NOVA IMS Information Management School

BUSINESS PROCESS MANAGEMENT

MSC. DATA SCIENCE AND ADVANCED ANALYTICS

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Introduction

This report has the objective of providing insights regarding the business process model of the *Caring Pharmacy* entity. Even though there are numerous processes involved in this company, the main core of this analysis is the *Order-to-Cash* process, *O2C*, where the IT/IS and the management changes are joined together, which can enhance and influence the process in question, being the main scope of the project to understand, model, analyze and to redesign the O2C process.

Our approach englobes the understanding of the process in hands and its modelling phase, the AS-IS business process, through Bizagi Modeler's software as our support to conduct a clear and realistic analysis of the respective process. To assist our path in order to achieve the final model, it was performed an analysis based on the concepts and knowledge acquired in the Business Process Management lectures, as also an even extra deeper research to complement the theoretical and practical perceivedness on this matter.

Nonetheless, as a start point of the enriching analysis conducted afterwards, the modelling phase is the crucial step to highlight. Basically, with the comprehension of the different existing subprocesses and the core business itself, the connections between each other and the customer journey in this process, we developed a quantitative and a qualitative analysis, taking always in consideration the information provided by the entity and being true with the data itself. Then, various *COULD-BE* simulations were performed with the respective data, where it was possible to dive into the problem in hands and to be more precise about which activities are more willing to enhance and/or are more indicated for that purpose, knowing that the goal is always to improve the process and be more efficient at the end of the day. For that, we have also applied different heuristics in each simulation, in order to enhance the business process in question.

Finally, as requested, the *TO-BE* process model is specified and developed, which demonstrates a redesign phase of the process afterwards, but keeping in mind its main focus of comparing its principal advantages and disadvantages in distinct scenarios. Here, the main goal is to improve the already existing model, knowing that not all the activities can be enhanced nor redesigned. Lastly, it is performed again a quantitative and qualitative analysis to better understand if there was indeed an improvement in the outcomes generated.

Background

The Caring Pharmacy is a well-known pharmacy in Portugal, and it is operating in different locations, more precisely, in Lisbon, Porto, Faro, Coimbra, Santarém, Torres Vedras, Braga and Évora. This pharmacy is in service since 1998 and has more than 80 employees working in distinct departments.

Nonetheless, the study taken into account was restricted to the Lisbon pharmacy, which englobes 4 technicians and 3 pharmacists, and whose timetable's service is from 10 a.m. to 6 p.m., every day. Furthermore, as we are focusing on the *Order-to-Cash* process, it is known that this begins when the company receives an order and ends with the customer's order being registered, which is the principal objective of this project, as it was required to assess the process of attending the customers.

As the Lisbon pharmacy receives around 220 clients per day, it is by common sense known that sometimes all the operations delimited do not occurred as expected. This is the reason why we are here to support this case study. Since some customer dissatisfaction until the moments when the worker is not able to serve all the customers during regular working hours, either by not serving them at all or delaying the service for the following clients, the managers want to understand their processes' flaws and overcome these difficulties, increasing its efficiency. In other words, the entity somehow needs an upgrade on the business process, improving the service's quality, reducing the costs and, essentially, enhancing the customer satisfaction!

In order to fulfil the requirements imposed, the concepts inherited from the Business Process Management were important to have good performances and outcomes, as they were our guide to conduct the further analysis. However, it was crucial to understand what it is indeed the meaning and the knowledge behind the concept "*Business Process Management*". As *Dumas* have stated, the *Business Process Management* is "a collection of inter-related events, activities and decision points that involve a number of actors and objects, and that collectively lead on an outcome that is of value to at least one customer" (Dumas et al., 2013), in other words, the core of the Business Process Management consists of ensuring the adequate outcomes and perceive the improvement opportunities we have at our disposal.

To complement the theoretical understanding of the concept itself, it was also followed the Business Process Management's steps and the rules inherited in it. In a more detailed description, the Business Process Management englobes distinct phases and activities in the business processes' lifecycle, which is mainly "a body of methods, techniques and tools to discover, analyze, redesign, execute and monitor business processes." (Dumas et al., 2013). The business processes' lifecycle, by *Dumas*, presents several phases which are crucial to implement in the Business Process Management domain, starting at the Process Identification that has as outcome the Process Architecture, followed by Process Discovery, which dedicates on the AS-IS Process Model. Then, the next phase is the Process Analysis to assess the insights extracted by the weaknesses and their impacts on the process, followed by the Process Redesign, that focuses on the To-Be Process Model to be executed on the Process Implementation phase. Consequently, by executing the respective process, it is then taken to the next phase of the business process' lifecycle, which is the Process Monitoring and Controlling that finalizes by getting the conformance and the performance insights.

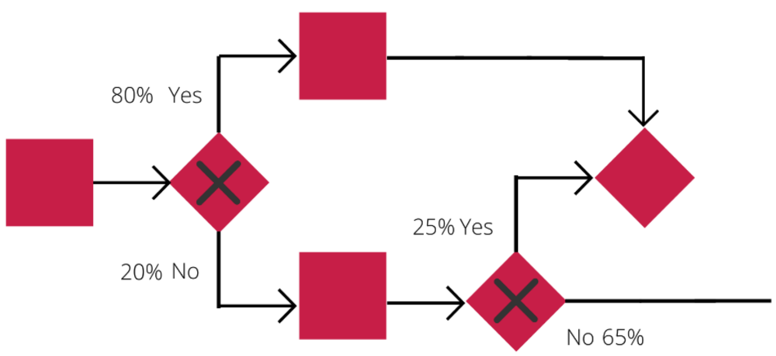
Assumptions Made

One of the main goals of this project is to optimize the pharmacy's process. For that, we must do simulations according to how the process is carried out. In order to complete these simulations, some assumptions needed to be made, since the pharmacy did not provide us all the necessary data.

General Assumptions

To start, it was necessary to define how often clients enter in the pharmacy and the time interval in which, on average, it happens. Taking into account that the Lisbon pharmacy receives around 220 clients per day, and that it is opened 8 hours every day, we calculated that each client arrives every 2.18min (8h*60min/220 clients). Then, the arrivals were defined as a *Poisson* distribution with 2.18min as mean.

When analyzing all the possible processes and which paths could the process take, we realized that some probabilities are not perfectly defined. According to the information provided by the pharmacy, we know that the medicines can be paid by the insurance 85% of the times – however, it includes not only when the medicine is already covered but also when it is replaced for another one. So, we considered that the first situation occurred 80% of the times, while the case where it cannot be covered was assumed as happening 20% of the times. When not covered, it is checked if the drug can be replaced – being defined that the drug is replaced 25% of the times (not be covered and be replaced (20%*25%=5%) + can be covered (80%) = 85%, as it is explained by the pharmacy).



Simulation Assumptions

- Distribution assumptions

Although each activity has an average time, this time can vary and not be always constant – something that must be considered when performing the simulation. We defined the distributions of each activity based on the following facts:

1. If it is performed by a software application or if it a task with short times and that do not vary much.
2. If it is a repetitive task.
3. If it is complex and involves analysis or decisions.

With this in mind, we defined the distribution for each task in the following way:

- *Request order* – Fixed value of 15 seconds since it is a fast task without complexity.
- *Register order without prescription* – this subprocess has 2 tasks, one of them has a time between 0.7 and 1.0 min and another that takes 0.4min. Thus, we considered it as a normal distribution, with a mean of 1.25 min (1 minute and 15 seconds, considering the sum of the first task mean - 0.85min – and 0.4min) and a standard deviation of 0.15min (9 seconds) by the difference between the mean of the first task (0.85min) and the maximum and minimum time they informed that the task may last.
- *Prescription Review* – since it is known that it is a very flexible task, we considered it with an exponential distribution with a mean of 1.9 minutes (1min54sec). This value is derived from the sum of the average time of all tasks of the sub-process.
- *Check Customer History* – As it depends on the client's history, we considered a normal distribution, with a mean of 1min and a standard deviation of 10 seconds (0.16667min)
- *Insert the note in the system* – it is a small task that does not involve anything complex or that varies depending on the client, so it was considered as a fixed value of 30 seconds.
- *Call the doctor* – this task involves discussion and decision making and the time can be inconstant, so we considered an exponential distribution with a mean of 3 minutes.
- *Tell the customer that is not possible to fulfil his order* – we considered it as a fixed value of 15 seconds, since it is a task only to inform and pass information, that does not vary much from the allocated time.
- *Send new Prescription to the client* – for this task, we assumed that the task of sending a prescription could be equated to the *insert a note in the system* one, so we considered it as a fixed value of 30 seconds. Furthermore, we added a waiting time of 2 minutes, since it is the time that the client and the pharmacist wait to receive the new prescription.
- *Check if the drug can be replaced* – It is a small task done by a software, so we considered a fixed value of 30 seconds.

- *Drug Replacement* – This task involves a call to the doctor, something that is not constant and that has decisions to be made, so we considered as an exponential distribution with a mean of 2.20 minutes (2 minutes and 12 seconds).
- *Check if the pharmacy has the medicine in stock* – fixed value of 30 seconds, because it is done by a software (the system).
- *Pass the information to the pharmacist* – As in the *Tell the customer that is not possible to fulfil his order* task, we supposed that the passing of information would be a quick procedure without major variations. So, this task has a fixed value of 15 seconds.
- *Go and get it* – task that depends on the medicine, since there are rare drugs or some that could be in storage. We considered it an exponential distribution with mean of 45 seconds.
- *Check again if the medicine is correct* – This task was assumed as having a normal distribution with mean of 0.5min (30 seconds) and standard deviation of 0.08333min (5 seconds).
- *Choose Alternatives* – For this task, we chose a Normal Distribution, since it involves a decision. The distribution has as parameters: mean of 1min and standard deviation of 10 seconds (0.166667min).
- *Notify the Customer* - Something repetitive and that varies, so it was considered as having a Normal Distribution with mean of 1.5min and standard deviation of 15 seconds (0.25min).
- *Inform the technician* – Again, a transfer of information – fixed value of 15 seconds.
- *Order the medicine from the supplier* – Order the medicine takes a similar time to *Insert a note in the system*. So, it was considered as a fixed value of 30 seconds.
- *Choose the New Product discussing with the client or the doctor* – it depends on a decision, so we considered an exponential distribution with mean of 3 minutes.
- *Receive the Payment* – The description of the process defines the payment time as being in fact 30 seconds, so we took it as a fixed time.
- *Package the medicines* – Since it is done in a very short time, with little variation, it was considered fixed at 5 seconds.

