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Frumherji Ltd., Reykjavik

The Vehicle Inspection and Emissions-Testing Process

Faculty:

Pedro Manuel Moreira Vaz Antunes de Sousa

Diogo Alexandre Breites de Campos Proença

Group 12:

Alícia Frango (92847)

Andrey Bortnikov (108489)

Bernardo Santos (99185)

Mafalda Ribeiro (99268)

Margarida Valente (96615)

Table of Contents

1. Introduction **3**

2. As-Is Process **4**

2.1. Company Overview 4

2.2. Assumptions 4

2.3. As-Is Process Landscape Model 6

2.4. As-Is BPMN Model 6

High-level Process 7

Subprocess 1: Customer Arrival and Check-in 7

Subprocess 2: Inspection Lane Entry, Inspection, and Emissions Testing at Base 2 8

Subprocess 3: Inspection in Base 3 9

Subprocess 4: Inspection in Base 4 10

Subprocess 5: Recording Results into the Database 10

3. Quantitative and Qualitative Analysis **12**

3.1. Issue Register 12

3.1.1. Issue 1: Receptionists have multiple jobs at the same time 12

3.1.2. Issue 2: Fees and Taxes Payment on the Reception 13

3.1.3. Issue 3: Delay in Inspection Lane Entry due to customer's mistakes 14

3.1.4. Issue 4: Vehicles delayed at Base 3 15

3.1.5. Issue 5: Inspectors work overtime 16

3.2. Value-Added Table 18

3.3. Waste Table 19

4. Business Process Redesign **20**

4.1. Issue 1: Receptionists have multiple jobs at the same time 20

4.2. Issue 2: Fees and Taxes Payment on the Reception 21

4.3. Issue 3: Delay in Inspection Lane Entry due to customer's mistakes 21

4.4. Issue 4: Vehicles delayed at Base 3 22

4.5. Issue 5: Inspectors work overtime 22

5. To-Be Process **23**
5.1. To-Be Process Landscape Model 23
5.2. To-Be BPMN Model 23
High-level Process 23
Subprocess 1: Customer Arrival and Check-in 24
Subprocess 2: Onboarding 25
Subprocess 3: Inspection Lane Entry, Inspection, and Emissions Testing at Base 2 26
Subprocess 4: Inspection in Base 3 26
Subprocess 5: Inspection in Base 4 27
Subprocess 6: Recording Results into the Database 28
6. Implementation Strategy **29**
7. Conclusion **31**
8. Appendix **32**
9. References **34**

1. Introduction

In the dynamic landscape of contemporary business operations, the optimization and enhancement of processes stand as pivotal elements in fostering efficiency, cost-effectiveness, and overall organizational effectiveness. This report embarks on a journey through the comprehensive analysis and redesign, transitioning from the current state ('as-is') to a reimagined and refined state ('to-be'). Framed within the context of Frumherji Ltd. Reykjavík, this endeavor aims to unveil the existing process's intricacies and meticulously design and simulate a more efficient and responsive system.

The assignment [1] encompasses a multifaceted approach, commencing with an in-depth exploration of the 'as is' process. This entails the meticulous dissection of the Vehicle Inspection Process through the lens of BPMN modeling. In the present work, the ‘Camunda’ modeler was used. The subsequent stages involve a judicious analysis, both qualitative and quantitative, to unearth the nuances and issues within the current framework.

Following the identification and documentation of issues, the report transitions into the conceptualization and delineation of a refined 'to-be' process. This redesigned model encapsulates strategic alterations, innovations, and automation facets, each meticulously crafted to address the shortcomings identified in the 'as is' analysis. The rationale behind the proposed changes, the discarded alternatives, and the anticipated impact on process efficiency are dissected precisely.

Moreover, the validation of the proposed changes is underscored through the prism of simulation, where the 'to-be' process undergoes rigorous testing to validate its efficacy against the backdrop of the 'as is' analysis.

This report endeavors to serve as a comprehensive guide, illuminating the journey from the meticulous dissection of the current Vehicle Inspection Process to the strategic reimagining of a more streamlined and efficient 'to-be' model. It aims to provide actionable insights and recommendations that stand to elevate Frumherji Ltd.'s operational efficiency within the realm of vehicle inspections and emissions testing.

2. As-Is Process

2.1. Company Overview

Frumherji Ltd. Reykjavík [2] is a prominent entity within the vehicle inspection and emissions-testing industry in Reykjavík, Iceland. Its core focus lies in ensuring compliance with regulatory standards, conducting thorough vehicle inspections, and emissions testing services for a diverse range of vehicles, encompassing both commercial and private segments.

Frumherji Ltd. Reykjavík specializes in comprehensive vehicle inspections to ascertain roadworthiness, safety compliance, and environmental friendliness. The company also offers emissions testing services aimed at measuring and controlling vehicle emissions to meet environmental standards and regulations.

The company is structured into specialized units catering to various aspects of vehicle inspection and emissions testing, including inspection bays, testing facilities, and administrative and customer service departments. The stakeholders involve inspectors, administrative staff, management personnel, and customers.

Frumherji Ltd. aims to ensure strict adherence to national and international regulations governing vehicle safety and emissions standards while striving to deliver high-quality inspection and testing services to maintain trust and reliability among its clientele. Enhancing operational efficiency and streamlining the inspection process is a priority to deliver prompt and accurate services.

2.2. Assumptions

The description of the current vehicle inspection process at Frumherji Ltd. Reykjavík involves several steps aimed at ensuring compliance with regulatory standards and ensuring vehicle safety and emissions standards are met. To move forward with the BPMN Modeling of the As-Is process, various assumptions were made.

- When customers don't fill in documentation correctly, the receptionists give them time to complement it or redo it on the side while serving another customer;
- When the Inspection ends, the monitor system is notified by the Inspector;

- By the time the inspector finishes the inspection in his base, he updates the inspection form and transmits it to the next inspector;
- When the customer drives the vehicle to a lane, to start the inspection, the Inspector at Base 2 is responsible for making sure that the vehicle is in the right lane. This happens even if the customer, by mistake, takes the car to another base;
- When the monitor shows the customer's turn, there is at least 1 inspector ready to take the car;
- When drivers go to the wrong Base, one of the inspectors informs them to go back to the right Base;
- Inspectors instruct customers to leave cars with keys inside;
- When the driver forgets to leave keys inside the car, the inspector has to go to Base 1 to retrieve them;
- On the inspection sub-activity there are implicit activities that aren't modeled (e.g. To check the interior components like the odometer, the inspector needs to sit in the driver's seat);
- The supervisor is the manager;
- The receptionist corrects the record;
- The receptionist delivers a copy of the inspection documents to the customer before registering into the database;
- Before sending the documents to the government database, documents are saved and shared in an internal database called the inspection documents database;
- When the manager reviews the Inspection Documents, the database has always the updated version, meaning that if the receptionist corrects it, it is automatically submitted to the database;
- The manager is the one who submits into the government database.

