TÉCNICO LISBOA

ANALYSIS AND IMPROVEMENT OF THE EQUIPMENT RENTAL PROCESS OF GRUPO VENDAP

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Abstract: Small and Medium-sized Enterprises have been facing difficulties in their operational efficiency caused by globalization and high competitiveness. Consequently, Grupo Vendap, being considered a Small and Medium-sized Enterprise, is forced to implement a continuous improvement strategy - a long-term strategy - to increase the quality of the services provided and thus increase its operational efficiency. The study to be developed at the Grupo Vendap facilities arose from the need to assess and analyse the efficiency losses and high levels of variability associated to the rental process of construction equipment, seeking to continuously improve this process. It is in this context of continuous improvement that Lean Six Sigma fits. This methodology is a combination of the Lean and Six Sigma methodologies which when applied allows process variability to be reduced and customer satisfaction to be increased. This is possible through the Define-Measure-Analyze-Improve-Control (DMAIC) cycle and some Lean and Six Sigma tools. This makes it possible to achieve the desired levels of efficiency. Despite being a methodology more focused on the manufacturing sector, Lean Six Sigma is also applicable in the service sector. It is only applicable through a re-evaluation of Lean and Six Sigma tools. Therefore, based on this methodology, improvement proposals will be made with the objective of making the Grupo Vendap a more efficient and competitive company.

Key Words

Operational Efficiency; Lean Thinking; Six Sigma; Lean Six Sigma; DMAIC

1 INTRODUCTION

Small and Medium-sized Enterprises have been facing difficulties in their operational efficiency caused by globalization and high competitiveness.

The study to be developed at the *Grupo Vendap* facilities arose from the need to assess and analyse the efficiency losses and high levels of variability associated to the rental process of construction equipment, seeking to continuously improve this process. It is in this context of continuous improvement that Lean Six Sigma fits.

This methodology is a combination of the Lean and Six Sigma methodologies which allows process variability to be reduced and customer satisfaction to be increased. This is possible through the Define-Measure-Analyze-Improve-Control (DMAIC) cycle and some Lean and Six Sigma tools. This makes it possible to achieve the desired levels of efficiency. Despite being a methodology more focused on the manufacturing sector, Lean Six Sigma is also applicable in the service sector. It is only applicable through a re-evaluation of Lean and Six Sigma tools. Therefore, based on this methodology, improvement proposals will be made with the objective of making the Grupo Vendap a more efficient and competitive company.

2 DESCRIPTION OF THE PROBLEM

This chapter will present the company involved in the dissertation, the Group Vendap and its current organisational structure (section 2.1). Section 2.2 characterises the case study in question

2.1 GRUPO VENDAP

Grupo Vendap is a Portuguese company dedicated to the rental of equipment for civil construction and industry, covering the entire national territory

except for the Azores archipelago. National territory coverage is ensured through the delegations in Porto Alto, Porto, Nelas, Pombal, Sines, Elvas, Ferreiras and finally in Funchal, Madeira Island.

To provide a clear overview of the departments involved in the study, a more detailed description of the main responsibilities of the departments involved is presented.

Park and Transportation Management: This department is responsible for: Planning and responding to rental requests; Selecting the most suitable equipment and operator (driver) for each type of rental; Providing technical support to the Commercial Department in the selection of the most suitable equipment for the type of use.

Commercial department: It is responsible for prospecting customers and business opportunities, surveying customer needs and advice, selecting the solution in conjunction with the Transport & Park Management department.

2.2 CONTEXTUALIZATION OF THE PROBLEM

It is highlighted the fact that the Transport & Park Management Department has a key role in the management of rental requests. All rental requests must go through the park & Transportation Management Department and may be refused due to lack of equipment or accepted if there is equipment available.