Task	Distribution	Mean	Standard Deviation
Request order	Fixed Value	15sec.	
Register order without prescription	Normal	1min15sec.	9sec.
Prescription Review	Exponential	1min54sec.	
Check Customer History	Normal	1min.	10sec.
Insert the note in the system	Fixed Value	30sec.	-
Call the doctor	Exponential	3min.	-

Tell the customer that is not possible to fulfil his order	Fixed Value	15sec.	-
Send new Prescription to the client	Fixed Value	30sec.	-
Check if the drug can be replaced	Fixed Value	30sec.	-
Drug Replacement	Exponential	2min12sec.	-
Check if the pharmacy has the medicine in stock	Fixed Value	30sec.	-
Pass the information to the Pharmacist	Fixed Value	15sec.	-
Go and get it	Exponential	45sec.	-
Check again if the medicine is correct	Normal	30sec.	5sec.
Choose Alternatives	Normal	1min.	10sec.
Notify the Customer	Normal	1min30sec.	15sec.
Inform the technique	Fixed Value	15sec.	-
Choose the New Product discussing with the client or the doctor	Exponential	3min.	-
Order the medicine from the supplier	Fixed Value	30sec.	-
Receive the Payment	Fixed Value	30sec.	-
Package the medicine	Fixed Value	5sec.	-

Table 1 - Distributions and Parameters

Development / Content

Process Identification

Considering that customers nowadays are more demanding with regard to the services received, modelling and evaluating business processes is very important in order to maintain services operations and improve them to a higher level, letting the company stay competitive in the market.

Therefore, it is very important to understand and estimate costs and time for each task, considering the interdependency between them. According to Michael Hammer a business process can be defined as "a complete set of activities end-to-end that creates value for the customer". The Order to Cash process starts with an event, when a customer enters in the pharmacy, then this triggers a set of activities and decisions performed by or involving *Caring Pharmacy* technicians, pharmacists, and the client, with the objective of retrieving business value to *Caring Pharmacy.*

The main challenge of this project is modelling an Order to Cash pharmacy process located in Lisbon. In the BPM life cycle, the modelling process consists of activities that can be represented graphically, providing an end-to-end perspective. This representation includes activities, tasks, responsibilities, resources, events, inputs/outputs, and so on.

To be considered as process, the business must have included in their routine steps that have to be accomplished in order to create value and reach the goal. The table below describes the type of the steps and how it is applied in the Caring Pharmacy business process.

Step	Definition	O2C Caring Pharmacy Example
Event	Things that occur automatically and interfere in the process flow. Most of the time has a cause and impact and require reaction	Client enters the pharmacy
Activity	Consisted of many steps and can have multiple inputs and multiple outputs. An activity does not occur automatically	Drug replacement
Task	When the work cannot be decomposed, being a single unit of work, it is considered as task	Request prescription
Actor	Can be a person, system, organizations, and physical objects. The entity responsible for the activity execution	Technician, Caring Pharmacy, system or the client
Decision Points	Part of the process in which a decision must be taken and influence the process or the outcome. Can be evidenced when a question is raised and for each question answered there could be an outcome	Does the insurance policy cover the prescription?
Outcome	Can be single or multiple, positive or negative depending if the gave process value	Client left/Order registered

Table 2- Process definitions

The group identified the business functions as: Receive client, enter and check prescription, fulfil order, deliver and payment. We categorized in three stages: the registration, checking prescription/stock, package and payment. The second guideline was to separate them vertically, since are different process.

	System	Pharmacy
Receive Client		Request and register prescription
Enter and Check Prescription	Checking by system	Checking by the pharmacist
Fulfil order		Packing medications and receiving payment by technician
Deliver and payment		

Table 3 – Vertical Designation Phase

As-Is Process Model Description

In the analysis of the business processes, describing the As-Is process is the first phase after identifying the scope of the business, being defined as a process management strategy that identifies and evaluates the business's current processes, that is, the way the processes are currently done, taking into account the current workers and its associated costs. Also, it is crucial to consider the processes descriptions and the assumptions made (previously explained) in the construction of the AS-IS model.

- Order-to-cash (O2C)

The order-to-cash is the core process of the business and embraces all the steps and subprocesses that are set into motion when a client places an order, covering everything that the employees do until the moment of the payment.

This process starts when a client enters the pharmacy, and since the technician is the one responsible for receiving and serving the customer, his first task is to request the client's order. Then, he will verify if the customer has a medical prescription, if it is the case, he will analyze it (subprocess *Prescription Review*), otherwise the subprocess *Register order without Prescription* takes place which itself has two possible outcomes, either the order gets registered or not. For the case where the order could not be fulfiled, the client leaves without it.

Sometimes during the analysis of the medical prescription, an alarm is raised, which leads to the pharmacist intervention, having to study the client's history. When this does not happen, that is, when the alarm is not triggered, the technician will check in the system if the customer's insurance policy covers the medicines, if so, or if the client's order is fulfiled without a prescription, the technician will check if the pharmacy has the medicines in stock.

On the contrary, if the customer's insurance policy does not pay for the drugs in the prescriptions, the technician should analyze if it is possible to proceed with the drug replacement by a covered one, if yes, the pharmacist will carefully investigate the situation with the objective of trying to find the best drug alternative (*Drug Replacement* subprocess).

Afterwards, the instances where the drug could not be replaced by a covered one and still the client wanted to proceed by paying for it, or in the case when the drug could be replaced and the client decided to continue with the purchase, or when the insurance covered the prescription, or even when an order without prescription was already registered, proceed further in the technician's lane to check if the requested is available in stock. Contrariwise, in both situations the client leaves the pharmacy without the order.

When an alarm was raised and the pharmacist is checking the customer's history, he will discover if the medication is beneficial for the client or not, if so, he will insert a note in the system and the technician will see if the medicine is covered or not by the client's insurance policy. On the contrary, if the drug is not appropriate for the customer, the pharmacist will call to the doctor (subprocess) to better understand the situation and find a solution. Posteriorly, the client must choose if he wants to proceed with the purchase, if yes and if the doctor's prescription was really wrong either the doctor will send a new one to the client's mobile phone (for the case that the client has an electronic prescription), or the pharmacist will tell the customer that's not possible to fulfil his order and consequently the client leaves without the medication (if the client does not have an electronic prescription). When the doctor sends a new prescription for the client, the process starts again with the technician requesting the new order. In situations where the doctor was not mistaken, being mandatory for the customer to take all the prescribed medicines, the pharmacist will insert the justification for the prescription in the system, followed by the verification of the insurance policy coverage.

After the technician certificates that the drugs are available in stock, he will pick them. Then the pharmacist will ensure again if the medicine is correct, if so, the technician will package the medicines and receive the client's payment. In the other way around, that is, if the pharmacist realizes that the drug is not the right one, he will identify the proper one, and posteriorly the technician will see if the new one is available in stock. Additionally, when the chosen drug is out of stock, the technician passes the information to the pharmacist who will have to choose alternatives. For the cases where there are not substitutes, the pharmacist advises the technician, and the latter will notify the client of the situation, and this will leave without his order. Then, the technician will order the medicine from the supplier. If there are alternatives available, the pharmacist will have to choose the new product taking into account the doctor's or the client's opinions. If a consensus is reached for the drug change, the technician will see in the system if the new medicine is in stock. Contrariwise, if there is no possible alternative for the medicines, the pharmacist will inform the technician, following the same process in the case where there were no other options for the drug replacement.

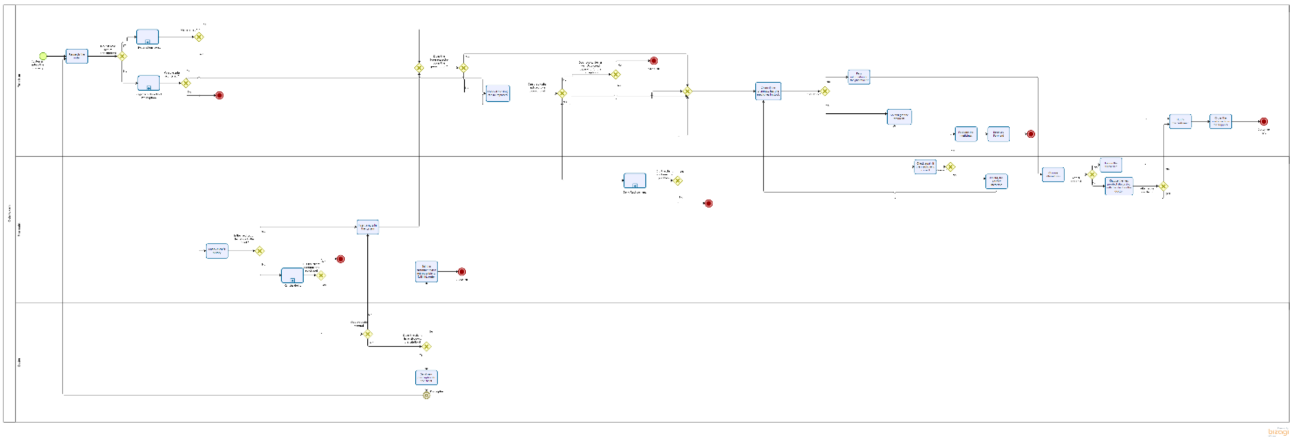


Fig.1– Order to Cash process (see Attachment 1)

- Subprocesses

To ease our modelling and posterior analysis we divided our process into several subprocesses: *Level 2- Prescription review*, *Level 2- Register order without Prescription*, *Level 2- Call the doctor* and *Level 2- Drug Replacement.*

Prescription Review

Concerning the prescription review subprocess, it belongs to the Technician Lane and it starts when a client has a medical Prescription, cases where it is necessary to check in the system if the prescribed drugs can be picked up by the customer. Thus, the first task is to receive the prescription (which can be either delivered in paper format or shown via mobile phone). Afterwards, the details of each prescription (as doctor details, patient details and medication details have to be inserted by the technician in the pharmacy's system, which performs an automated check (Drug Utilization Review – DUR), determining if the drugs are compatible with the past drug history of the client and with other customer data maintained in the system. The outcome of the previous task is one of two, either an alarm is raised or not, which is the ending event of this subprocess.