2.3. As-Is Process Landscape Model

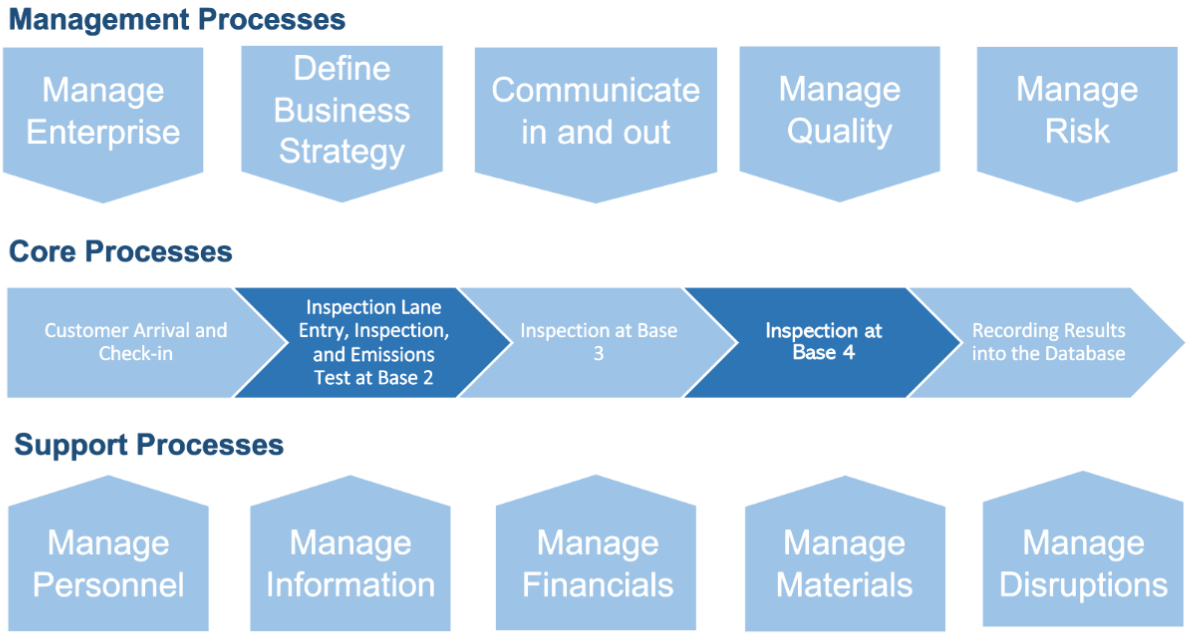

Figure 1 - As-Is Process Landscape Model

2.4. As-Is BPMN Model

Firstly, the current state is modeled in the “As-Is” model, which will allow the identification of problems and possible actions to improve. In Figure 2, a high-level process is presented. Each of the sub processes will be presented in detail in the following figures. All files from “Camunda” will be forwarded to the faculty for better viewing.

High-level Process

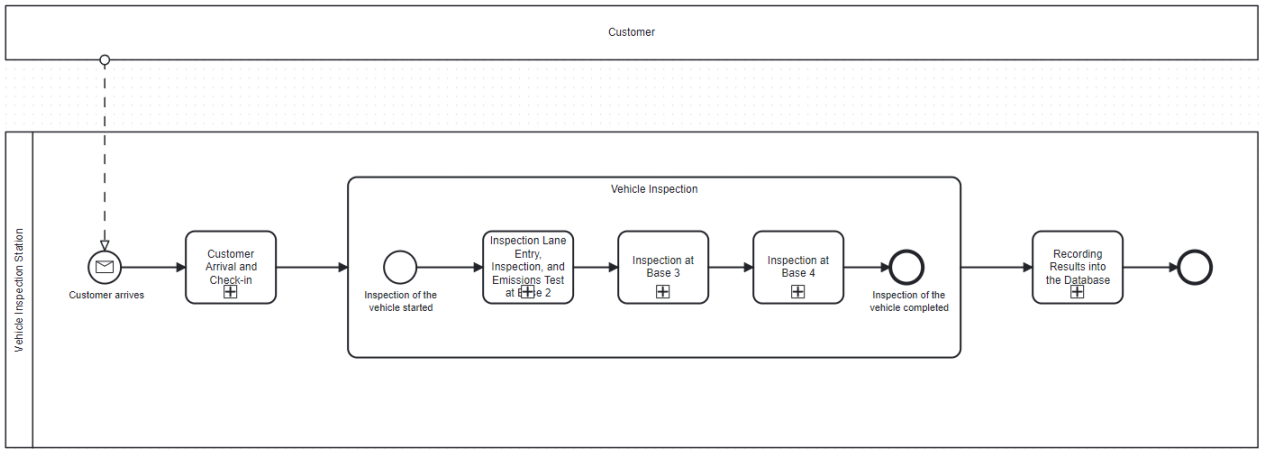

Figure 2 - High-level Process, from the As-Is Model.

Subprocess 1: Customer Arrival and Check-in

To translate the first subprocess into Camunda, it was necessary to understand the workflow of the reception area. Firstly, the employers call a number and either proceed with the check-in or tend to other customers' needs. The other services were not modeled as there is no information on them as well as they aren't the main part of the assignment. In case the customer wants an inspection, the employer will need to check the documentation as well as the state of the insurance payment. In case the customer's insurance isn't paid, the employer solicits the payment status change to the customer, and then one of two things can happen. The employer either receives a status change, which will bring it back to the analysis of the insurance payment gateway, or the payment is declined, and the check-in is aborted. If all is satisfied then the paperwork is approved, a payment solicit is made and, with the handout of an inspection form and a new system number to the customer, the next subprocess can begin.