It was concluded through an analysis, that 61% of all rental requests refused due to unavailability of equipment were consider incorrect, which is equivalent to over 300 lost rental requests annually. We can verify the analysis in figure 1:

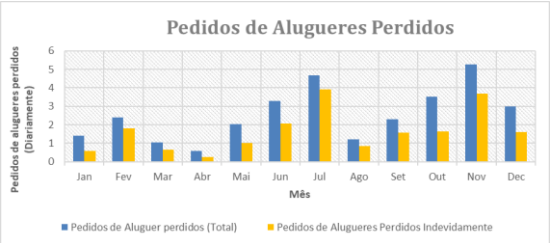

Figure 1 - Lost rental requests VS Wrongly lost rental requests

All these equivocated rental requests were referred to as **Wrongly Lost Rental Requests**. Through informal interviews with the departments involved, the 5 causes of Lost Rent Requests were identified, namely:

1) **The unawareness of the collection date** - One of the main causes is the little credibility in the delivery forecast provided by the customer itself. There are a considerable number of contracts that exceed the date forecast by the customer.

2) **Rent requests are made beforehand** - This happens when the customer makes a rental request for a date later than two weeks. It has been noted that, due to the uncertainty associated with the end date of the contract for the rented equipment, all these rental requests, if there is no equipment, are left on hold until, eventually, a new equipment from the end of the contract appears. Many customers end up going to the competitors.

3) **The unawareness of the end date of the contract -** The commercial department divides contracts into short-term contracts (less than or equal to 28 days) and long-term contracts (over 28 days). For long-term contracts, only 28 days are specified in the contract because the company's invoicing is done every 28 days. Thus, the Transport & Park Management Department finds it difficult to understand which contracts have not yet ended.

4) **Unpredictability of equipment in maintenance -** There is a considerable amount of equipment under maintenance and that a notable amount of this equipment that does not have a repair time forecast. Thus, all rental management is conditioned by the lack of predictability of the equipment under maintenance.

5) **The availability of the equipment at the desired location -** The coverage of the national territory is ensured by several delegations. Note that, it is only charged to the client the cost of transport from the delegation closest to the location intended by the client to the rental location. When the cost of transport between delegations is higher than the rental price, for business reasons, Transport & Park Management department is obliged to refuse the proposal despite the existence of an available machine.

3 LITERATURE REVIEW

3.1 LEAN THINKING

After the Second World War, the Japanese automobile industry was experiencing great difficulties. The lack of resources and the intense internal competition gave rise to a new method that revolutionised the industry in all sectors, Lean Production (Peter Hines, 2004).

When we approach Lean we have to talk about transformation - it is not just about the widespread use of tools, or changing manufacturing process procedures - it is about a complete change of the business - how the supply chain is run, how directors run businesses and even how all employees carry out their daily work. It is everything that can be improved in a company (Melton, 2005).

Lean Thinking is a summary of all Lean methodologies. It is the continuous search for the elimination of all waste with the aim of continuously improving the organisation. The concept of continuous improvement or Kaizen (Japanese term) has evolved over the years and is currently structured as a process of continuous improvement based on innovation involving the whole organisation (Caffyn, 1999).

3.2 LEAN SERVICES

As reviewed in chapter 3.1, Lean can be seen as an integrated multidimensional approach that encompasses a wide variety of management practices based on the philosophy of eliminating waste through continuous improvement. Lean is not just a toolbox that helps improve quality in an organisation, but rather, a culture, a way of thinking, a practical philosophy (Gupta, Sharma, & Sunder M., 2016).

According to Kotler and Armstrong (Kotler & Armstrong, 2010) a service is an act or activity that an organization can offer to customers, essentially intangible goods. Another researcher (Gronroos, 1990) defines services as a more or less intangible activity or set of activities. In these activities there are interactions between the customer and the service provider. The services sector when compared to the manufacturing sector is unique. It is due to characteristics exhibited by services such as - intangibility, heterogeneity, inseparability, simultaneity and perishability (Lovelock & Gummesson, 2004).

In the service sector, although there is an engagement with the principles of Lean methodology, many of the tools used in the manufacturing context are not immediately applicable. Thus, the Lean concepts and tools should be re-evaluated before their application in the processes (Andrés-Lópeza, González-Requenaa, & Sanz-Lobera, 2015).