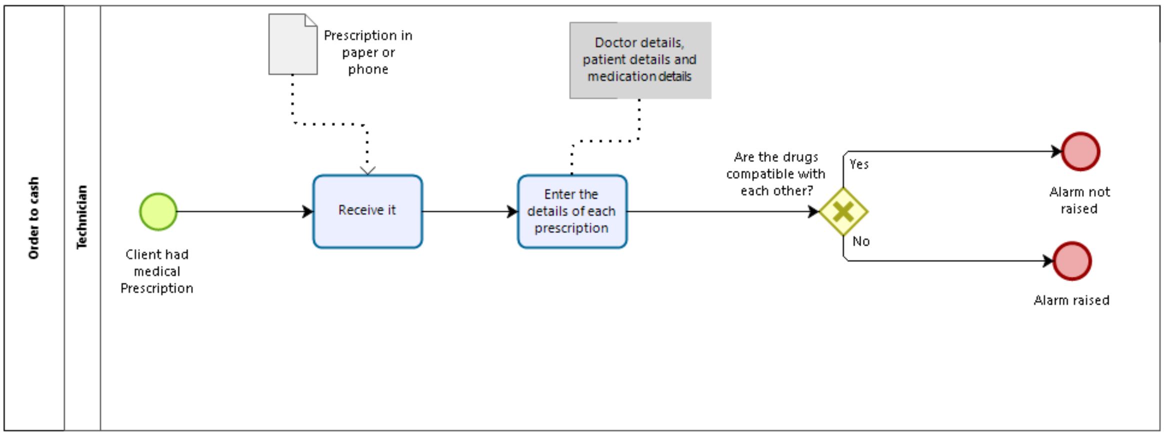


Fig.2– Prescription Review subprocess

Register order without Prescription

Regarding the subprocess *Register order without Prescription,* it starts when a client does not have a medical prescription (which is the start event) and it occurs in the technician's lane. The first task performed is to take note of the order. Next, the technician must check the system to know if the ordered drug can be picked up or not. In case the order can be fulfiled, the subprocess ends with the order registration, otherwise it ends with the customer leaving the pharmacy without it.

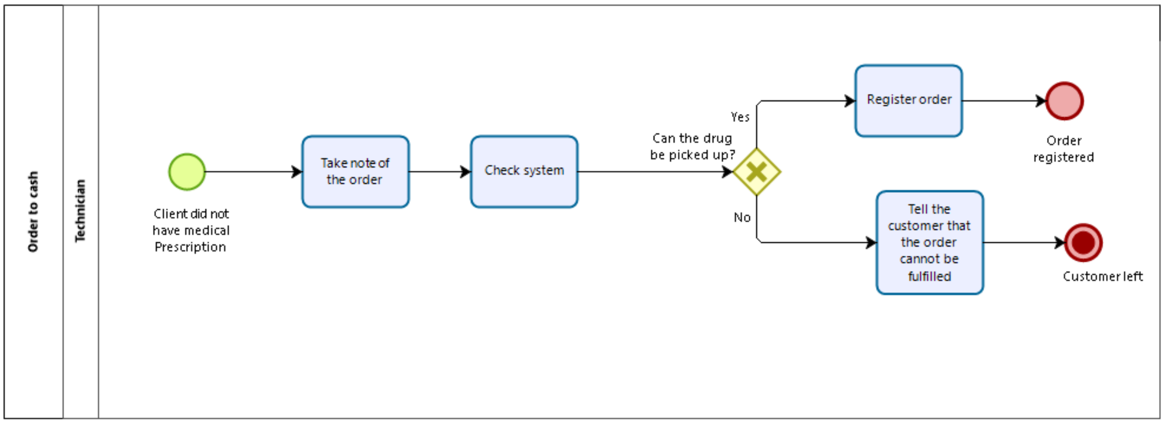


Fig.3– Register order without Prescription subprocess

Call to the doctor

The next subprocess identified was the *Call to the doctor*, which occurs in the pharmacist lane. This process starts when after checking the client's history, the pharmacist concluded that the medication wouldn't be beneficial. The task that proceeds is to call the doctor, which has two possible outcomes: either the doctor answers the call or not. In the positive case, the situation is discussed with the doctor, ending, subsequently, the subprocess. In the opposite case, the subprocess ends with the client leaving.

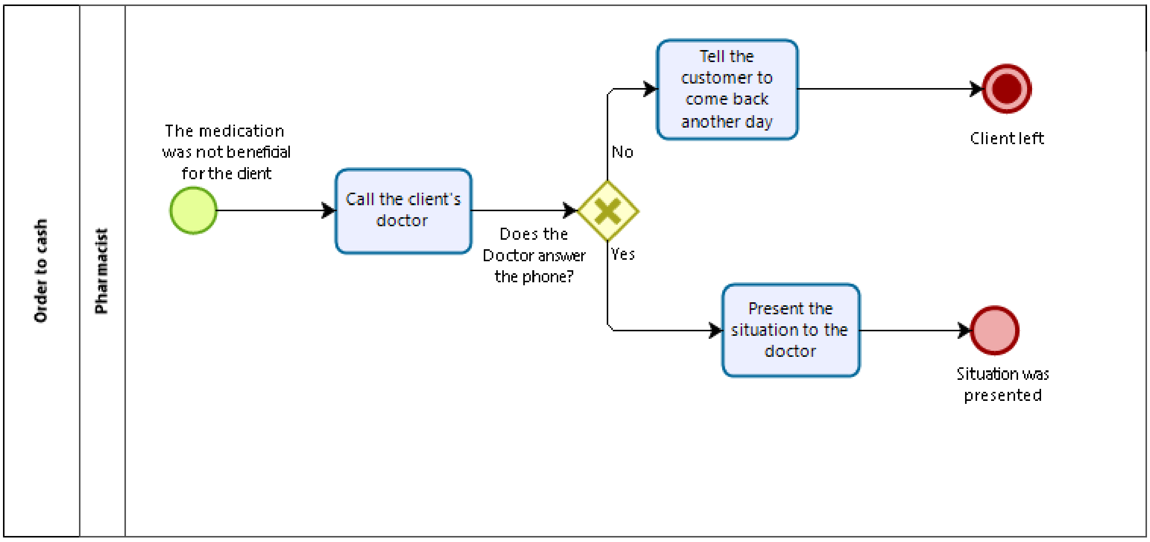


Fig.4– Call the doctor subprocess

Drug Replacement

Concerning the subprocess for the *Drug Replacement*, it occurs in the pharmacist lane as well.

This subprocess starts when the prescription was not covered by the insurance policy but there is place for a replacement. Thus, the pharmacist can decide to make a call to discuss the possible replacement either with the doctor or with the patient. If he proceeds by calling the patient, the process becomes really simple, being the end event the end of the call. On the contrary, if necessary to call the doctor there are two possible results: the doctor answers the phone or not. If he answers, the subprocess ends after the situation is discussed with him. If not, either the customer proceeds by paying for the prescription or decides to come back another day, ending the subprocess.

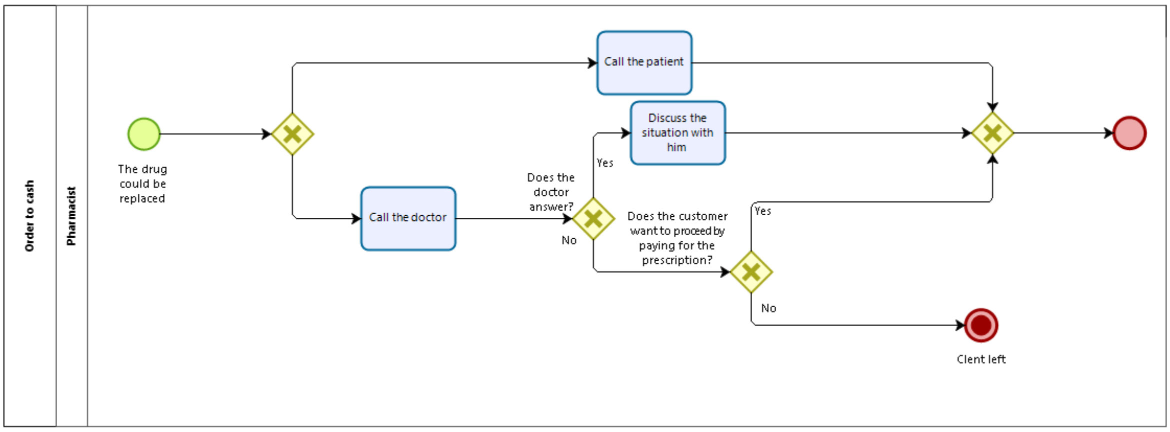


Fig.5– Drug Replacement subprocess

Quantitative analysis

As we know, the quantitative analysis is the process of collecting and evaluating measurable data in order to perceive the behavior and performance of the business. For this reason, we are going to proceed with the *Flow Analysis*, performing the cycle time efficiency, and analyzing the *Resources Costs*, especially the hired employees, in this case the four technicians and the three pharmacists.

Regarding the *Flow Analysis*, the first family of techniques we are going to assess, allows us to evaluate the global performance of process when knowing some previous performance of its activities. Here, four distinct subprocesses with distinct types of cycle time are going to be assessed.

For the first subprocess, the *Prescription Review*, the cycle of time presented here is the sequence one, where the only calculation needed to perform the total time of the subprocess is the summation of the tasks' time, in this case: 1.2 + 0.7 = 1.9 minutes, which comprises the total time of receiving the prescription and of inserting the details of each medical prescription. Furthermore, as it always depends on the circumstances, varying accordingly, and as there is not a fixed value, the assigned distribution for this subprocess was the *Negative Exponential* one, with a mean of 1.9 minutes, according with the previous calculations.

