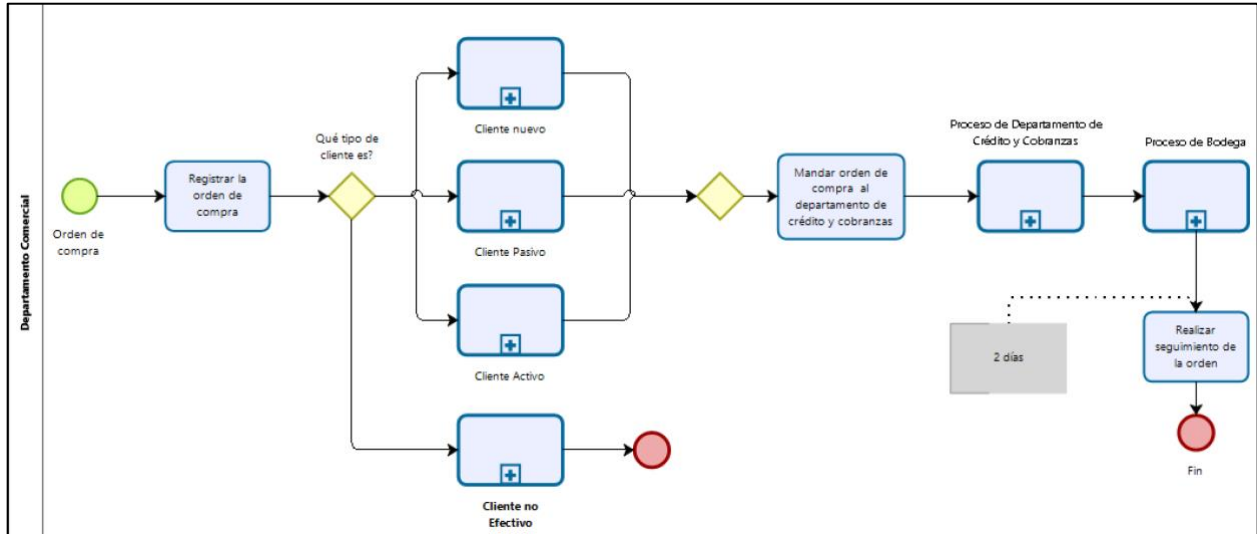
RECOMMENDATIONS AND LIMITATIONS

Computer tools such as zoom provide great help to carry out a Lean & Six Sigma implementation project. However, it is recommended that data collection and meetings with the company are on-site because there may be a bias when analyzing company's data. Despite discussions with the company's CEO and guidance on how best to conduct data collection, there may be little understanding of the questions or what is being sought. It is also recommended that the company starts using a cloud database, which increases security and sharing among those involved in the business process in the files being handled. An important recommendation for the company is that in the future, it can stop outsourcing the logistic transport for the province because the control of the order is lost at a significant percentage. Usually, the problems of delays of deliveries are in this type of orders, therefore if it is possible to handle this transport of own way, great benefits for the company will appear. Some of them are a notorious improvement to the level of service and general satisfaction of the customer.

In the limitations of the project, it could not be possible to reach the control phase of the DMAIC due to the pandemic and the time frame of the project. A significant limitation is that in the realization of this project, the team had to consider the costs of implementing a plan because we are working with an SME, where the goal was focused on making it fast, practical, and not very expensive implementations. Finally, the simulation carried out for the company was based on assumptions because it was impossible to visit the company's facilities to take the warehouses or offices' exact measurements. It was simulated through the information and photos provided by the company's general manager. For this reason, the order generator in the simulation does so randomly, only three types of products were part of the simulation, and the operator's speed was assigned to an average seen in the literature.