3.3 SIX SIGMA

Six Sigma is a set of practices originally developed by Motorola Corporation in 1980 with the aim of expanding profits and improving the effectiveness and efficiency of operations (Kwak & T.Anbari, 2006). At that time, the company needed to make improvements in its quality levels due to the high competitiveness felt throughout the electronics industry. (Linderman, Schroeder, Zaheer, & Choo, 2002).

Six Sigma is a business strategy that focuses on improving management systems, productivity and financial performance. The application of the Six Sigma method has allowed many organisations to maintain a competitive advantage by integrating their own process knowledge with statistics, engineering and project management (Anbari, 2002).

Researchers such as (Zu, Fredendall, & Douglas, 2008) and (Schroeder, Linderman, Liedtke, & Choo, 2008) have tried to determine what elements in Six Sigma make it so effective. Apart from the function structure, the structured improvement procedure of Six Sigma is seen as a novelty and an effective contribution to quality management. This improvement procedure is generally known by the acronym DMAIC - Define, Measure, Analyse, Improve and Control.

Define: Identify all the problems and define the processes in question. It is important that the whole process of identifying and understanding the problems includes all the entities that are linked to these processes. There are two important points to consider related to services: use of any input given by the customer and the understanding of all the processes, with the purpose of identifying and

contextualising the problems in question. (Hensley & Dobie, 2005)

Tools used (Taghizadegan, 2006), (Werkema, 2004)

SIPOC process map ; Project charter

Measure: measure the current process by collecting data and measuring current problems. It is also necessary to check the reliability of the data collected. In services many processes are not controlled as closely as in production. The entity "customer" may cause variability in the execution of the process (Hensley & Dobie, 2005).

Tools used (Taghizadegan, 2006)

- Data collection plan; Check data Sheet; Pareto diagram ; Histogram

Analyse: the purpose of this step is to identify the critical factors of a product/service and the root causes of defects in the process (Brook, 2010).

Tools used (Taghizadegan, 2006) and (Schildmeijer & Suijkerbuijk, 2019)

- Multi-vari Charts; Scatter plots

3.4 LEAN SIX SIGMA

The first organisation to integrate and popularise the Lean methodology with Six Sigma was the George Group company in the 1980s. As of the 1990s, several companies allied themselves with the objective of sharing the knowledge of the methodologies used. As an example we have Boeing, leader in Lean management, and General Electric, leader in Six Sigma (Salah, Rahim, & Carretero, 2010).

The DMAIC method is the standard approach for conducting LSS projects to improve product and process performance (Werkema, 2014).

An Lean Six Sigma approach allows the organisation to choose the right tools to tackle different problems, either in the form of Kaizen events or using deeper analyses for more complex projects. Six sigma and Lean should not be used in parallel, but rather simultaneously, so that the synergy between the two can be harnessed. Using both methodologies in parallel is not always successful, as they are applied separately to solve problems. Companies that choose to use the methodologies separately end up facing problems in the prioritization of initiatives, resource allocation, selection of the right methodology and verification of financial gains (Salah, Rahim, & Carretero, 2010).

4 DEFINITION AND PRELIMINARY ANALYSIS OF THE CASE STUDY

In this section, several methodologies regarding LSS are applied to define the study to be developed at the Grupo Vendap facilities and identify/evaluate the impact of the causes in all unduly lost rental requests. This chapter deals with the Define-Measure phase of the DMAIC cycle.

4.1 CHARACTERISATION OF THE INITIAL SITUATION AND DEFINITION OF GOALS

With the objective of planning the continuous improvement project and characterizing the initial situation, three tools were used, which are widely used in continuous improvement projects and, specially, in LSS projects. The tools used were Dojo & Quality Circle; Project Charter; SIPOC process map.

The Dojo & Quality Circle tool allowed, through the knowledge sharing of all employees involved in the equipment rental process and the encouragement of employees to improve the whole process through their own proposals, to characterize the initial situation and define the project goals.

After the meetings where the Dojo & Quality Circle tool was applied, the Project Charter was carried out. Through the Project Charter it was defined:

1) **The scope of the project** - Characterize the problem and propose improvements the reduction/elimination of unduly lost rental requests.

2) **The Project Schedule** - Define: 1 week / Measure: 4 months / Analyse: 1.5 months / Proposals for improvement: 1 week.