Relatively to the *Register Order Without Prescription* subprocess, the cycle time displayed is a mix between the sequence and the alternative paths. Having this said, when the technician is taking the order, which takes basically 0.4 minutes, and then he/she checks in the system if the drug in question is allowed to be picked up by the customer, which can take from 0.7 to 1 minute, we are in presence of a sequential cycle time, being the outcome the sum of the previous two activities, in case it is a static value. Then, we are encountered with an alternative path, as depending on the answer of the previous task, the order is registered, which embraces 85% of the times, or the order is not executed forward, obligating the client to leave the pharmacy without any purchase. This previous case of an alternative path is usually made by the sum of both tasks taking in consideration the probabilities of each activity to be realized. So, at the end, we are in presence of a *Normal Distribution*, whose mean is 1.25 minutes and its standard deviation is 0.15 minutes, with the following line of thought: as 0.4 minutes is a fixed value and the time spent when inserting the information concerning the details of the prescription can vary according with each case, since 0.7 minutes to 1 minute, it was summed both previous values to the 0.4 minutes, having then the maximum and the minimum values that could really be faced, resulting to 1.1 minutes and 1.4 minutes. Additionally, the mean between these two values is then 1.25 minutes, which indeed is the mean taken into consideration for the *Normal Distribution* assigned and the standard deviation is the difference between this mean and the maximum and minimum values, which is 0.15 minutes.

Regarding the *Call the Doctor* subprocess, there are two hypothesis that can happen when phoning the doctor: either the doctor indeed answers the call and we present to him the situation we are dealing with (in this case the fact that the medicine is not beneficial for the client); or if there is not any answer form the doctor's side, the client leaves the pharmacy. Hence, we are dealing with an alternative path cycle time, where we have the probabilities of each event occurring. Mathematically, the calculation made was the following: 5*0.6 = 3 minutes, where we assumed there is a need for 5 minutes to discuss the matter with the doctor, which usually occurs 60% of the time. Here, it was not included the probability of 40%, concerning the hypothesis of not having an answer from the doctor, due to the fact it is expected that the customer leaves the pharmacy, which does not influence the remaining business process. Nonetheless, as this usually depends on the way the phone call is conducted, which can indeed increase over time, the *Call the Doctor* subprocess was assigned to have a *Negative Exponential* distribution with a mean of 3, which was the outcome of the previous calculation.

Concerning the last subprocess, the *Drug Replacement*, this is more complex in terms of reasoning and calculations, as we are in presence of multiple alternatives paths of cycle time. Taking step-by-step, firstly there is 80% of probability that the pharmacist calls the patient and 20% of probability that the phone call is answered by the doctor. When looking at the first case mentioned, usually the time spent on the call is 2 minutes, which allows us to do the following calculation: 2*0.8 = 1.6 minutes. Nonetheless, when we are in presence of the second situation, there are also two more branches with different probabilities: the case when he/she indeed answers the call or the case it is rejected. Regarding the first hypothesis, it is possible to discuss the situation with the doctor, which takes 5 minutes, allowing us to perform the following calculation: 0.2* 0.6 * 5 = 0,6 minutes. Relatively to the second case, as there is not any activity or task to be performed, there is no need for any calculations. Having said, the total time spent in this subprocess is 2.2 minutes, which was assessed to follow a *Negative Exponential* distribution, as it can vary according to the different phone calls and the way it is approached the problem at hand.

Focusing on the Model AS-IS performed, the times obtained for the process as a whole and in order to perceive the time required for completing it, are demonstrated above:

Model AS-IS	Min. time (m)	Max. time (m)	Total time (m)	Total time waiting resource (m)
Order to Cash	0.773449564	18.672772974	1114.22471604	12.2768593384

Table 4– AS-IS time analysis.

As it is observable, it is possible to infer that usually the customer journey can vary between less than 1 minute to approximately 19 minutes. Nonetheless, the total time of the process is approximately 18h 34min, which also reinforces and stimulates the enhancement of this process and indeed it is too time-consuming.

Furthermore, concerning to the *Resources Costs* and its utilization, we are aware that this pharmacy only employs 4 technicians and 3 pharmacists, which obviously lead to some expenses. The details are shown in the table below:

Resources	Utilization	Monthly Salary	People employed
Pharmacist	23.02 %	1300€	3
Technician	40.56 %	1000€	4

Table 5– AS-IS resources analysis.

The table above alerts us regarding the usage of the different resources in the process. As it is possible to see, the Pharmacists are usually used 23.02% of the time and the technicians 40.56% of the time, which seems not to be so rentable as ideally would be. For this reason, we are going to approach this situation, attempting to improve it in the further scenarios.

Nonetheless, the expenses taken at the end of the month are 1300*3 + 1000*4 = 7900€, which is indeed high when analyzing the percentage of time, they are indeed working.

Qualitative analysis

The two main objectives of qualitative analysis are to identify and remove waste and the identification and prioritization of problems.

- ## Waste Analysis

Another way of studying a business process model is by using Waste Analysis, which involves identifying, quantifying, eliminating, and preventing waste through processes. As stated by Taiichi Ohno, the waste analysis can be defined as "All we are doing is looking at the timeline, from the moment the customer gives us an order to the point when we collect the cash. And we are reducing the timeline by reducing the non-value-adding wastes".

Thus, the principal objective of this analysis is the reduction or even the elimination of unnecessary tasks, for example, the handovers if exist, (all of them are a form of waste) since they generate queues that will lead to an increase in the cycle time, however, we cannot remove all the handovers that are present in the process, since it does not make any sense for a single person to perform all the tasks - some tasks need to be performed by specialists whereas others do not.

In our process model, we can identify at least one situation for each one of the three categories of waste, this information is presented in the table below:

Step	Category	Justification
Enter the details of each prescription	Move: Transportation	Since it sends the details as input – could be automatized
Send new prescription to the client	Move: Transportation	It is an activity related to movement, in which documents are sent
Pass information to the pharmacist	Move: Transportation	It is a handover
Check again if medicine is correct	Overdo: Over-Processing	Unnecessary perfectionism, since it is the second check
Identify the correct medicine	Overdo: Defects	Because it is a correction, since they had taken the wrong medicine
Inform the technician	Move: Transportation	It is a handover
Choose the new product discussing with the client or the doctor	Overdo: Defects	Overdo – It is the second choice, since the first was wrong
Order the medicine from the supplier	Overdo - Defects	Because it is sign that there are not enough medicines.
Wait for the new prescription	Hold: Waiting	The client and the pharmacist are waiting for the new prescription, so it is waste time
Inform the pharmacist	Move: Transportation	It is a handover
Tell the customer that is not possible to fulfil his order	Move: Transportation	It is a handover
Tell the customer to come back another day	Move: Transportation	It is a handover
Tell the customer that the order cannot be fulfilled	Move: Transportation	It is a handover

Table 6– Waste analysis.

- Value-added analysis

Value-added aims to detect unessential steps in a process with the intention of eliminating them, in other words, this analysis focuses on what adds value to business processes as perceived by the customer. A process that does not add value to the product or service should be redesigned or eliminated altogether.

The steps can be classified in a qualitative purpose by three main characteristics:

- Value Adding - Steps which add value directly for the outcome business process or customer.
- Business Value Adding – Steps that are necessary but do not directly add value for customer or business process.
- Non-Value Adding – Steps that do not add any value for the outcome or customer and should be redesigned or removed from the process.

To execute this analysis, we decomposed each task of the process into steps and then we classified each one of them according to its importance through the process (activities labelled as VA or BVA or NVA). This classification can be seen in the tables shown below.

Receive client		
Activity	**Performer**	**Classification**
Request order	Technician	Value Adding (VA)
Receive it	Technician	Value Adding (VA)
Enter the details of each prescription	Technician	Value Adding (VA)
Take note of the order	Technician	Business Value Adding (BVA)
Check system	Technician	Business Value Adding (BVA)
Register order	Technician	Business Value Adding (BVA)
Tell the customer that the order cannot be fulfilled	Technician	Non-Value Adding (NVA)

Table 7– Receive client Value-Add analysis.

Enter and Check Prescription		
Activity	**Performer**	**Classification**
Check clients' history	Pharmacist	Business Value Adding (BVA)
Insert a note in the system	Pharmacist	Business Value Adding (BVA)
Call the client's doctor	Pharmacist	Business Value Adding (BVA)
Tell the customer to come back another day	Pharmacist	Non-Value Adding (NVA)
Present the situation to the doctor	Pharmacist	Business Value Adding (BVA)

Send new prescription to the client	Doctor	Value Adding (VA)
Tell the customer that is not possible to fulfil his order	Pharmacist	Non-Value Adding (NVA)
Check if the drug can be replaced	Technician	Business Value Adding (BVA)
Call the doctor	Pharmacist	Business Value Adding (BVA)
Discuss the situation with the doctor	Pharmacist	Business Value Adding (BVA)
Call the patient	Pharmacist	Business Value Adding (BVA)

Table 8– Enter and Check Prescription Value-Add analysis.

Fulfil order		
Activity	**Performer**	**Classification**
Check if the pharmacy has the medication in stock	Technician	Business Value Adding (BVA)
Pass the information to the pharmacist	Technician	Business Value Adding (BVA)
Choose alternatives	Pharmacist	Business Value Adding (BVA)
Inform the technician	Pharmacist	Non-Value Adding (NVA)
Notify the customer	Technician	Business Value Adding (BVA)
Order medicine from the supplier	Technician	Non-Value Adding (NVA)
Choose the new product discussing with the client or the doctor	Pharmacist	Business Value Adding (BVA)
Go and get the medicine	Technician	Business Value Adding (BVA)
Check again if the medicine is correct	Pharmacist	Non-Value Adding (NVA)
Identify the correct medicine	Pharmacist	Business Value Adding (BVA)

Table 9– Fulfil order Value-Add analysis.