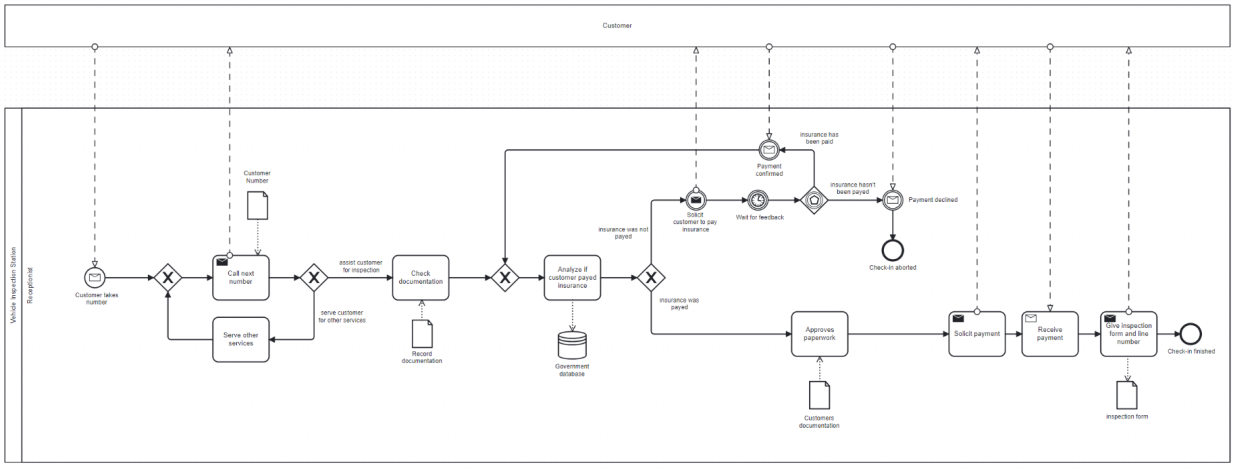

Figure 3 - Step 1: Customer Arrival and Check-in, from the As-Is Model.

Subprocess 2: Inspection Lane Entry, Inspection, and Emissions Testing at Base 2

With the end of subprocess 1, the following is ready to begin. Within the second subprocess, there are 3 starting events. The first one is the trigger to the second one, the Inspection lane is available, so the next number of vehicles can enter the inspection lane. Sometimes the vehicle isn't in the correct lane or the keys are not in it after the customer exits the vehicle.

In both cases, an exclusive gateway was used to ensure the correct procedure. Once the inspection lane is finished, the third stage of this subprocess can begin, and so, the inspection and emissions testing at base 2 starts. Multiple steps are performed sequentially and according to the vehicle sequences until the end of the subprocess. It is important to state that checking interior components activity implies checking the odometer, the gearing, and seat belts, and checking exterior components activity implies checking the headlights, windshield, rear lights, license plate lights, tires, and the function of the doors and trunk.

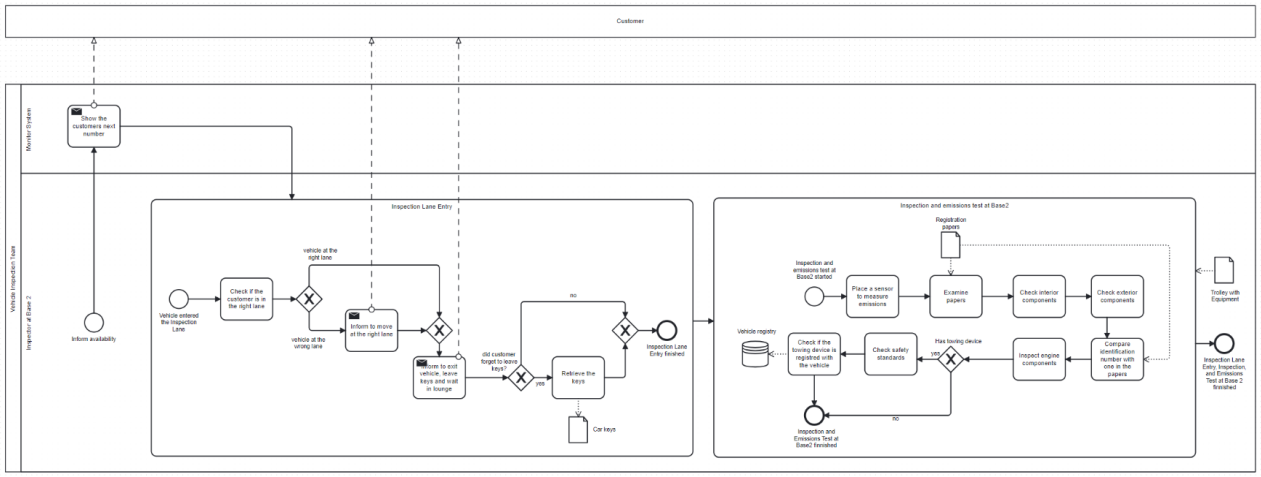

Figure 4 - Step 2: Inspection Lane Entry, Inspection and Emissions Testing at Base 2

Subprocess 3: Inspection in Base 3

The inspection at base 3 is marked by sequential activities until the completion of the subprocess. If there's a delay in base 4 then an inspector from base 3 will also assist the next subprocess.

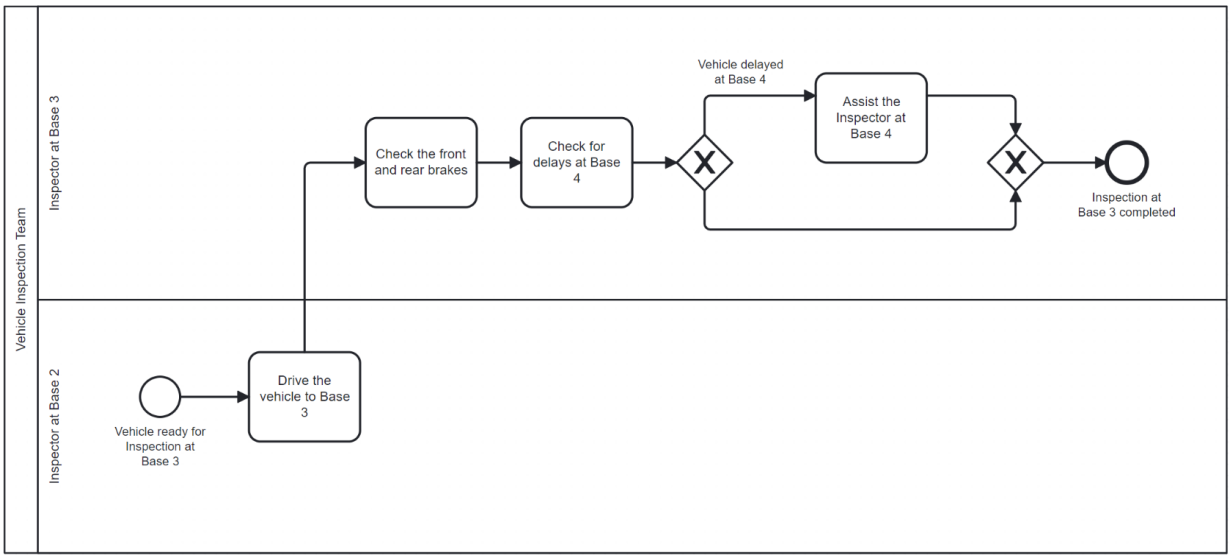

Figure 5 - Step 3: Inspection in Base 3

Subprocess 4: Inspection in Base 4

Like the preceding subprocess, subprocess 4 also takes place with sub-sequential activities. The subprocess ends after notifying the customer.