3) **The Associated Risks/ Assumptions** - Unavailability of team members (hours) / reliability of worker response and reliability of database of past records.

4) **The Project Team** - park management department (5 technicians), director of the continuous improvement department and of the controlling department, external company (1 worker) and a trainee.

After the Project Charter was carried out, the **SIPOC process map** was prepared.

The SIPOC process map aims to summarise the inputs and outputs of one or more processes in table form and provide an overview for those who are not familiar with the process.

The SIPOC process map carried out, associated with the process of equipment rental requests, as shown in figure 2, allowed to: 1) Identify the most relevant elements throughout the equipment rental request process; 2) To obtain a clearer vision of the components that the park management department has to take into consideration to accept or refuse an equipment.

SIPOC				
Fornecedor (*Supplier*)	**Entrada** (*Inputs*)	**Processo** (*Process*)	**Saida** (*Outputs*)	**Cliente** (*Customers*)
Departamento Comercial: →Construção & Indústria → Eventos e entidades publicas	Pedido de Aluguer: → Tipo de equipamento → Data inicial do contrato → Previsão da data final →Localização do pedido de aluguer → Requisitos do cliente	Verificação de disponibilidade do equipamento pedido acordo com: → O tipo de equipamento; → Duração do contrato → Localização do pedido de aluguer → Requisitos do cliente (utilização de um software específico - InspHire)	Caso não haja disponibilidade: → Anulação da proposta Caso haja disponibilidade: → Proposta de aluguer → Alocação de transporte	Departamento Comercial: →Construção & Indústria → Eventos e entidades publicas Motorista Departamento Financeiro

Figure 2 – SIPOC Process Map: Equipment Rental

As can be seen in the figure 2, the park and transport management department, if there is an available equipment, makes a rental proposal and communicates to the transports the schedule that the respective customer needs the equipment. The commercial department, after confirming the availability of the equipment, transforms the rental proposal into a contract and confirms to the transports the date and time of the rental request.

4.2 DATA COLLECTION

After checking the records of past rental requests, it was noted that there was no evidence as to why the rental requests were lost, which prevented the data collection from being carried out and the measurement of the impact of causes to be done based on past records. For this reason, the importance of tracking all lost rental requests on a daily basis was highlighted in order to identify and ascertain what the impact of each cause was on the unduly lost rental requests.

The data collection plan was carried out so that all the data would be collected correctly.

Figure 3 shows the data collection plan:

Plano de Recolha de dados							
Who	***What***			***When***	***Why***	***How***	**Other**
Responsável	Definição operacional	Tipo de Dados	Tamanho da amostra	Data	Perguntas a responder	Método de registo de dados	Comments
Estagiário	Seguimento do processo de aluguer de equipamentos desde que é feito o pedido de aluguer até à suposta data de entrega.	Quantitativo	197 Pedidos de aluguer perdidos indevidamente	01/11/2020 até 22/02/2021	Quais as causas e qual o impacto de cada causa nos pedidos de aluguer perdidos indevidamente?	Questionários e inquéritos; Observações.	Utilização do Excel para recolher a informação/contar os pedidos de aluguer perdidos indevidamente. (check data sheet)

Figure 3 – Data collection plan

The key information to be collected was also defined at this step. The information collected was: Number of the rejected proposal; The date the proposal was rejected; The worker who rejected the proposal; Category of equipment; Proposal start date; Proposal end date.

In addition to this information being collected, it was necessary to monitor and record the availability of equipment for each request on a daily basis, from the date on which the proposal was refused to the initial date of the proposal, always taking into account the duration desired by the customer. If equipment became available until the proposal start date, the rental request was considered to be unduly lost and a form was sent to the equipment park manager so that the cause could be properly identified

Figure 4 shows the Check Data Sheet used to collect the data:

Nº Proposta	Indevida	Causa	Data proposta recusada	Gestor de parque	Equipamento	Data inicial da proposta	Data final da proposta*	1	2	3	4	5	6	7	8	9	10	11
90008	Não		2-Nov-2020	x1	Plataforma elevatória	04-Nov	06-Dec											
90021	Sim	Desconhecimento da data de recolha	2-Nov-2020	x2	Compressor	06-Nov	08-Nov											
90032	Não	-	2-Nov-2020	x1	Gerador	06-Nov	20-Nov											
90034	Nao	-	2-Nov-2020	x1	Plataforma elevatória	10-Nov	12-Nov											
90040	Sim	Desconhecimento da data de recolha	3-Nov-2020	x2	Plataforma elevatória	09-Nov	10-Jan											
90051	Não	-	3-Nov-2020	x3	Empilhador	09-Nov	06-Dec											
90059	Não	-	3-Nov-2020	x3	Gerador	09-Nov	16-Nov											
90068	Não	-	3-Nov-2020	x2	Gerador	10-Nov	06-Dec											
90073	Sim	Desconhecimento da data de recolha	3-Nov-2020	x1	Plataforma elevatória	09-Nov	16-Nov											
90089	Sim	Desconhecimento da data do final do contrato	3-Nov-2020	x2	Compressor	10-Nov	16-Nov											
90092	Não		4-Nov-2020	x4	Plataforma elevatória	06-Nov	08-Nov											
90112	Sim	Desconhecimento da data de recolha	4-Nov-2020	x1	Empilhador	06-Nov	23-Nov											
90119	Sim	Pouca previsibilidade dos equipamentos em manutenção	4-Nov-2020	x2	Empilhador	10-Nov	20-Nov											
90127	Não	-	4-Nov-2020	x3	Plataforma elevatória	10-Nov	18-Nov											

Figure 4 – Check data sheet

As shown in figure 4, in addition to collecting all the information referred to above, all lost rental requests were tracked and registered. If there was no equipment available, a red colour was given to the date of verification of the equipment availability. If there was available equipment, a green colour was put on the equipment availability check date, turning a lost rental request into an unduly lost rental request. Thus, it was possible to identify all the rental requests unduly lost with an associated cause to subsequently analyse all the collected data.

4.3 PRELIMINARY ANALYSIS OF THE DATA COLLECTED

After 312 lost rental applications were collected, of which 197 lost rental applications were unduly lost, a preliminary analysis was conducted.

The preliminary analysis aimed to: 1) Verify which causes were associated with the process of unduly lost rental requests; 2) Assess the impact of each cause on the unduly lost rental requests.

The verification of the causes and the assessment of the impact of each cause associated with the rental orders unduly lost was performed through the Pareto Diagram.

The result, obtained through data collection, can be seen in figure 5.

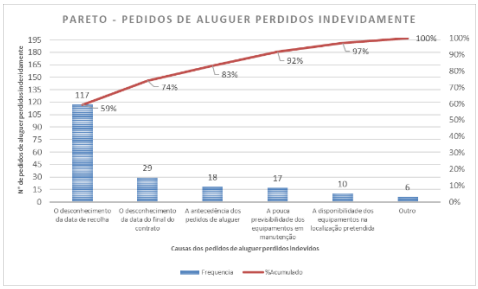

Figure 5 – Check data sheet

As can be seen in the Pareto diagram, the cause of unawareness of the collection date has the greatest impact on unduly lost rental requests. Of the 197 cases of rental requests unduly lost, about 59% (117 cases) had as the main cause the unawareness of the collection date. The park and transport management department and the commercial department are often forced to ignore the forecast given by the customer due to its lack of credibility.

Regarding the cause of unawareness of the end date of the contract, it is the second cause that has more impact on the rental requests unduly lost. About 15% (29 cases) of the rental requests were lost due to the cause of unawareness of the end date of the contract.

Regarding the cause rent requests made beforehand, it is the third cause that has more impact on the rental requests unduly lost. About 9% (18 cases) of rental requests were lost due to this cause.

Other causes such as the low predictability of equipment in maintenance and the availability of equipment in the desired location, although verified in data collection, are causes that only represent about 14% of all rental requests unduly lost and, many of these cases, are due to business strategies of the Grupo Vendap, and these causes are more difficult to reduce/eliminate.