Deliver and Payment		
Activity	**Performer**	**Classification**
Package the medicines	Technician	Value Adding (VA)
Receives payment	Technician	Value Adding (VA)

Table 10– Deliver and Payment Value-Add analysis.

Furthermore, the goal of performing this analysis is to minimize BVA steps to turn the process simpler and to eliminate NVA steps to make it more efficient.

Issue Register

The purpose of Issue Register analysis is to maintain, organize and prioritize identified weaknesses (issues) in the business process model, that is after its identification we can easily understand the impact they bring to the company (either quantitative or qualitative). Some of the issues found can lead to a direct impact on the model performance while others can trigger these direct issues.

The issues encountered are exhibited in the table below.

Issue	Priority	Description	Data & Assumptions	Qualitative Impact
Wrong medicine	1	The prescription medicine is not the proper one	10% of the time the Doctor prescribes the wrong drug	Loss of time.
Doctor does not answer the call	4	Sometimes calls are not answered, making it impossible the request to proceed.	40% of the time the doctor does not answer the calls	Customer satisfaction decreases; Loss of profit;
Medicine not available in stock	2	The technician very that the medicine is not available in stock and pass the information to the pharmacist to search for alternatives	25% of the time, the drugs are not available in the pharmacy	Customers can go to the competitors; Customer satisfaction decreases; Information regarding the availability in stock not updated.
No alternative medicines	3	The Pharmacist searched for an alternative to the initial medicine since this was not available in stock, but without success (no other options)	35% of the time there is not medicine for replacement	Customers can go to the competitors; Customer satisfaction decreases; Loss of customer loyalty.
No electronic Prescription	5	In some situations, not having an electronic prescription will not allow proceeding with the order.	15% of the time the customer does not have an electronic prescription	Loss of efficiency and time.

Table 11– Issue Register analysis

Simulation

After having understood the problem at hand, designed and modeled the AI-IS business process, qualitatively and quantitatively analyzed the pharmacy's order-to-cash process, and made all the assumptions, we have the necessary tools to simulate the current process of the pharmacy.

This simulation will enable the identification of issues and problems with the process (like non-value adding steps, wastes, bottlenecks) and consequently, through the What-if analysis (perform alterations in the inputs of the AS-IS process, with the aim of testing and consequently choosing the best scenario to propose the TO-BE), the development of possible solutions to mitigate them, presented through several scenarios.

Lastly, we will propose a TO-BE process model, properly describing all its advantages and limitations.

AS-IS Model

Through the simulation of the AS-IS business model it was immediately possible to conclude several aspects, to uncover certain problems/issues with it and to know which activities take more time being performed or have higher waiting times.

Firstly, analyzing the resources utilization (Table 12), we noticed that between the pharmacist and the technician the rates of utilization are really low, where, in particular, the three pharmacists only have 23.02% of utilization.

Resource	Utilization	Number of Resources
Pharmacist	23.02 %	3
Technician	40.56 %	4

Table 12– Resource Utilization in the AS-IS business model's simulation.

The order to cash process, between all the resources, tasks and started instances, had a total time of approximately 18h 34min 13s and a waiting time of 12.27 min which although a small number for a period of activity of 8h should be examined. (Table 13)

	Instances started	Total time (m)	Total time waiting resource (m)
Order to Cash	202	1114.22471604124	12.2768593384259

Table 13– Order-to-cash in the AS-IS business model's simulation.

Studying now with more depth the time's distribution through the different tasks as well as the number of instances completed in each, we noticed that the task that has greater values for the total time is *Prescription review* followed by *Go and get the medicine* and *Check* *again if the medicine is correct.* This pattern although explainable by the number of instances completed in each (155, 142 and 142, respectively) should be analyzed carefully, as an improvement in them could agile the process. Additionally, looking at the average time of each instance, the task *Choose the new product discussing with the client or the doctor* is the one that takes more time.

Reviewing the waiting times, *Requests the order* is the one that takes more time with 2.2 minutes which spread by the 202 customers that, in our simulation, entered the pharmacy is unsignificant (with an average per instance of only 0.011 min). Even looking at the rest of the averaged waiting times, the maximum value is only 0.014 min for the *Prescription Review*. The lack of waiting times, although the objective and a very positive fact to point out, when conjugated with the low percentage utilization of the technicians and pharmacists might be an indicator that we do not have waiting times because we have more resources than we actually need and not due to a great process design, for example. So, the use of resources should be looked at, aiming at its optimization.

Task Name	Instances completed	Avg. time (m)	Total time (m)	Avg. time waiting for resource (m)	Total time waiting resource (m)
Insert a note in the system	50	0,503	25,127	0,003	0,127
Tell the customer that is not possible to fulfil his order	0	0,000	0,000	0,000	0,000
Requests the order	202	0,261	52,707	0,011	**2,207**
Check if the drug can be replaced	36	0,513	18,478	0,013	0,478
Check if the pharmacy has the medicines in stock	168	0,512	86,078	0,012	2,078
Pass information to the pharmacist	38	0,262	9,944	0,012	0,444
Go and get the medicine	142	0,767	**108,928**	0,010	1,417
Check again if the medicine is correct	142	0,507	**71,986**	0,009	1,287
Identify the correct medicine	10	0,500	5	0	0
Package the medicines	132	0,089	11,787	0,006	0,787
Choose alternatives	38	1,056	40,144	0	0
Inform the technician	16	0,250	4	0	0
Notify the customer	24	1,501	36,024	0	0
Choose the new product discussing with the client or the doctor	21	**3,360**	70,563	0	0
Order the medicine from the supplier	24	0,506	12,154	0,006	0,154
Check client´s history	58	1,017	58,957	0,001	0,046

Send new prescription to the client	0	0	0	0	0
Receives Payment	132	0,505	66,620	0,005	0,620
Prescription review	155	2,112	**327,314**	**0,014**	2,179
Register order without Prescription	47	1,255	59,007	0,010	0,453
Call the doctor	15	2,177	32,649	0	0
Drug Replacement	10	1,676	16,757	0	0

Table 14– Order-to-cash in the AS-IS business model's simulation.

What-If Analysis

Taking into account the problems encountered and to make the process more efficient, we have created four different scenarios (could-be processes) that are improvements of the AS-IS model currently used by the Caring Pharmacy entity.

In order to analyze the scenarios, simulations were made considering the changes for each case with the interest of obtaining the best scenario to be proposed for the business.

Following the literature and applying BPM concepts, in all cases distributions as Normal, Exponential and Fixed Value were given according to the task/activity.

For the start events, the appropriate distribution is Poisson once the objective is to know the independent events in a certain period of time.

- ### Scenario 1 – Change Resources

The first scenario carried out was based on the heuristic number seven, more specifically, the resource optimization. We decided to perform this change as in the AS-IS model the resource utilization for the pharmacist and technician was substantially low, which indicates that the task distribution was not ideal. For this same reason and knowing that the resource utilization is higher (40.56 %) for the four technicians, we decided to hire another one and fire a pharmacist, since it seems that three pharmacists are too many considering the work performed by them (too little work for each one of them).

With this adjustment done it is possible to observe (*Table 15*) a greater balance of work among the employees.

Resource	Utilization	Number of Resources
Pharmacist	34.38 %	2
Technician	32.44 %	5

Table 15 – Resource Utilization in the Scenario 1 business model's simulation

Now concerning the Total time and Total time waiting for resources in this scenario and comparing these results with the ones achieved in the initial model, it is clear that both times have increased, 19h10 for the total time and 45.46 minutes for the total time waiting for resource, which in itself is not very positive, which may indicate that this modification by itself is not enough to optimize the process. This information is presented in the *Table 16*.

	Instances started	Total time (m)	Total time waiting resource (m)
Order to Cash	202	1146.49020456243	45.4624542124338

Table 16 – Order-to-Cash in the Scenario 1 business model's simulation

As previously stated, in general terms the times have not gone down, however, in some specific tasks, the changes are slightly noticeable.

Looking to the table displayed below (Table 17) which presents the number of instances completed in each activity and the time's distribution for each one performed some values stand out immediately, as they are the highest ones. For the average time, the tasks that are more time consuming (just like before, given that these were not changed) are the following: *Choose the new product discussing with the client or the doctor*, *Prescription review,* and *Call the doctor,* with 3.572, 2.102 and 2.281 minutes, a future improvement could be trying to reduce the times for these activities with the implementation of another heuristic. Furthermore, regarding the total time the activities that take the most time are the *Go and get the medicine* and the *Prescription review,* with times of 108.4 and Prescription review, respectively. These tasks are the ones we should look into since these values are too lofty and certainly, they can be diminished. Moreover, for the Avg. time waiting for resource the values are pretty low which is very good since the main objective here is to have the values of the tasks as close to zero as possible, in order to avoid queues. The activities with bigger values are the *Identify the correct medicine, Inform the technician*, and *Choose the new product discussing with the client or the doctor* (0.2117, 0.196, and 0.245, accordingly). Lastly, concerning the *Total time waiting for resources*, the only activity that stands out negatively is the Check again if the medicine is correct, which occupies 15.73 minutes.

With this, we can conclude that a good upgrade to this scenario to a better version, is to automate the process as much as we can, taking into consideration the changes performed at this stage.