ANNEXES

Annex A: Pro Security Clean Commercial Process



Annex B: Pro Security Clean 5s Implementation

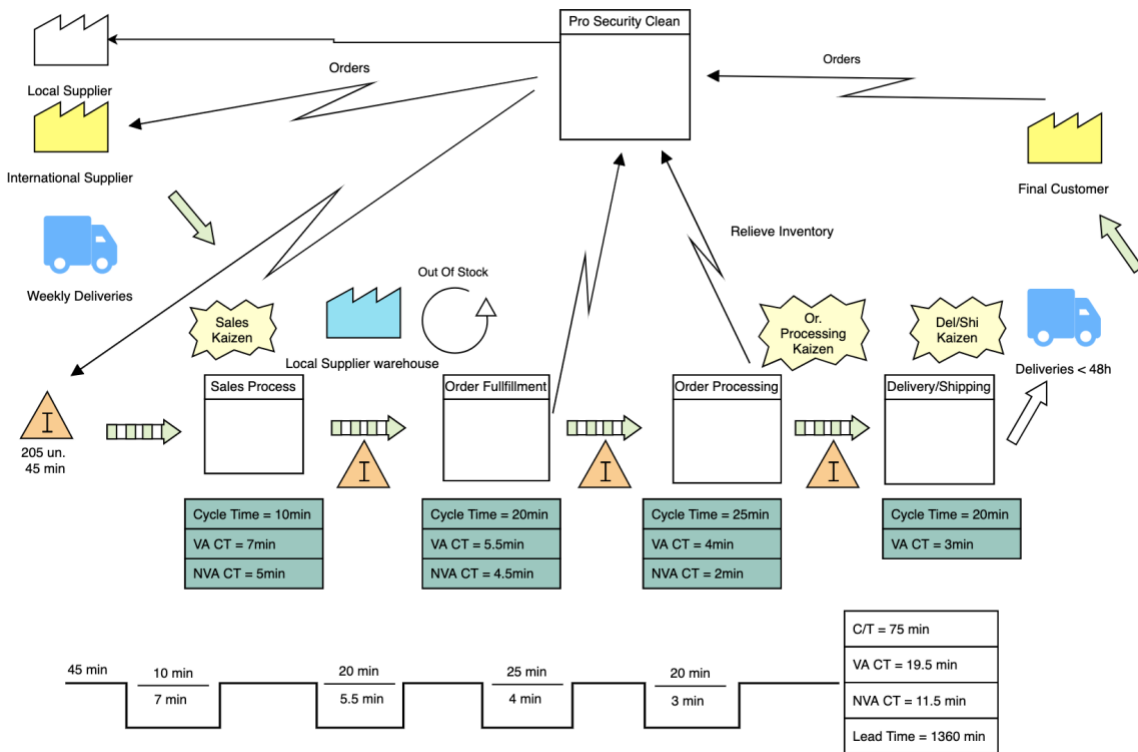


Annex C. Pro Security Clean Brainstorming

Pro Security Clean		
Effect	Low Customer Satisfaction	
Inventory	Product Quality	Missing Products
System errors	Bad quality of products	Payment delays
Lack of products	Expiration of products	Complaints & Claims
Excessive amount of inventory	Manufacturing process errors	Low level of demand planning
Transportation errors	Bad labeling on products	Low process comprehension
Lack of technological tools implementation	High costs	Product not ready from partners

Pro Security Clean		
Effect	Low Customer Satisfaction	
Service Quality	Process	Information
Bad management of claims	Necessities identification	Disorder in workplace
High response time	Suppliers agreements	Disagreements
Low staff training	Transportation (local-province)	Technological errors
Bad service quality	Lack of technology usage	Low sales
	Low knowledge on Inventory management	Business reputational risk
		Customer complaints

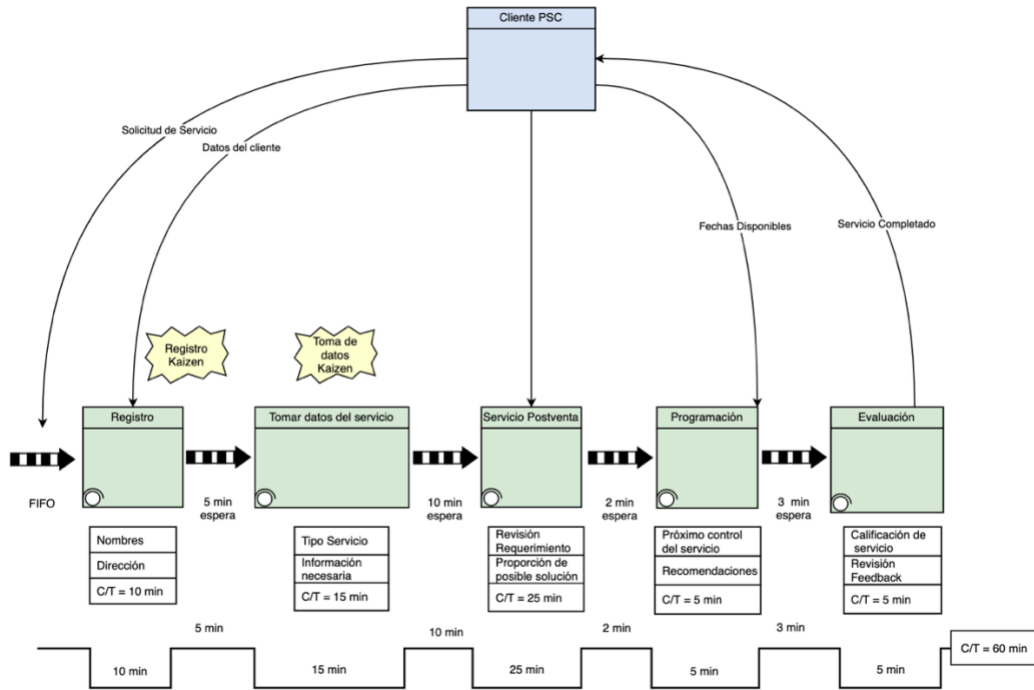
Annex D: Pro Security Clean Process 1 VSM