5 ANALYSIS OF THE CASE STUDY AND PROPOSED IMPROVEMENTS

In this section several methodologies are applied regarding the LSS with the objective of analysing the case study and, subsequently, proposing improvements to the Grupo Vendap. The improvement proposals aim at eliminating rental requests unduly lost referring to the causes of not knowing the collection date, not knowing the end date of the contract and the antecedence of the rental requests. In this chapter, the Analyse phase of the DMAIC cycle is approached and improvements are also proposed.

5.1 ANALYSIS OF THE CASE STUDY

As mentioned in the previous chapter, the main causes that point to the existence of rental requests unduly lost are: the unawareness of the collection date, the unawareness of the end date of the contract and rent requests made beforehand. All these causes point not only to some inefficient processes related to the rental of equipment, but also to the little credibility given by the customer when he provides the contract forecast.

In order to have a more general view of what the rentals of the Grupo Vendap are, the rental contract duration was analysed in detail. Figure 6 shows the histogram with the rental duration of past records.

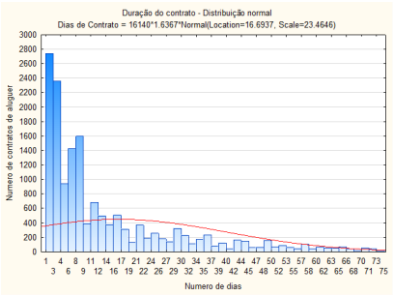

Figure 6 – Histogram of contract duration - Normal distribution

Through the Histogram - duration of rental contracts, shown in figure 15, we conclude that the vast majority of rentals of the Grupo Vendap are of short duration. It should be emphasised that approximately 17% of all past rentals have a

duration of [1,2] days and that 56% of all contracts in the records of past rentals are between [1,10] days in duration.

Data was also extracted such as the mean - which points to 17 contract days - the standard deviation - considerably large of 24 contract days - the variance - 551 contract days

Note that the standard deviation is greater than the average meaning that there is a large variation between the values, and an abnormal distribution of the data.

In the following sub-chapters it was analysed: 1) Duration of rentals versus the forecast provided by the customer; 2) Rent delay dimension - forecast provided by the customer is lower than the rent duration 3) Dimension of anticipation of rentals - forecast provided by the customer is greater than the rental duration; 4) Segmentation of the most relevant customers;

5.1.1 DURATION OF RENTALS VERSUS THE FORECAST PROVIDED BY THE CUSTOMER

This analysis aims to understand what the relationship is between the forecast given by the customer and the actual rental duration.

A statistical factor that provides this relationship is the correlation. Figure 7 shows the correlation between the variable rental days and the rental forecast provided by the customer:

Variável	Previsão do aluguer
Duração do aluguer	0,876

Figure 7 – Correlation rental days versus rental forecast

This value was calculated using the formula:

$$p = \frac{\sum_{i=1}^{n}(xi - \bar{x})(yi - \bar{y})}{(n-1)SxSy}$$

$\bar{x}$ - Sample mean for the first variable
Sx - Standard deviation for the first variable
$\bar{y}$ - Average of the sample for the second variable
Sy - Standard deviation for the second variable

It is this difference - correlation of 1 (perfect and positive correlation between the two variables) for a correlation of 0.876 - that mostly affects the unduly lost rental requests, namely, the causes of unawareness of the collection date and advance notice of rental requests.

To analyze the variability between the rental forecast given by the customer and the rental duration, a scatter plot was made. Figure 8 shows the scatter plot of the rental forecast (x-axis) and the rental duration (y-axis).

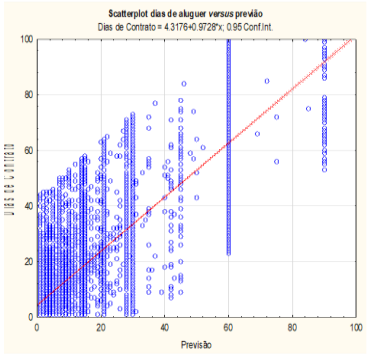

Figure 8 – Scatter plot - Rental forecast vs rental duration

Through the graph, it can be concluded that, although the forecast provided by the customer and the contract duration are correlated, there is high variability between these two variables.