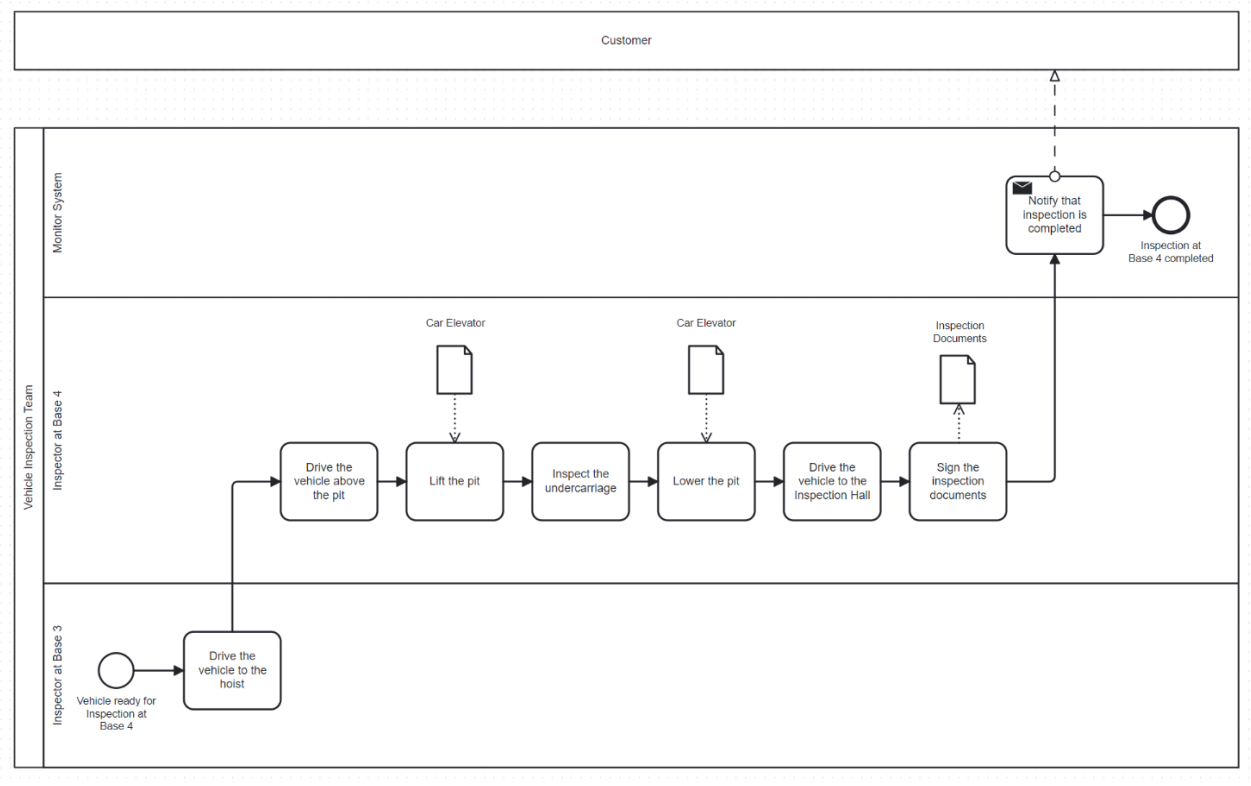

Figure 6 - Step 4: Inspection in Base 4

Subprocess 5: Recording Results into the Database

As for the last subprocess, it can be said that it is divided into two groups, the work of the clerk and the work of the manager. As for the first one, the clerk checks the inspection documents, records them, and saves them to the database various times per day. It's then the manager's job to, access the database, review the documents and submit them to the government database. Sometimes there are mistakes or the regulating agency has negative feedback about them, and, for each of those cases, there is a gateway that will remit the documents back to the clerk for corrections. The loop is completed when there are no errors in the documents.