Annex E: Pro Security Clean Process Kaizen Proposal

KAIZEN: SALES PROCESS			
Improvement Opportunities	An ERP computer system can be added so that it can be worked on directly in one place.		
Objectives and Scope	Increase the speed of service and improve customer relations.		
Start Date	Jun-21	End Date	Aug-21
Team Leader	Andrés Rodríguez		
Sponsors	Pro Security Clean		
Team Members	Commercial Team		

Annex F: Pro Security Clean Process 2 VSM



Annex G: Pro Security Clean Kaizen Proposal

KAIZEN: DELIVERY			
Improvement Opportunities	Management of software integrated into the system for route mapping and information collection.		
Objectives and Scope	To give real-time information in the process of delivery to the clients increasing in this way the satisfaction of these.		
Start Date	Jun-21	End Date	Aug-21
Team Leader	Andrés Rodríguez		
Sponsors	Pro Security Clean		
Team Members	Commercial Team		

Annex H: Pro Security Clean Kaizen Proposals

KAIZEN: DATA REGISTER			
Improvement Opportunities	Stop collecting data manually and automate it through ERP.		
Objectives and Scope	Reduce waiting times and unnecessary time in the process.		
Start Date	Jun-21	End Date	Aug-21
Team Leader	Andrés Rodríguez		
Sponsors	Pro Security Clean		
Team Members	Commercial Team		

KAIZEN: DATA COLLECTION			
Improvement Opportunities	Automation in data collection using a cloud database.		
Objectives and Scope	The information will be more secure, and the customer's waiting time will reduce.		
Start Date	Jun-21	End Date	Aug-21
Team Leader	Andrés Rodríguez		
Sponsors	Pro Security Clean		
Team Members	Commercial Team		

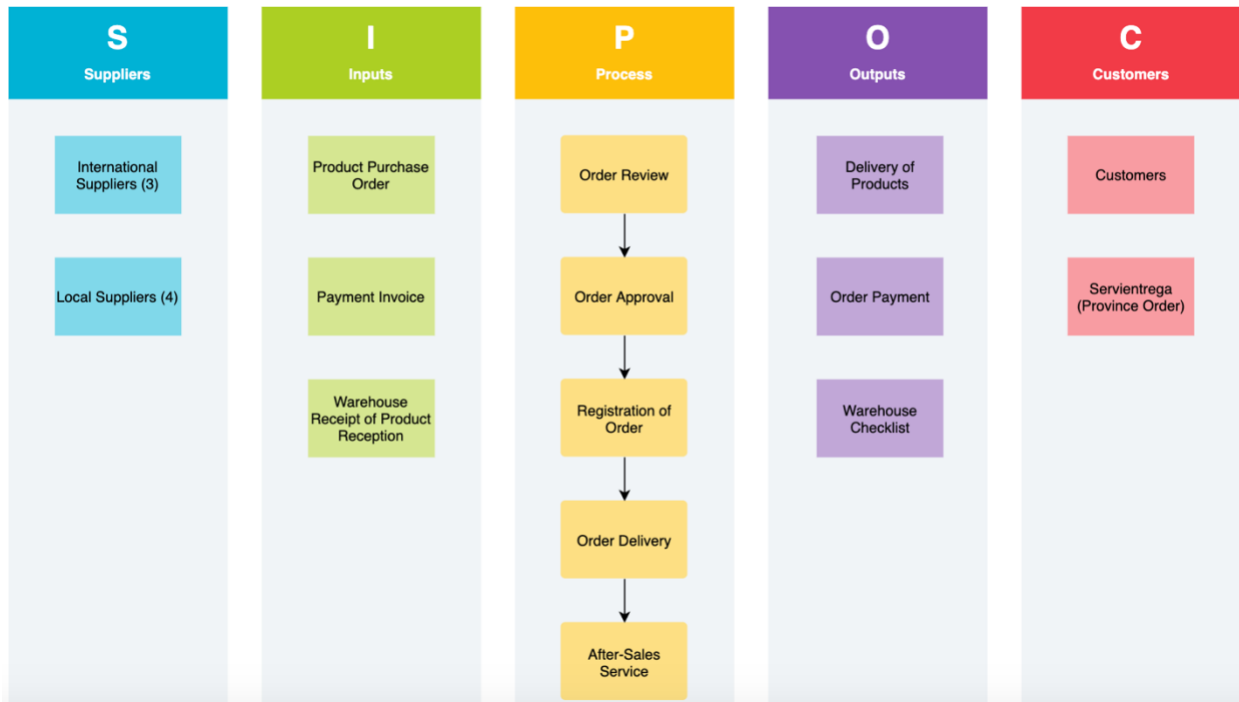
Annex I: Pro Security Clean Project Charter