Task Name	Instances completed	Avg. time (m)	Total time (m)	Avg. time waiting for resource (m)	Total time waiting resource (m)
Insert a note in the system	50	0.615	30.74	0.115	5.740
Tell the customer that is not possible to fulfil his order	0	0,000	0	0	0
Requests the order	202	0.251	50.62	0.0006	0.1189

Check if the drug can be replaced	36	0.5	18	0	0
Check if the pharmacy has the medicines in stock	168	0.50	84.08	0.0005	0.083
Pass information to the pharmacist	38	0.25	9.5	0	0
Go and get the medicine	142	0.763	**108.4**	0.006	0.873
Check again if the medicine is correct	142	0.609	86.43	0.111	**15.73**
Identify the correct medicine	10	0.712	7.117	**0.2117**	2.117
Package the medicines	132	0.084	11.06	0.0004	0.056
Choose alternatives	38	1.137	43.22	0.081	3.081
Inform the technician	16	0.446	7.140	**0.196**	3.140
Notify the customer	24	1.501	36.02	0	0
Choose the new product discussing with the client or the doctor	21	**3.572**	75.02	**0.245**	5.379
Order the medicine from the supplier	24	0.508	12.19	0.008	0.192
Check client´s history	58	1.116	64.75	0.099	5.840
Send new prescription to the client	0	0	0	0	0
Receives Payment	132	0.504	66.49	0.004	0.485
Prescription review	155	**2.102**	**325.9**	0.005	0.724
Register order without Prescription	47	1.246	58.55	0	0
Call the doctor	15	**2.281**	34.22	0.105	1.569
Drug Replacement	10	1.709	17.09	0.033	0.332

Table 17 – Scenario 1 business model's simulation for the different tasks

- ### Scenario 2 - Scenario 1 + Automation

Besides the first scenario presented above, we decided to test some more. In this second scenario, we decreased the times of some activities, and consequently, the cycle times, where we consider that the same tasks could be taken in a quicker or in a different way with the aim of automatizing the process. Having said that, this scenario is the junction of the first scenario that used Heuristic 7, the resource optimization, with the heuristic number nine, the Automation.

Thus, the changes performed are the following:

- Automate the prescription review, where instead of being the technician entering the details of the prescription into the system, the system will read it instantly through a QR code/bar code. Therefore, and since this activity will be done much faster, we decided to change the time of the task to 30 seconds with a fixed distribution.

- Automate the Go and Get it, where a machine will perform the task instead of the technician, and for this same reason the time needed to execute the activity will be less since the machine is programmed to do the job quickly with a constant time, and also the error rate will be significantly lower. So, the time considered for the machine to automatically fetch the medicine is fifteen seconds.

Considering the first scenario and the new changes implemented, the results can be observed in the Table 18, that the resource utilization increases for the pharmacist and decreases for the Technician.

Resource	Utilization	Number of Resources
Pharmacist	40.86 %	2
Technician	19.54 %	5

Table 18 – Resource Utilization in the Scenario 2 business model's simulation

Concerning the Times of the Order-to-cash process, fortunately with this new modification, the times have been reduced, passing from 19h10 min to 15h11 min concerning the total time of the tasks. Beyond that, the total waiting time for resources also decreased from 45.46 to 44.57 minutes. The values described are presented in the Table 19.

	Instances started	Total time (m)	Total time waiting resource (m)
Order to Cash	202	906.97997801372	44.5791706802693

Table 19 – Order-to-Cash in the Scenario 2 business model's simulation

In respect to the time distribution and the number of instances accomplished in each task, *Table 20*, the quantity of higher values that stands out is much lower when comparing to the previous scenario, which is indeed is a good indicator of improvement, once the times to perform the majority of the activities decreased. An example of this reduction, is the subprocess *Prescription review* whose high values for the *Avg. time and Total time* in the second presented scenario were greatly reduced, passing from 2.102 and 325.9 to 0.5 and 82, respectively. When exploring the Average time values, the one that we should consider for further analysis of improvement is related to the *Choose the new product discussing with the client or the doctor activity*, with 3.680 minutes respectively. Apart from that, concerning the total time, the two most worrying tasks are the *Check again if the medicine is correct* and the *Choose the new product discussing with the client or the doctor* (96.76 and 125.1 minutes), as both values have grown in relation to the ones obtained in Scenario two. Additionally, regarding the average time waiting for resource almost all the tasks have values nearly zero, which indicates the absence of queues, however the activity with a higher value is *Inform the technician*, with an average waiting time of 0.3978 minutes. The last metric we took into account to measure the performance of this scenario was the *Total time waiting resource* in which the higher value presented is related to the activity *Check again if the medicine is correct*, with a time of 18.77 minutes.

Having explored the activities that occupy the most time in this scenario, a further step is to try to reduce them even more. For that purpose, in the next scenario we will proceed with the process re-design in order to solve the issues/ problem found and try to optimize them.

Task Name	Instances completed	Avg. time (m)	Total time (m)	Avg. time waiting for resource (m)	Total time waiting resource (m)
Insert a note in the system	65	0.588	38.24	0.089	5.737
Tell the customer that is not possible to fulfil his order	0	0	0	0	0
Requests the order	203	0.25	50.75	0	0
Check if the drug can be replaced	34	0.5	17	0	0
Check if the pharmacy has the medicines in stock	178	0.5	89	0	0
Pass information to the pharmacist	48	0.25	12	0	0
Go and get the medicine	157	0.25	39.25	0	0
Check again if the medicine is correct	157	0.616	**96.76**	0.119	**18.77**
Identify the correct medicine	5	0.5	2.5	0	0
Package the medicines	152	0.083	12.67	0	0
Choose alternatives	47	1.105	51.93	0.074	3.579
Inform the technician	13	0.648	8.422	**0.3978**	5.172
Notify the customer	20	1.554	31.09	0	0
Choose the new product discussing with the client or the doctor	34	**3.680**	**125.1**	0.143	4.867
Order the medicine from the supplier	20	0.5	10	0	0
Check client's history	70	1.103	77.18	0.080	5.600

Send new prescription to the client	1	2.5	2.5	0	0
Receives Payment	152	0.5	76	0	0
Prescription review	164	0.5	82	0	0
Register order without Prescription	39	1.252	48.84	0	0
Call the doctor	11	2.003	22.03	0.042	1.569
Drug Replacement	9	1.520	13.68	0.044	0.332

Table 20– Scenario 2 business model's simulation results for the different tasks

- ### Scenario 3 – Task elimination + resource optimization

After several analysis and scenarios simulations, it was concluded that there was not more room for improvements using the previous methods. Thus, the next step was to redesign the pharmacy's model through an Exploitative Redesign, resolving the identified problems incrementally, one step at a time.

Our main goals at this stage were: to get better processing times, keep the small waiting times and optimize the resources usage. Although there is not a golden rule to follow when improving the design of a process, several heuristics were used to help us achieving a good result. Specifically, these were applied on both a Task-level and Process Level.

Firstly, looking the current process structure, we noticed that after the technicians check if the pharmacy has a certain medicine in stock, either they would pass the information to the pharmacists or they would get the medicine so that the pharmacist could then check if the medicine taken was the correct one. In either case, the process would flow to the pharmacist's lane (immediately or after one task). Thus, from our understanding, the best choice was to assign the task *Check if the pharmacy has the medicines in stock* to the pharmacist.

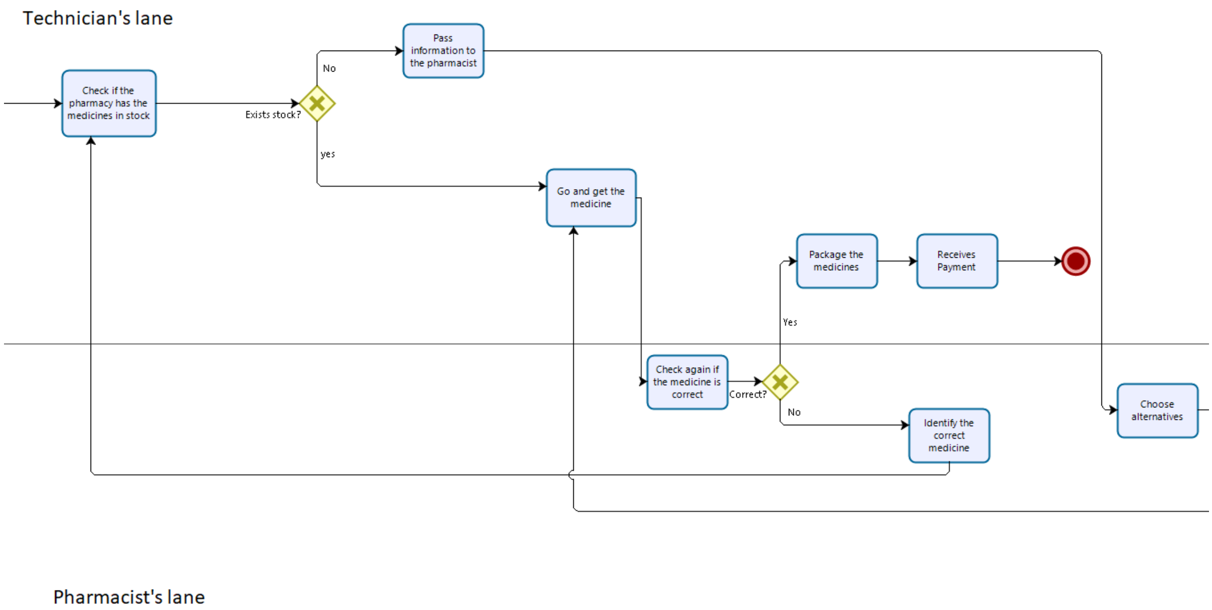
Similarly, the disposal change of some activities to the Pharmacist Lane also included the *Go and Get the Medicine* one. This change was made based on *Heuristics 7 - Resource optimization* – on the assumption that the pharmacist has the skills to get the medicine, with this change, on one hand we can avoid the Technicians to get overloaded with this task when the Pharmacist's utilization is smaller and, on the other hand we can optimize the resources usage by moving this set of tasks to another lane instead of being changing several times between the two lanes.

With this change, the logical choice was to also eliminate the task *Check again if the medicine is correct* as it would be made by the pharmacist, and he already was the one who took the medicine. For the previous step we considered the *Heuristics 1 - Task elimination,* carefully reflecting on the trade-off between the cost of the check and the cost of not doing it – in this particular case, given that this task is among of the ones that are most time-consuming (total of 71.986m) and that being executed in 142 instances of our simulation, only 7% of the times the medicine was not the correct one, the benefit of removing this task would outweigh the benefits of keeping it.

Naturally, the task *Identify the correct medicine* was also removed as keeping it without the checking procedure would be meaningless.

Furthermore, in the cases where the medicine was not in stock and there were not available alternatives, instead of letting the pharmacist inform the technician so that the latter could *Notify the Customer* and *Order the Medicine from the Supplier*, we re-designed the process so that these two tasks would be kept at the pharmacist's lane, removing the time of transferring the information (by removing the task *Inform the technician - H1* and *H7* for the same reasons as presented before).