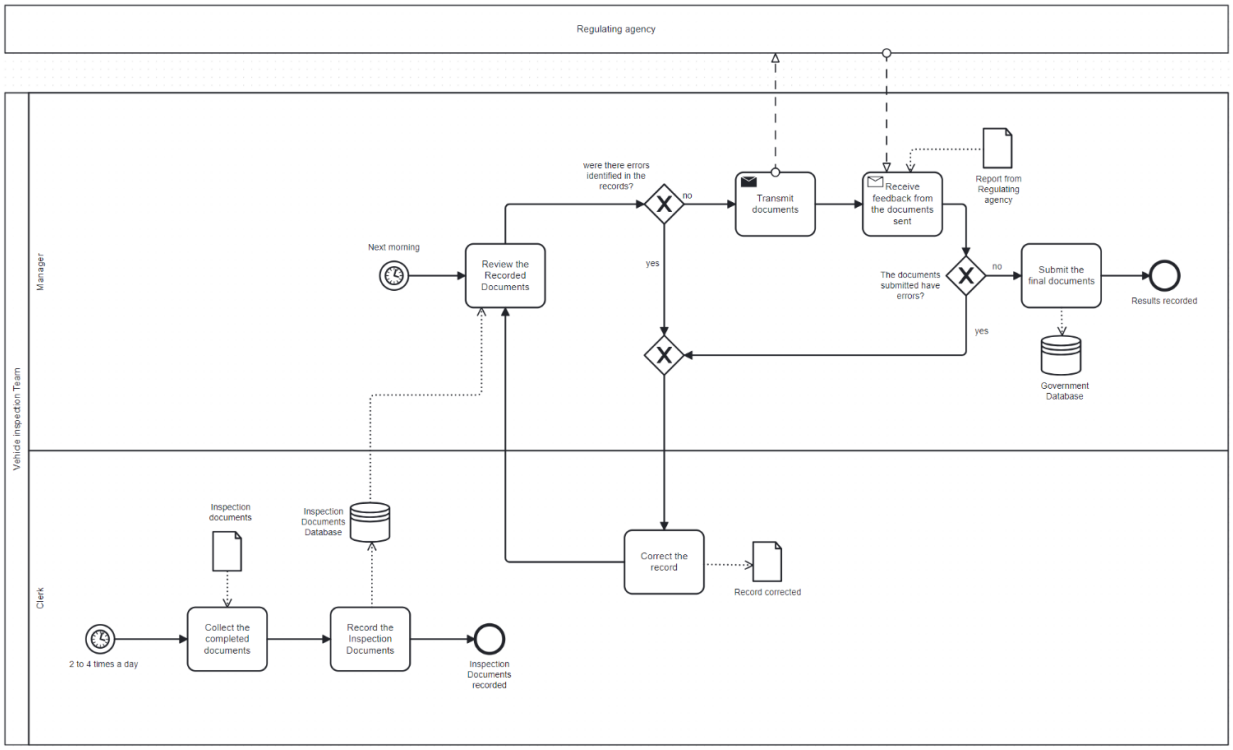

Figure 7 - Step 5: Recording Results into the Database

3. Quantitative and Qualitative Analysis

3.1. Issue Register

The first method of qualitative analysis used in the evaluation of the "As Is" Process was the Issue Register, whose main purpose is to maintain, organize and prioritize perceived weaknesses of the process.

3.1.1. Issue 1: Receptionists have multiple jobs at the same time

Step: Customer Arrival and Check-in

Priority: Low

Description:

The receptionist, outside of performing the inspection check-in, also had to serve customers who were there for other services such as driver testing, picking up their licensing plates, and buying drinks and sweets.

Assumptions:

It is assumed that there are 100 customers per day, of which 75% go to the reception to process paperwork and get a number for the inspection and the remaining 25% go there for the other activities described above. It was also assumed the employees take 5 to 10 minutes to change work type and serve the driver testing, pick up their licensing plates, and buy drinks and sweets for customers.

Qualitative Impact:

Juggling between multiple jobs can lead to heightened stress, burnout, and reduced job satisfaction for receptionists. A receptionist's limited time and focus may result in less personalized interactions with customers, impacting the overall quality of service. Longer waiting times for customers.

Quantitative Impact:

Time spent attending to clients for other services:

100 x 0.25 x average(5,10) = 187.5m for other services ~+3h

3.1.2. Issue 2: Fees and Taxes Payment on the Reception

Step: Customer arrival and Check-in

Priority: High

Description:

When the client is doing the check-in for the Inspection, if he hasn't paid the insurance fee and vehicle tax, the process of requesting the customer to pay and waiting for payment is all done at reception and causes delays in serving other customers.

Assumptions:

It is assumed that there are 75 customers per day and that 1.7% of the customers haven't paid all fees and taxes. When so, the service time increases from 10 minutes to 45 minutes, on average.

Qualitative Impact:

Extended service times can lead to frustration and dissatisfaction among customers, who may experience delays in receiving services. Besides that, the receptionists may face increased pressure and workload due to delays in payment processing.

Quantitative Impact:

We will simulate from check documentation to receive payment tasks, in order to calculate how much time will the check-in take. It is possible to verify that during an entire day of work, it takes, on average, almost 6 hours to perform all the 75 check-ins. The full table simulation can be seen at the appendix section, appendix 1.

Name	Type	Instances completed	Instances started	Min. time	Max. time	Avg. time	Total time	Min. time waiting resource
Vehicle Inspection Station	Process	74	75	5h 36m 30s	6h 13m	5h 54m 45s	18d 8h 19m 30s	

Figure 8 - Simulation data from Bizagi, total check-in time, As-Is Process.

3.1.3. Issue 3: Delay in Inspection Lane Entry due to customer's mistakes

Step: Inspection Lane Entry, Inspection, and Emissions Testing at Base 2

Priority: Medium

Description:
Customers prolong waiting times due to poor infrastructure of the inspection process. For example, some customers drive to the wrong base instead of Base 2 due to lack of signs, the customer forgets to leave keys and the inspector needs to go to the lounge to retrieve them, and customers may also fall asleep inside the car while waiting.

Assumptions:
It is assumed that there are 90 customers per day (summer season, the worst scenario) and 15% of customers are causing delays. Delay is 6 minutes in total and 25% of vehicles are going through a second inspection. Prices for the first and second inspections are average from the values mentioned in the case study.

Qualitative Impact:
Delays are causing breaks in the schedule that lead to stress for all employees, including clerks. Customers wait longer, stress about mistakes, and get dissatisfied with the process of inspection. The company loses potential income from customers who are not served due to a lack of time slots in the schedule.

Quantitative Impact:
15% of customers cause delay:
90 x 0,15 x 6 = 81 minutes of lost time.

The inspection takes from 10 to 90 minutes, so potentially up to 8 more vehicles could be inspected.
0,75 * 8 * $95 + 0,25 * 8 * $18.75 = ~$607.5 per day

3.1.4. Issue 4: Vehicles delayed at Base 3

Step: Inspection in Base 3 & Inspection in Base 4

Priority: Medium

Description:

Base 4 must be finished so the vehicles at the previous Base (3) can proceed. When that happens, the Base 3 Inspector helps at Base 4. The delay happens due to the rise of the vehicle in the pit.

Assumptions:

It is assumed that there are 75 customers per day and that 30% of vehicles get delayed at Base 3. This delay takes 5 minutes, on average, per vehicle.

Qualitative Impact:

The Inspector at Base 3 gets more tired from keeping rotating between these bases (overwork) and, as they do such, their schedules break, translating into stress for the employer. Customers might also get stressed due to the added delay.

Quantitative Impact:

30% of customers get a 5-minute delay:

0,30 x 75 x 5 = 112,5 ~1h 52m 30s lost time per day

3.1.5. Issue 5: Inspectors work overtime

Step: Inspection Lane Entry, Inspection, and Emissions Testing in Base 2 & Inspection in Base 3 & Inspection in Base 4

Priority: High

Description:
Inspectors work more time than predicted. This happens depending on the season, and a major factor is that there are no scheduled inspections.