1. General Project Information				
Project Name:	Implementación de herramientas Lean & Six Sigma dentro de un plan de mejora continua			
Company Name:	Pro Security Clean (PSC)			
Beginning Date:	September 24-2020			
Impact of project:	Alta			
2. Project Team				
	Name	Department	Telephone	E-mail
Project Leader:	Andrés Castillo	USFQ	0989085114	Andres_cr96@hotmail.com
Involved members:	Pablo Buerno	USFQ		
	Andrés Rodríguez	Director General de PSC		
3. Business Case				
La empresa Pro Security Clean, no tiene los procesos del área comercial levantados, lo que genera una incertidumbre al momento de analizar si existen desperdicios o re procesos que no estén generando valor. Las actividades que se realizan en la empresa no se encuentran asignadas a un responsable y no se ha realizado antes un plan de mejora continua.				

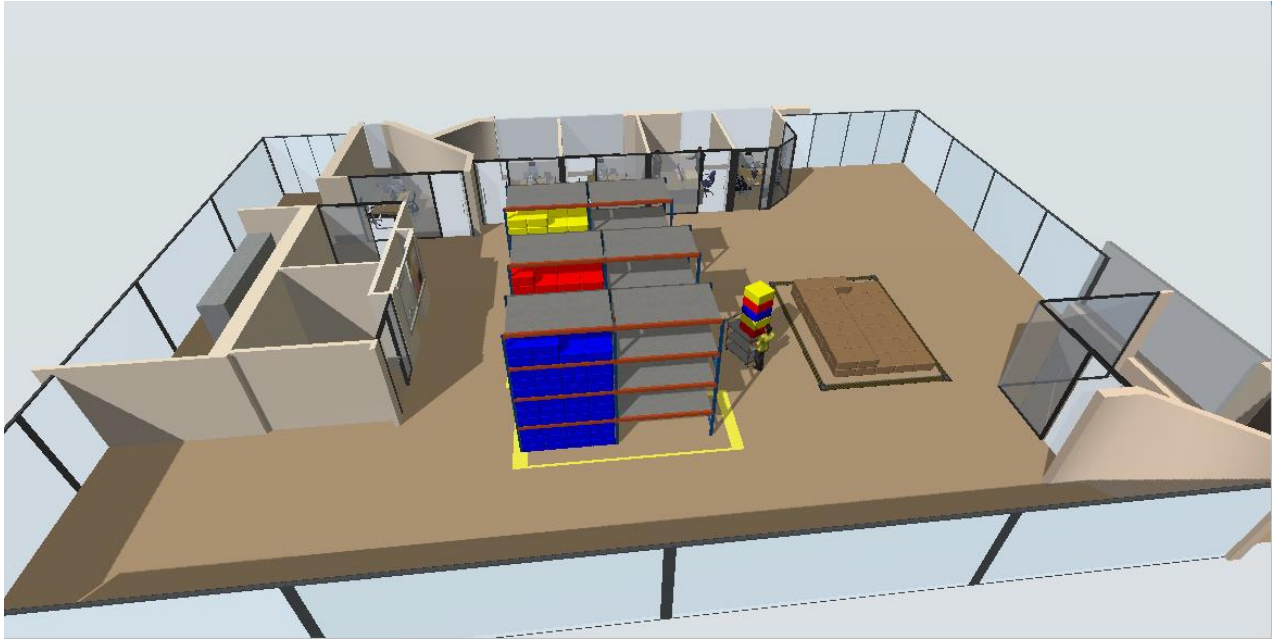
Annex J: Pro Security Clean Project Charter