Fig.6– Part of current AS-IS model prior to redesign.



The part of the current AS-IS model that was redesigned can be observed above (fig. 6) as well as the new presented alternative (fig. 7).

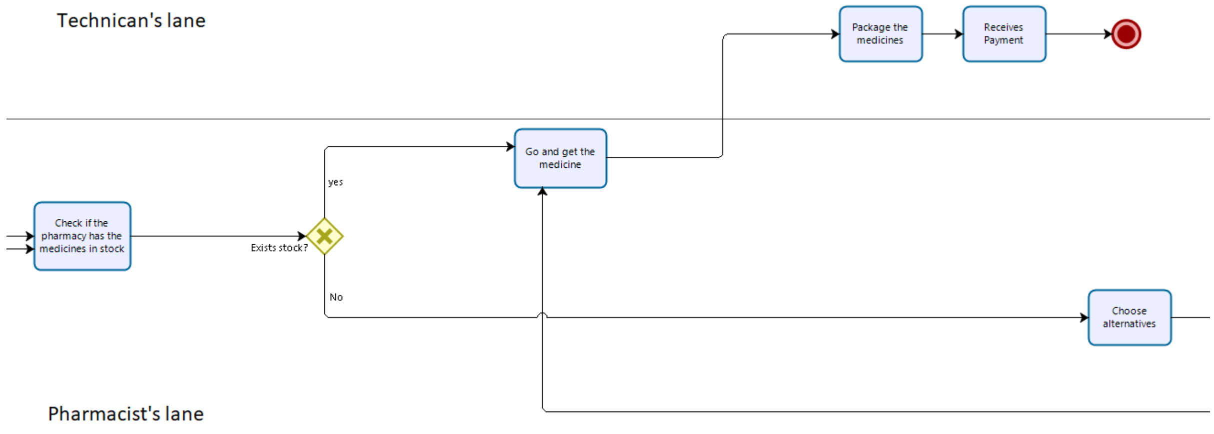


Fig.7– Redesigned part of the business process model

To assess if this model's redesign was in fact effective, we proceeded by simulating it. Immediately and as expected, we noticed that there was a growth in the percentual utilization of the pharmacist resource and a decrease in the technicians. From this we can already hypothesize that maybe with this new redesign a reduction in the number of technicians could be a further scenario.

Resource	Utilization	Number of Resources
Pharmacist	38.05 %	3
Technician	25.64 %	4

Table 21– Resource Utilization in the redesigned business model's simulation (Scenario 3)

Also, we noticed that from the original AS-IS model, the total time decreased even though more instances were started in this new scenario simulation (total time decreased approximately 1h, to a total of 17h28m). This happened as certain information flow tasks were eliminated (*Pass information to the pharmacist* and *Inform the technician*) as well as *Check again if the medicine is correct* and *Identify the correct medicine*. Additionally, with this redesign, the total time waiting for resource decreased from 12.27m to 4m, being the average time waiting approximately zero in all of the tasks' instances, which also was one of the goals.

	Instances started	Total time (m)	Total time waiting resource (m)
Order to cash	209	1048.42576678314	4.00803877521858

Table 22– Order-to-Cash in the redesigned business model's simulation (Scenario 3)

Now analyzing the different tasks individually, it is observable that for the tasks that were left the time distribution remains similar to the original process, as when redesigning we assumed the same distribution for tasks that now are performed by the pharmacists but that were once executed by the technician. The results of the simulation of this scenario can be observed in table 23.

Overall, this scenario shows great improvements in relation to the pharmacy's current AS-IS business model, not bringing costs associated with it and solving some issues identified previously. Obviously, there are certain aspects which can still be improved, being them explored with more depth in the next scenario that we present, the TO-BE model.

Task Name	Instances completed	Avg. time (m)	Total time (m)	Avg. time waiting for resource (m)	Total time waiting resource (m)
Send new prescription to the client	2	2,5000	5	0	0
Insert a note in the system	50	0,5171	25,8554	0,0171	0,8554
Requests the order	210	0,2500	52,5000	0	0
Package the medicines	153	0,0833	12,7500	0	0
Receives Payment	153	0,5000	76,5000	0	0
Choose the new product discussing with the client or the doctor	31	3,2322	100,1995	0,0043	0,1333
Tell the customer that is not possible to fulfil his order	0	0	0	0	0
Check if the drug can be replaced	28	0,5000	14	0	0
Check client´s history	61	0,9952	60,7087	0,0146	0,8919
Choose alternatives	48	0,9949	47,7569	0	0
Notify the customer	27	1,6003	43,2088	0	0
Check if the pharmacy has the medicines in stock	180	0,5033	90,5939	0,0033	0,5939
Go and get the medicine	153	0,7719	118,1008	0,0093	1,4258
Order the medicine from the supplier	27	0,5040	13,6078	0,0040	0,1078
Drug Replacement	6	2,3960	14,3759	0	0
Call the doctor	15	2,5016	37,5239	0	0
Register order without Prescription	37	1,2335	45,6409	0	0
Prescription review	172	1,6866	290,1033	0	0

Table 23– Redesigned business model's simulation for the different tasks (Scenario 3)

The results of the transactional Process Redesign specifics can be observed in the following table, both on Task-level and Process Level (note: the heuristics that were not used, as well as the flow level were omitted from this table as they were not applied during this redesign).

Level	Heuristic	Description	Time	Cost	Quality	Flexibility
Task	1	Task elimination	Improves	No effect	Worsens [*]	Improves
Process	7	Resource optimization	Improves	No effect	No effect	Improves

Table 24– Summary of the transactional process redesign

[*] By removing the task of checking again if the medicine was correct, we might incur in a risk which could impact the customer satisfaction and consequently the quality of the service (even though the 7% of error rate was not considered as being worth it to repeat this task in every instance).

- ### Scenario 4 – Scenario 3 + Scenario 2

Regarding the last scenario developed, it took in consideration the previous two scenarios already mentioned, scenario 2 and scenario 3, which generated a good outcome after all. In order to not duplicate the information already stated, in an overview vision the following heuristics were applied here: *Heuristics 1 - Task elimination, Heuristics 7 - Resource optimization* and *Heuristics 9 – Automation*.

Nonetheless, regarding the *Heuristic 7 - Resource optimization*, there was a difference compared to the previous one: instead of reducing the number of pharmacist and technicians both to 2, we have decided to keep the same number of pharmacists, due to the fact the business process' redesigning implemented as it requires more work from them, than the technicians. Having said that, we have configured the number of technicians to 2 and we have maintained the number of pharmacists, already stated before. With this, we have reduced some fixed costs, as we are now just remunerating less employees as before.

Resources	Utilization	People employed
Pharmacist	35.30 %	3
Technician	29.57 %	2

Table 25– Resource Utilization for the business model's simulation (Scenario 4)

With this approach and the application of the distinct heuristics, the accomplished outcome was really promising. Overall, we have reduced the *Total time* of the process to approximately 13h30min, despite the evidence of the *Total time waiting resource*'s increasing by approximately 2 minutes.

	Instances started	Total Time (m)	Total time waiting resource (m)
Order to Cash	209	809.848001572	18.42886859464

Table 26– Order-to-Cash for the business model's simulation (Scenario 4)

Overall, the average time of each activity was similar to the original one, highlighting a great decrease when assessing the *Prescription Review* activity, as it turns out to be reduced from 2.122 minutes to 0.5185 minutes, which is a good sign of the decision taken. Nonetheless, despite of existing some activities whose *Total time* and *Total time waiting resource* has slightly increased, due to the reduction of technicians in the pharmacy, there is a special situation that needs to be referred: the *Go and Get the medicine* and the *Prescription Review* activities, that indeed revealed a huge difference of *Total time*, when comparing with the original business process, the Model AS-IS. The reason behind this fact is the application of the *Heuristics 9*, the *Automation*, on these two activities.

Task Name	Instances completed	Avg. time (m)	Total time (m)	Avg. time waiting for resource (m)	Total time waiting resource (m)
Send new prescription to the client	0	0	0	0	0
Insert a note in the system	61	0,5361	32,7032	0,0361	**2,2032**
Requests the order	208	0,2640	54,9100	0,0139	2,9100
Package the medicines	141	0,1016	**14,3243**	0,0183	**2,5743**
Receives Payment	141	0,5071	71,4988	0,0071	0,9988
Choose the new product discussing with the client or the doctor	31	3,2478	**100,6810**	0,0198	0,6148
Tell the customer that is not possible to fulfil his order	0	0	0	0	0
Check if the drug can be replaced	40	0,5055	20,2183	0,0055	0,2183
Check client's history	67	0,9942	**66,6107**	0,0111	**0,7462**
Choose alternatives	51	1,0137	**51,6999**	0,0209	**1,0646**
Notify the customer	34	1,6065	**54,6199**	0,0191	0,6493

Check if the pharmacy has the medicines in stock	175	0,5038	88,1633	0,0038	0,6633
Go and get the medicine	141	0,2597	**36,6122**	0,0097	1,3622
Order the medicine from the supplier	34	0.5267	**17,9065**	0,0267	**0,9065**
Drug Replacement	15	2,0621	**30,9310**	0,0023	0,0338
Call the doctor	14	2,6184	36,6580	0.0023	0,0321
Register order without Prescription	34	1,2532	**42,6093**	0,0071	0,25
Prescription review	173	**0,5185**	**89,7015**	0,0185	**3,2015**

Table 27 - Redesigned business model's simulation for the different tasks (Scenario 4)

To-Be Model

The process redesign approach done in this project identifies some possibilities for improving the design of the process, using mostly an Exploitative Redesign – does not put into question the current process structure and seeks to identify problems and resolve them incrementally, one step at a time - something that we believe will be valued by the pharmacy and that will not completely change the system that is implemented nowadays. Furthermore, some redesign Heuristics were used, that are based on the past experience in process redesign projects, which guarantees some consistency and approximation to reality to our simulations.