Assumptions:
It is assumed that there are around 75 customers per day. Since the overtime work is being tested in the most populated season, it will be assumed that in summer there are 90 customers per day. To calculate how much time inspectors work additionally, assumptions on the three inspection steps will be made.
For the Inspection Lane entry, it is assumed that the time for the customer to see they were called added with the time to drive until the right lane without any mistake is 4 minutes. 20% of customers drive in the wrong lane, adding 2 minutes to the time taken. 15% forget to leave keys, adding 4 minutes to the time taken since the inspector needs to go to the lounge, find the person, and retrieve the keys.
For the Inspection at Base 2, the work takes from 4 to 10 minutes, so on average takes 7 minutes to be done.
For inspection at Base 3, the work done by inspectors takes on average 1 minute and a half. 30% of cars get delayed at this stage, meaning that it will add 5 minutes to the inspection duration. Given these assumptions, 70% will take 1:30 minutes and 30% will take 6:30 minutes.
For Inspection at Base 4, which takes 4 to 12 minutes, it's assumed that it takes the average between 4 and 12 which is 8 minutes.

Qualitative impact:
As inspectors work overtime without possible breaks, inspectors may lose focus, which could lead to potential mistakes in the inspection process.

Quantitative impact:

Inspectors work from 8 AM to 5 PM (9 hours).

Inspection Lane Entry:

0,65 x 4 + 0,2 x 6 + 0,15 x 8 = 5 min p/ customer

Inspection at Base 2:

Average (4, 10) = 7 min

So inspection Lane Entry and Inspection at Base 2 will take ~12 min p/ customer

For Inspection at Base 3:

0,7 x 1.5 + 0,3 x 6,5 = 3 min p/ customer

For Inspection at Base 4:

average (4, 12) = 8 min p/ customer

In summer, 9h34min for the 90 customers, meaning that each inspector works 34 minutes of overtime per day.

Name	Type	Instances completed	Instances started	Min. time	Max. time	Avg. time	Total time
Total Inspector working time	Process	90	90	7h 38m	11h 30m	9h 34m	35d 21h

Figure 9 - Simulation data from Bizagi, total inspector working time, As-Is Process.

In Appendix 2, the full table can be found. It is possible to see that on average, inspection lane entry and inspection at Base 2 takes 3h 16m per day, Inspection at Base 3 takes 3h 40m 30s per day and Inspection at Base 4 takes 2h 47m 30s per day.

3.2. Value-Added Table

Value-added analysis is one of the methods implemented in the Qualitative Analysis of the process and consists of the classification of each activity according to the value added to the project. A Value-Adding (VA) activity produces value or satisfaction for the customer by meeting his requirements. A Business Value-Adding (BVA) activity is necessary or useful for the business to operate and collect revenue. A Non-Value-Adding (NVA) activity does not contribute to the product or service, in the eyes of the customer, the customer would be unwilling to pay for it.

By classifying activities into VA, BVA, and NVA categories, a value-added analysis provides a structured framework for evaluating and improving the process. It helps in optimizing resource allocation, reducing waste, and ultimately delivering greater value to both the organization and its customers.

Table 2 - Value-Added Analysis

Step	Performer	Classification
Analyze if the customer paid the insurance	Receptionist	BVA
Paperwork approval	Receptionist	VA
Check Documentation	Receptionist	BVA
Solicit payment	Receptionist	VA
Check if the customer is in the right lane	Inspector	NVA
Inform to move to the right lane to leave the car with keys inside and return to the lounge	Inspector	VA
Retrieve the keys	Inspector	NVA
Drive the vehicle to Base 3	Inspector	NVA
Check the front and rear brakes	Inspector	VA
Assist the Base 4 Inspector	Inspector	BVA

3.3. Waste Table

Waste Analysis is another of the methods implemented in the Qualitative Analysis of the process, since identifying waste in the business is a good opportunity to improve work processes and, most importantly, optimize resources.

Building the Waste Table consists of categorizing waste, i.e. any activity that does not add value to the end product or the customer and which could be removed from the process without affecting its course, into 7 types, these being transportation, motion, inventory, waiting, defects, overprocessing, and overproduction. The following table represents the main wastes identified during the project, their type, and the performer within our process.

Table 3 - Waste Table

Waste	Type of waste	Performer
Waiting for feedback	Wait	Receptionist
Warn the customer that the line is long	Over-Do	Receptionist
Juggling between multiple jobs	Motion	Receptionist
Waiting for the customer to arrive at the right lane	Wait	Inspector
Retrieve the keys	Motion	Inspector
Informing the customer to move to the right lane	Defect	Inspector
Waiting for Base 4 to finish	Wait	Base 3 Inspector
Helping Base 4 Inspector	Motion	Base 3 Inspector

4. Business Process Redesign

Multiple approaches were taken to further analyze the viability of the proposed implementations. The issues in the present chapter are presented by order of priority, which was defined before.

4.1. Issue 1: Receptionists have multiple jobs at the same time

This issue arises because the inspection center offers a range of customer services, all managed by receptionists. These receptionists are not only responsible for checking in customers (the primary service) but also, at the same time, have to handle a diverse set of additional tasks.

For a better understanding of the impact of this issue, a Why-Why Diagram was designed to efficiently pinpoint root issues, examine various problematic areas along with their multiple causes, and, ultimately, gain clearer insights into potential solutions.