4. Project Scope Statement
Project Purpose / Business Justification
El propósito del proyecto es poder ayudar a la empresa para aumentar la satisfacción de los clientes y sus ventas es en: Velocidad de entrega, calidad en los productos, y eficiencia en el servicio de post venta.
Objectives
Implementar herramientas de Lean & Six Sigma en una empresa de bienes y servicios, para reducir desperdicios y aumentar la eficiencia operativa, reducir los costos y aumentar las ventas un 10%
Scope
<p>Con la implementación de la metodología se espera tener una reducción de los desperdicios del proceso comercial de la empresa y optimización de recursos para reducir costos.</p> <p>Se espera comunicar constantemente los avances con el director general de la empresa, compartir información, involucrar el plan de mejora continua en toda la organización de esta forma cambiando su cultura organizacional.</p>

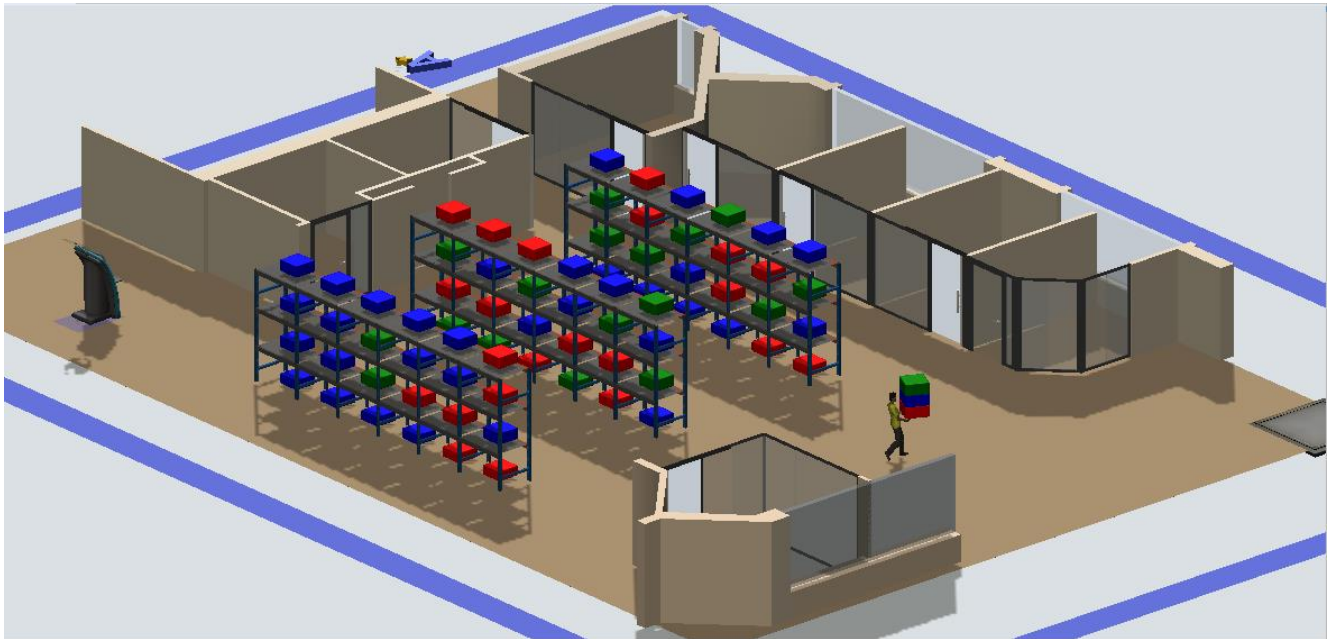
Annex K: Pro Security Clean SIPOC Diagram