Considering the four Scenarios developed in the previous section, we should choose the Model which not only does the process cheaper (cut costs), but also faster (reduce turnaround times) and better (reduce error rates). With this in mind, and taking into account all the results shown, we chose the **Scenario 4** as our To-Be model. This Scenario allows the pharmacy to reduce its total time in 300 minutes (equivalent to 5 hours of work) with a reduction of resources (translated in costs).

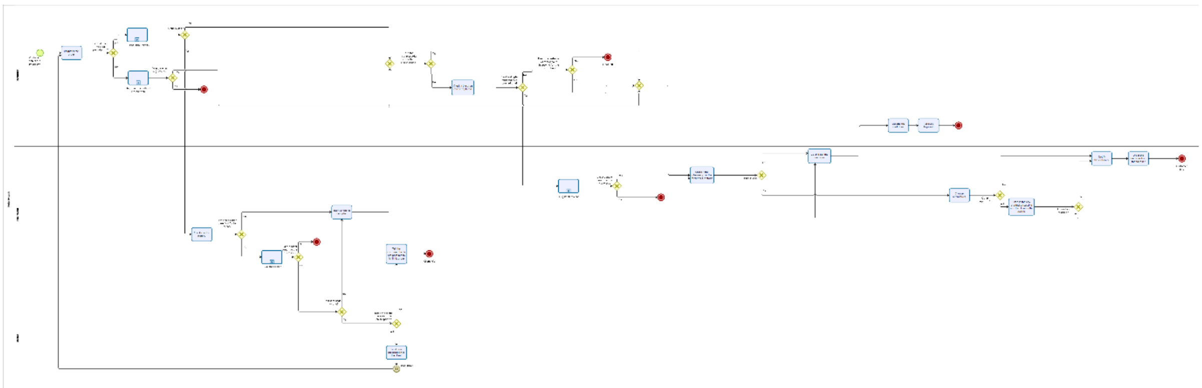


Fig.8– TO-BE model business process (see Attachment 2)

However, we are aware that the model is not perfect, and we can detect both advantages and disadvantages.

On the one hand, with this model, the Pharmacy needs to do an investment: the automated equipment includes a high capital to invest, and a higher level of maintenance needed than with a manually resource. On the other hand, it contributes for the higher production rates (as it was already said, a total of 5 hours saved, accompanied by a utilization increased) and decreases the error rate, providing a better service quality and improving safety – which could decrease the probability of, for example, getting the wrong medicine or making unnecessary calls to the doctor when the situation can be solved in the pharmacy. Furthermore, the implementation of Automation processes allows us to decrease the number of employees, which will contribute for some cut costs (3.000€ by month, 36.000€ by year) – which is a big gain to the company.

To these facts, we can add the client's perspective. Since the total time decreased, the average time of service decreased as well. We went from an average time of 5.57 min per client to 3.63 min – a reduction of 35% of the time - which will lead to more satisfied clients. Moreover, this implementation increases the capacity of the pharmacy, allowing it to acquire more clients without harming the waiting time. According with our tests, if the pharmacy receives around 260 clients per day (arrival interval of 1.85minutes) the total waiting time increases around 2 minutes – which over the entire day has no impact on time results, and these 40 more clients can bring a great impact on the pharmacy's profit.

Limitations

During this project, our group faced some limitations both regarding the Bizagi modeler and with the information provided. In order to minimize the problems, there was a need to find solutions making it possible to turn around some of the problems found and complete the project successfully.

About the Bizagi modeler itself, some issues were encountered that could influence the model implementation. The first issue is that the tool cannot describe in which moment of the day the business receives more customers, that way, the management of resources could have been done more realistically. As known, any business has periods of the day or of the week with more customers arriving (high peaks). Having this information and being able to apply it in the software, would make the model proposed closer to reality, with the possibility of allocating the resources according to the period of the day with a real need. Even having the possibility of discriminating this distribution, in order to have a better analysis about the quantity of resources, it would be needed to run the simulation several times to obtain a conclusion. This could be avoided if the Bizagi modeler could calculate the resources' utilization according to the period of a day with higher demand.

Regarding the process description, the group did not have access to the local analysis, only to the document provided by Caring Pharmacy. We noticed that some steps were not included in it, which could have been important to consider enabling a more realistic model. Interviews, business observations, and local time analysis are very important for any business process improvement and to overcome this lack of information we had to make several assumptions. Our approach for the assumptions made consisted of analyzing the steps without enough data and comparing them with steps for which we had information. Thus, for the tasks/activities with lack of information, the group assigned similar parameters to the ones already provided by the Caring Pharmacy document.

Finally, another point about the qualitative information, was that for some steps we were not able to detect if it was made by resource or by the system. So, the assumptions made were according to the most common daily scenario.

Despite the limitations mentioned, we believe that good improvements were suggested, and the business will obtain good results on implementing the model chosen in the O2C pharmacy process and the adjustments will not interfere significantly.

Future work

In order to provide improvements reliable, we would like to suggest ideas and software options to be applied in future moments.

Considering the database that Caring Pharmacy has, one possible option could be the use of Celonis - a process mining management system tool that could measure and have a better understanding of the business process.

Process mining is a very important approach that offers fact-based insights from actual data, helping the business to monitor, analyze, improve processes, and remove execution gaps. Considering the data that this particular business already has, would be crucial to keep having a better understanding of the process by applying process mining techniques while still analyzing other aspects that were not possible to perceive when retrieving the information.

Another suggestion is providing a better document with more detailed process steps, which will guarantee, for future improvements, no needs for assumptions, leading to a future model proposal closer to the daily reality, with no need for rework. Creating and store better documentation will assure that in the future the business would enhance the optimization faster.

Also, for future work, it is important to clarify that there are two steps to be applied: the model implementation and monitoring and controlling.

For modeling implementation, it is important to create guidelines not only for documenting the process for future analysis but also to guarantee that the changes suggested will be in fact implemented. It is also important to schedule the time for each step of implementation taking into consideration the staff's training.

Finally, it is important for the business to keep controlling and monitoring the implemented to-be process model, once it was made based on assumptions made, some adjustments will be probably needed but will only be noticed if the implemented model is being constantly monitored. Another important reason for keeping control in monitoring the implemented model is to assure that the steps changes will not become useless because of new future needs.

Conclusion

The main objective of the project was to redesign the order to cash process of Caring Pharmacy considering the BPM life cycle and taking into consideration time analysis, resources, and process steps.

So, after designing the AS-IS model, the group proposed four different models, developing different scenarios for each of them. In addition, some important aspects considered were the resources analysis, time improvement, automatization, and reordering steps to obtain the best improvement solution. It is also important to emphasize that to be possible to create those scenarios the BPM literature was needed and applied, which provided reliable scenarios and an accurate AS-IS model.

During the analysis, the group was able to analyze each step and categorize them according to the importance of the business process. This qualitative analysis is very important once allows change based on task and activities that could really add value to the process, eliminating those that do not provide any.

The redesigned model would probably increase costs in the implementation phase, once new machines and also time for training the staff will be necessary, however in future, we truly believe that Caring Pharmacy will benefit not only by increasing profits but also improving time process (diminish cycle time), reducing errors and eliminating reworks which by consequence improve efficiency.

We truly recommend the implementation of the TO-BE model, once there were many more positive aspects increasing value for the business in general.

References

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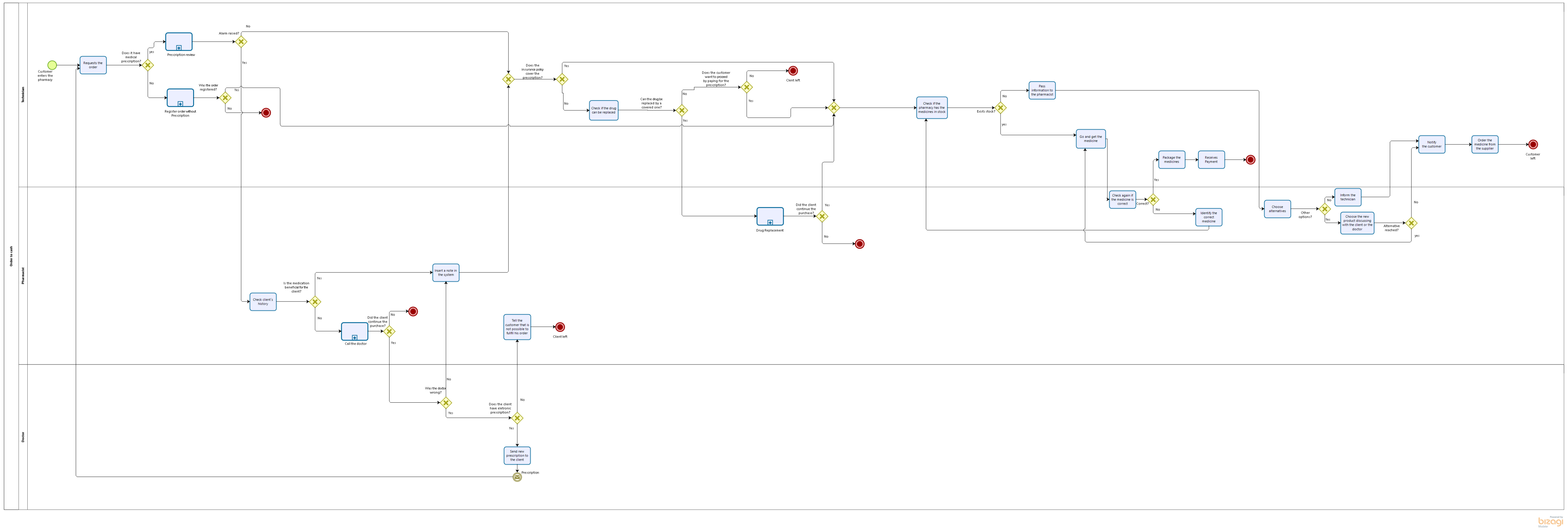
[2] Bizagi, One Platform; Every Process. User Guide Studio

[3] Dumas, M., Rosa, M. L., Mendling, J., & Reijers, H. A. (2013). Fundamentals of Business Process Management 2nd Edition. Springer Berlin Heidelberg

Attachments

Attachment 1 – As-Is Model



Attachment 2 – To-Be Model