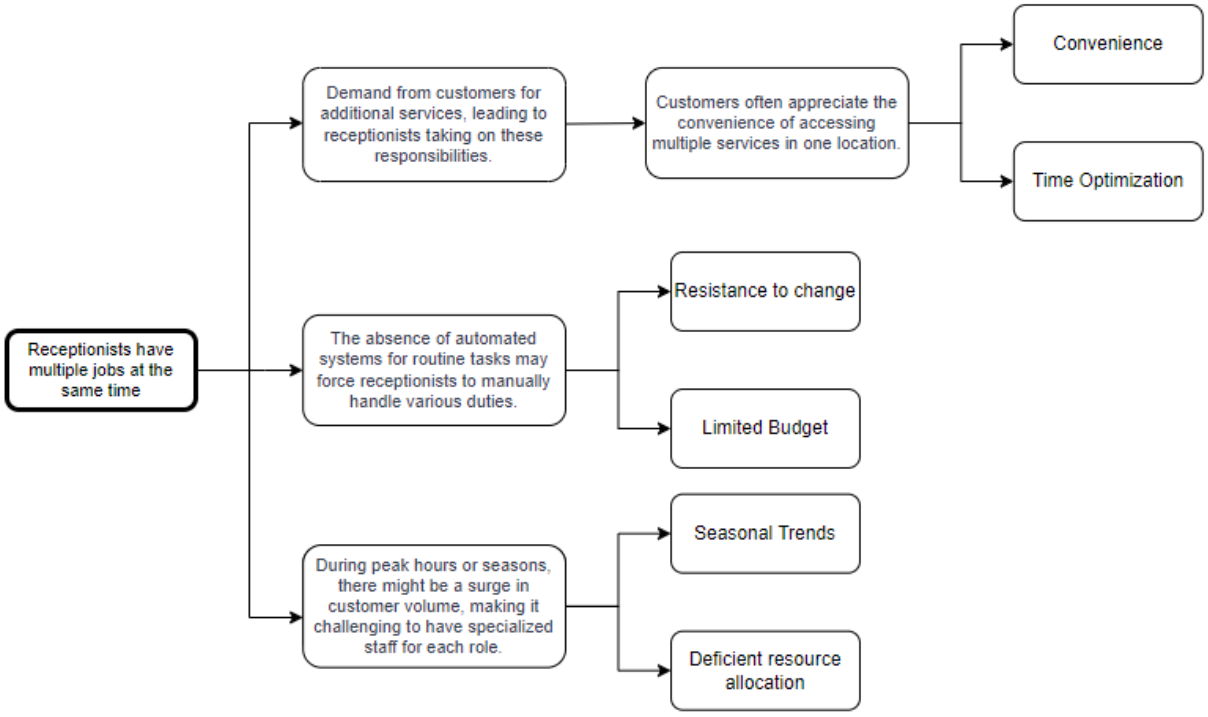

Figure 10 - Why-Why diagram for issue 1

To address this problem and based on the diagram we suggest a more efficient allocation of resources, because a person loses focus if they keep switching tasks and wastes time switching contexts, suggesting that only one receptionist focus their work on attending to the secondary services provided by the inspection center (driver testing, picking up their licensing plates, and buying drinks and sweets) and that the rest dedicate themselves to checking in customers who want to have their vehicle inspected, allowing everyone's work more fluid. The initial sorting of these customers would be done through an electronic ticket system, differentiating inspection tickets from other services tickets.

4.2. Issue 2: Fees and Taxes Payment on the Reception

This issue is motivated by customers forgetting to pay their insurance fees and vehicle taxes in advance. To address this, we propose implementing an online scheduling system that mandates prepayment during appointment booking. This system includes an online verification process to ensure tax payments are completed beforehand. By informing customers in advance about the mandatory payments, the proposed solution streamlines the check-in process for those with scheduled appointments. This not only improves overall efficiency but also reduces pressure on receptionists, leading to a smoother experience for both customers and staff.

4.3. Issue 3: Delay in Inspection Lane Entry due to customer’s mistakes

This issue is related to customers' mistakes that cause delays. To solve this issue, we propose to change the process of onboarding vehicles for the inspection. In the original process, customers deliver their vehicles themselves, including handing over the keys. To eliminate the possibility of causing delays, customers will be asked to park their vehicles in the parking lot near inspection lanes in advance and to leave the keys during the Check-in process, Inspectors then take the keys from reception and drive vehicles by themselves to the right inspection spot. It will not only save a decent amount of time due to the lack of possible mistakes and also improve customer experience.

4.4. Issue 4: Vehicles delayed at Base 3

Since the problem is due to the raising and lowering of the vehicle so that the inspector can go under it to perform the inspection, it is proposed that there's an alteration in the equipment used.

For such, it is necessary to perform a study of the costs associated with changing the equipment and the viability of the alteration. Taking into account that in chapter 3.1.4., the time lost per day was 1h 52m 30s and assuming that within that time there can be 4 new inspections.

Knowing that the distribution of inspection between the first time and second time for 4 inspections is 3 first-time inspections to 1 second time, at 95$US and 18.75$US, respectively.

Extra income due to less lost time: 3*95$US + 1*18.75$US = 303.75$US per day.
Cost of a new railway pit: ~2000$US. [5]
Time to pay for the new equipment: 2000/303,75=6,584 days~7 days~3/2 of a working week.

4.5. Issue 5: Inspectors work overtime

In order to take the load off employers and better improve the system, it is suggested that a new ticket system is implemented for the inspection area (add a subprocess at the end of subprocess 1). The system would take into account the hours left in the work day, and have the information of how long, on average, an inspection takes. This solution is similar to the one suggested in issue 2, but targeted to the inspection only. When a customer is in condition to proceed with the inspection, after check-in is completed, the receptionist checks the system to see if there's availability for the present day, providing a number if that's the case. Otherwise, if the day is already full, the receptionist suggests the next free slot (for the upcoming days) and the customer can either agree or not reserve a slot. A new type of ticket will then be needed in the system.