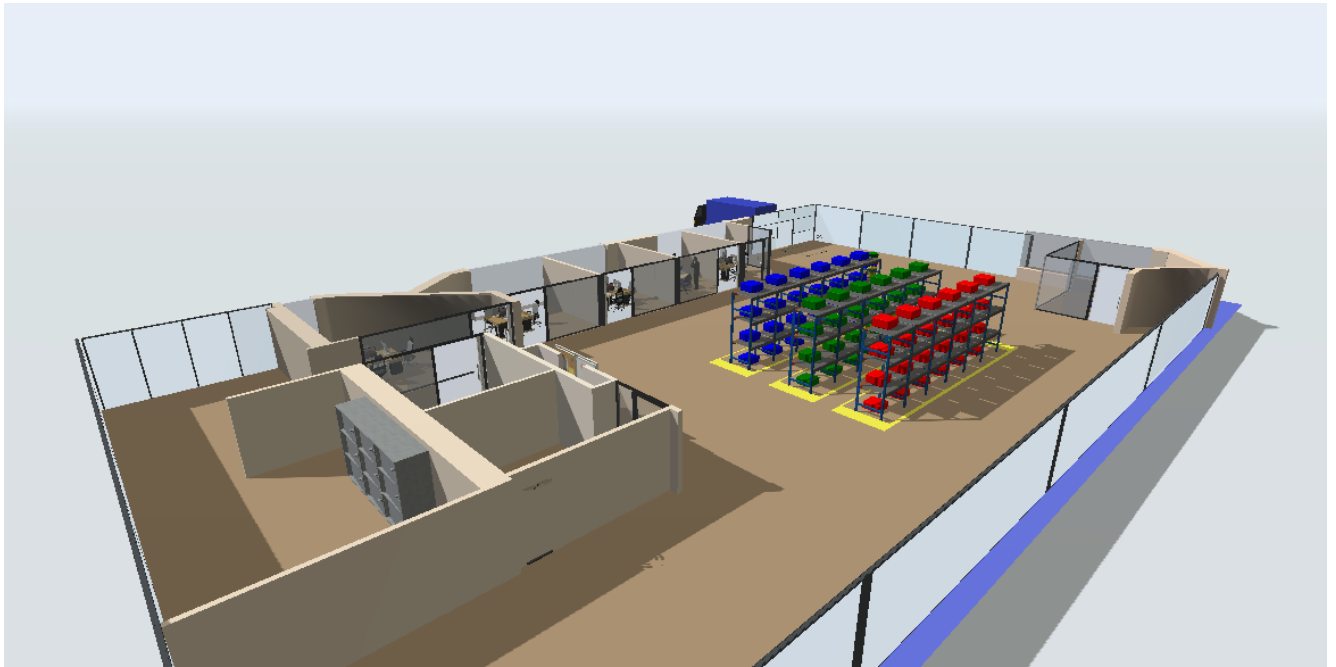
Annex P: Pro Security Clean Process Simulation (After)



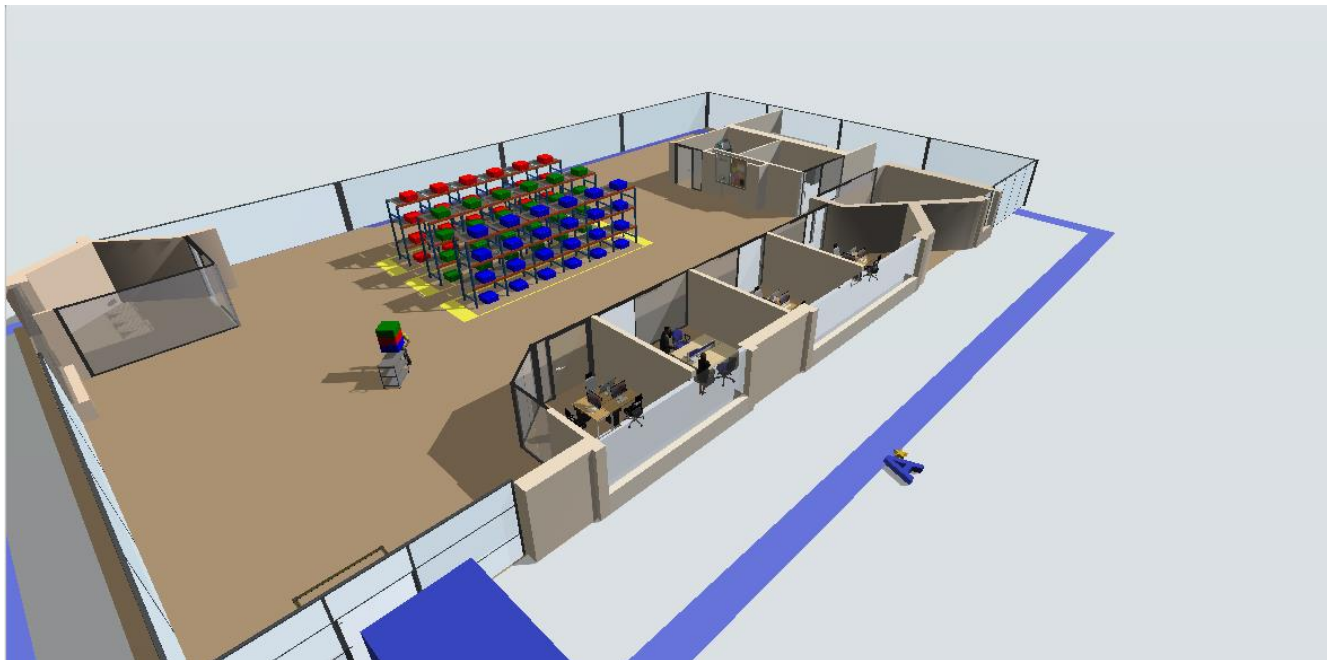
Annex Q: Pro Security Clean Order Preparation & Dispatch Process (Before)