This variability is visible through the dispersion of the Cartesian coordinates. As can be seen in the graph, there is a considerable amount of Cartesian coordinates off on the dashed line (95% confidence interval), thus confirming the high variability regarding the forecast provided by the customer and the contract duration. Note that the confidence interval is almost unobservable in the graph - interval very close to give straight line.

5.1.2 THE EXTENSION OF RENT ARREARS

The first finding was that some 10,658 of the 16,138 rentals already made (66%) were late in relation to the forecast provided by the customer. The elimination of unduly lost rental requests involves eliminating rental requests with a rental forecast shorter than the actual rental duration.

Figure 9 shows the distribution, in number of days, of all rentals that were at least one day late in relation to the forecast given by the customer.

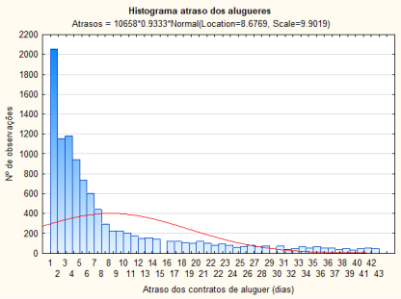

Figure 9 – Histogram - rent delay

1. Average number of days late: 9 days
2. Standard Deviation: 10 days

The Histogram - rent arrears, shown in Figure 9, shows that most of the arrears are within a few days. We highlight that about 20% of all delays of past rentals records were only 1 day and that 70% of all delays of past rentals records are between [1,7] days late.

5.1.3 THE EXTENT OF ANTICIPATION OF RENTAL CONTRACTS

The first conclusion, drawn from past rental records, was that some 3147 of the 16,138 rentals already made (19%) had forecasts provided by the customer that were longer than the rental duration. Figure 10 shows the distribution, in number of days, of all rentals that were at least one day in advance of the forecast given by the customer:

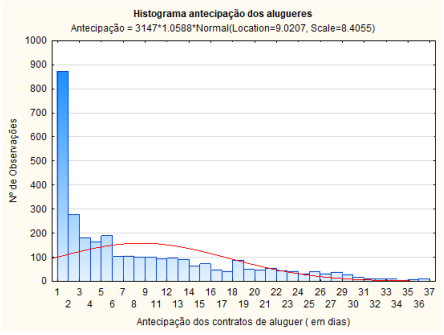

Figure 10 – Histogram - anticipation of rental contracts

1. Average anticipation of rental contracts: 9 days
2. Standard deviation: 8 days

The Histogram - anticipation renting contracts shows that, as in the case of the delay of the rental contracts, the great majority of the anticipation renting contracts is only a few days. We highlight that about 28% of all renting contract anticipations of past renting records were of only 1 day and that 60% of all anticipations of past renting records are between [1,7] days.

5.1.4 CUSTOMER SEGMENTATION

The first conclusion was that all rentals were carried out by about 4 000 customers. This means that the entire Grupo Vendap business depends on several customers. The Grupo Vendap business is not focused on a small number of customers. It was also found that most customers were at least one day late/earlier than the rental contract forecast (3559 customers).

Due to the large number of clients, these were divided into: Small Company; Medium Companies; Large Companies. Thus, it is possible to understand the type of clients the Grupo Vendap is used to dealing with.

Figure 11 shows the Pie Chart developed to segment all Grupo Vendap clients:

Figure 11 – Pie Chart - Customer Segmentation

Through the Pie Chart we concluded that a large majority of rental contracts come from small businesses - around 92%.

5.2 PROPOSALS FOR IMPROVEMENT

It was proposed to Grupo Vendap make a follow-up with the clients. For that, it is necessary to do a daily tracking of all contracts that are running. To facilitate the follow-up with the customers and the tracking of all contracts, a tool was developed in Excel for all employees of the park and transport management department.

This tool helps in the tracking of all the rentals that are in progress, and helps, mainly the communication between the park and transport management department and the commercial department. Visual Basic programming language was used for the development of this tool.

For this tool, it is suggested that the workers of the park and transport management department, first, do a daily trace of all the contracts that are going to

start or have started and have the following information in Excel: Rental contract Nº; Contract start date; Forecast end of contract; Week number of the expected end of the contract; Seller name; Email of salesman.