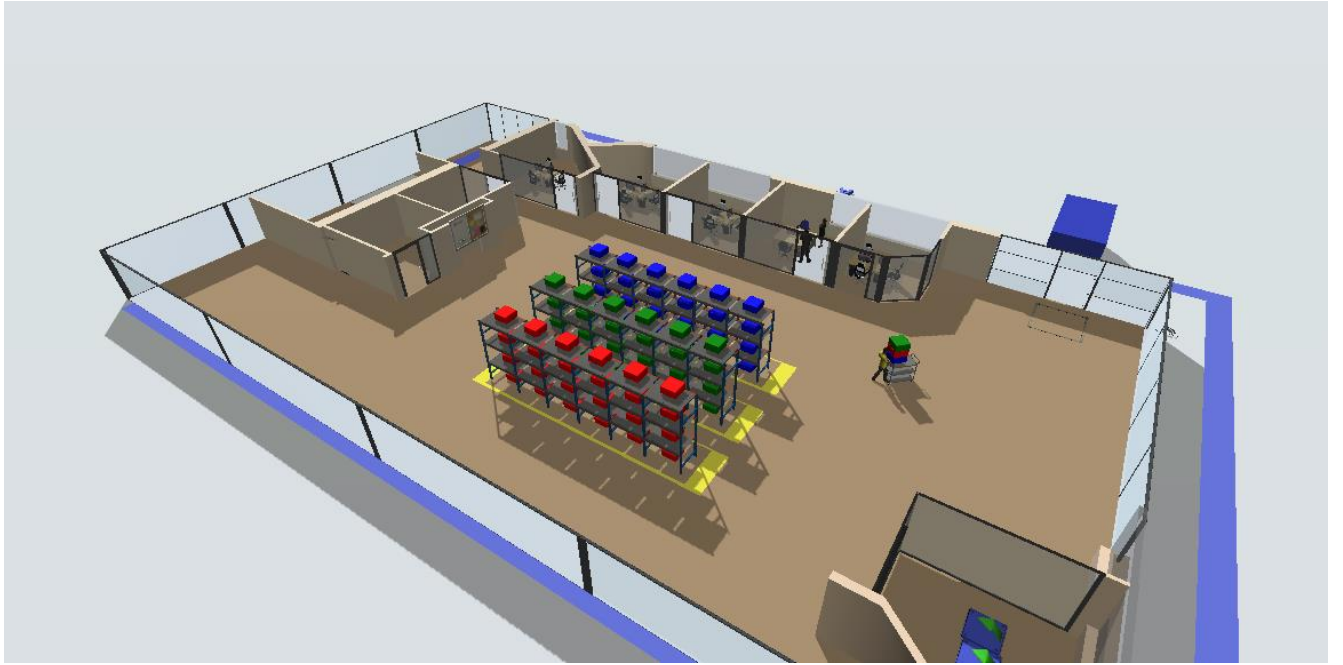
Annex R: Pro Security Clean Order Preparation & Dispatch Process (After – View 1)



Annex S: Pro Security Clean Order Preparation & Dispatch Process (After – View 2)



Annex T: Pro Security Clean Order Preparation & Dispatch Process (After – View 3)



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