The tool allows the park managers to automatically send an email to each salesman communicating that the contract is ending.

In figure 12, you can see the data to be entered by the park and transport management department so that, by clicking on the "Send emails" button, the emails are automatically sent.

N° do contrato	Data inicial	Previsao final	Vendedor	Email
90008	17/10/2021	08/11/2021	Jorge Silva	jorge.silva@grupovendap.com
90009	18/10/2021	09/11/2021	Jorge Silva	jorge.silva@grupovendap.com
90010	19/10/2021	10/11/2021	Diogo Ramos	diogo.ramos@grupovendap.com

Enviar emails

Figure 12 - Automatic communication tool

Although it is a very useful tool, if there is no measure for offending customers, the rental requests unduly lost will not be eliminated.

In this sense, for all rentals where the forecast is superior to the contract duration, it was proposed to Grupo Vendap, not to allow these anticipations of contracts if: 1) There is no exceptional reason from the customer regarding the anticipation of the rental contract. 2) The customer does not communicate to the Grupo Vendap one week in advance that they wish to anticipate the contract.

For all rentals where the forecast is less than the duration of the contract, it was proposed to the Grupo Vendap not to allow contract extensions if: 1) The equipment in question is already allocated to another contract in the days after the end of the contract previously forecast. 2) The client does not communicate to the Grupo Vendap one week in advance that he/she wants to extend the contract.

6 CONCLUSIONS

After an analysis, it was concluded that about 51% of all rental requests refused due to unavailability of equipment are erroneous, which amounts to more than 300 rental requests lost annually. All these lost rental requests were referred to as erroneously lost rental requests.

Through informal interviews, the 5 causes that lead to the unduly lost rental requests were identified, namely the unawareness of the collection date and the anticipation of rental requests, the unawareness of the end-of-contract date and the poor predictability of equipment in maintenance.

After a literature review focused on reducing variability and increasing customer satisfaction, it was concluded that the LSS, the junction of Lean Thinking with Six Sigma, is the methodology best suited to overcome the difficulties experienced by the Grupo Vendap. The LSS applies the tools from each methodology and uses the DMAIC cycle in the problem-solving approach.

Based on the data collection, 197 unduly lost rental requests were analyzed. Of this data, about 59% had as cause the unawareness of the collection date and 15% had as cause the unawareness of the final contract date. Since the rental request antecedence has the same root-cause as the unawareness of the collection date, this was also analyzed.

After the causes were identified, an analysis was performed with the support of some LSS tools. Through the analysis, it was initially concluded that the Grupo Vendap business is a result of short-term rentals - 56% of all contracts in the past rental records are between [1,10] days in duration (Chapter 5).

Subsequently, an analysis was carried out considering 4 topics: **Duration of rentals versus the forecast given by the customer** - although the forecast given by the customer and the duration of the contract are correlated there is a large variability between these two variables**; Delay of rental contracts** - about 66% of the recorded rentals had a delay in relation to the forecast given by the customer. Most delays are within a few days - 70% of all delays of past rental records are between [1,7] days late; Most of the **rent anticipations** are within a few days - 60% of all rent anticipations on past records are within [1,7] days; **Customer segmentation** – Grupo Vendap business depends on several customers and most of the customers are small businesses.

Based on the analysis, it was proposed to Grupo Vendap to track all rentals and use the tool developed in Excel to communicate the end of the contract to the commercial department and then to the customer. Furthermore, to reduce variability and to allow the company to plan future rentals, it was proposed to the Grupo Vendap not to allow customers to anticipate the rental contract without an exceptional reason and without advance notice and, also, not to allow customers to extend the rental contract if the equipment in question is

already allocated to another contract in the following days.

It is suggested to carry out workshops for the implementation of the above-mentioned proposals.

After implementation, it is suggested to have weekly meetings between the commercial department and the park and transport management department to address eventual problems and to plan future rentals. The good communication between these two departments is a fundamental point in the equipment rental process.

It is also suggested to follow up on lost rental requests daily. In case there is a rental request unduly lost.

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