5. To-Be Process

5.1. To-Be Process Landscape Model

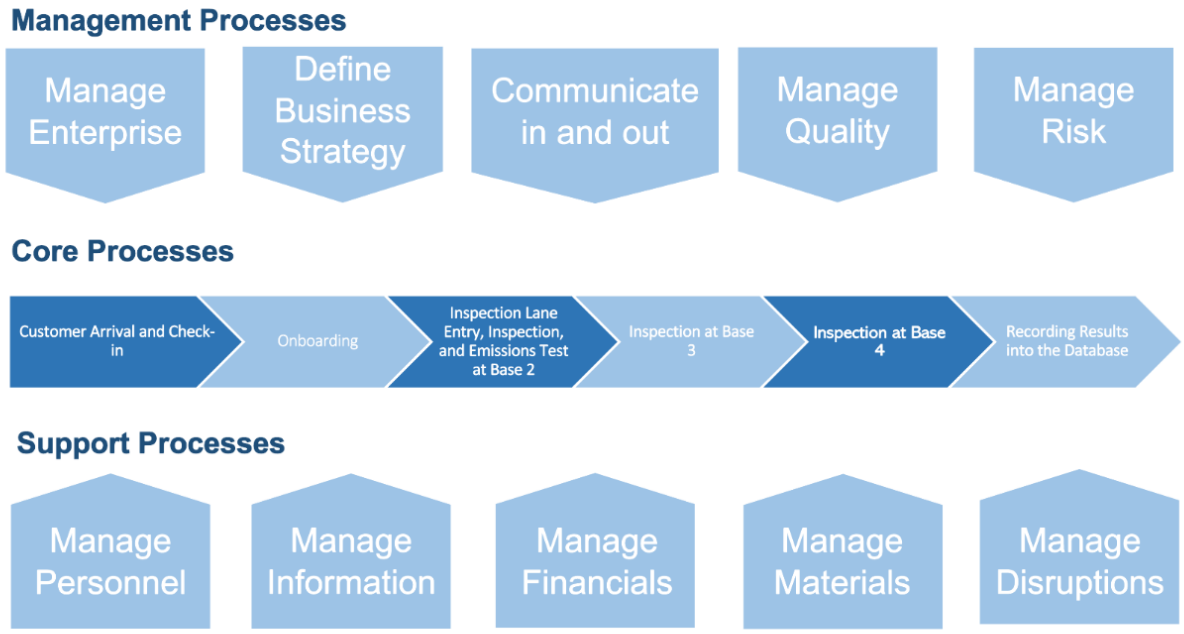

Figure 11 - To-Be Process Landscape Model

5.2. To-Be BPMN Model

High-level Process

The new high-level process, in Figure 11, contemplates a new subprocess. This has to do with the implementation of issue's 5 solution. More details about each of the sub processes will be presented in detail. All figures from the present chapter can be better viewed on the Camunda file "To-Be" that was delivered along with the present report.

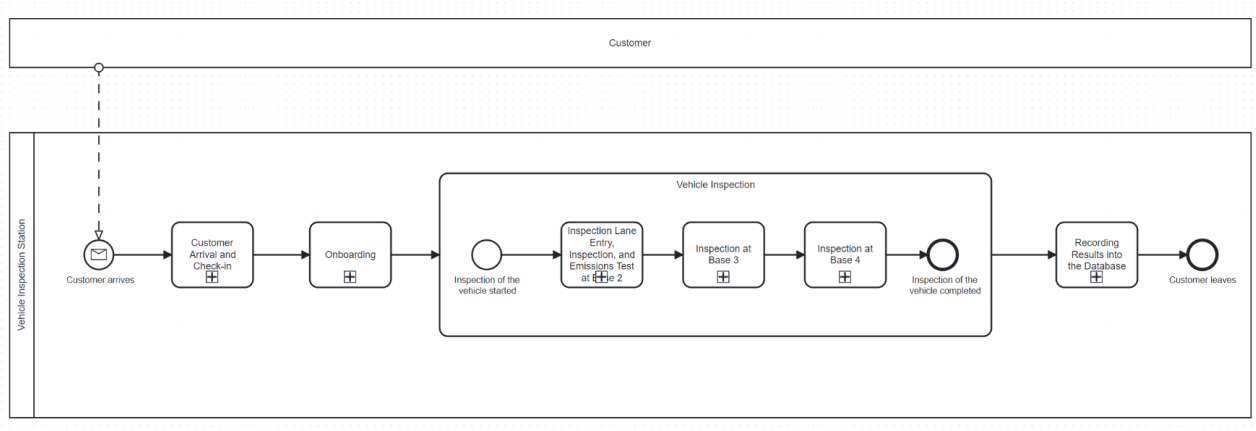

Figure 12 - High-level Process, from the To-Be Model.

Subprocess 1: Customer Arrival and Check-in

The changes at the beginning of the first subprocess are due to the implementation of the issue 1 solution, there is a new ticket system that will provide the customer with a number associated with the service they are in the reception area for. With this in mind, the To-Be Model is designed so that the receptionist calls the next number in the system and serves them. The system is the one sorting the order in which the customers are served, always prioritizing the inspection check-in and then, the other services. This prioritization takes place to limit juggling between multiple jobs, which, as identified in issue 1, can lead to longer waiting times and have an impact on the quality of the service.

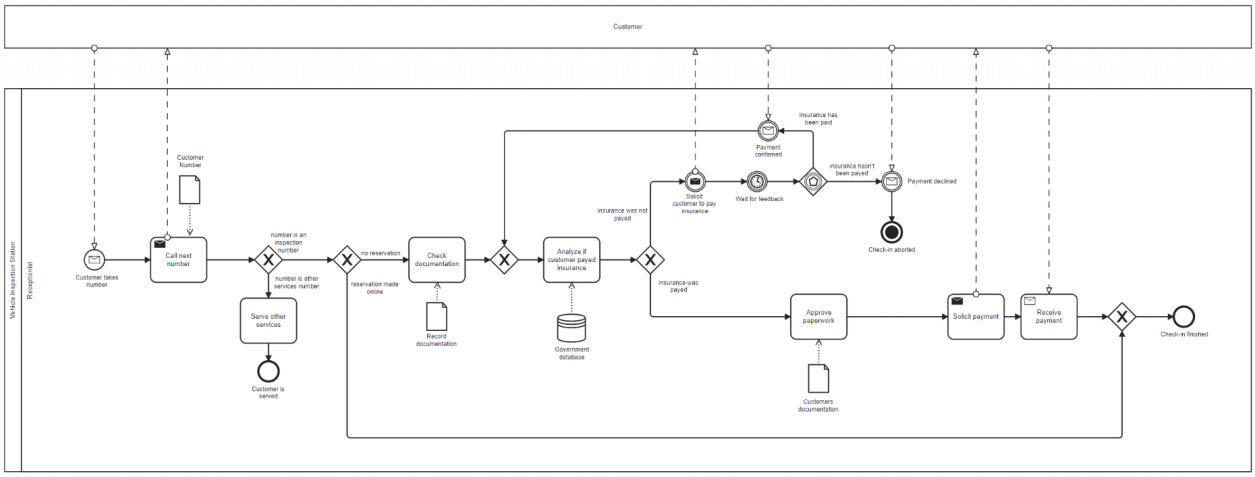

Figure 13 - Subprocess 1: Customer Arrival and Check-In, To-Be Model.

The second change is that as a result of the implementation of the proposed solution for issue 2, there will be a reservation system. This reservation system will alleviate the receptionist's work, as the customers now have the opportunity to submit documentation and pay for inspection before arriving at the inspection center. The more tech-savvy customers, after arriving at the reception area, might also consider doing these steps by themselves while waiting for service.

The final change to this subprocess is that it finishes after the payment of the inspection is completed. A new subprocess was added where the remaining tasks in the As-Is Model of the Check-In subprocess will be added.

Subprocess 2: Onboarding

As the solution to issue 5 was being created, there was an urge to separate the check-in from the onboarding. The check-in is now only to make sure the paperwork and payments are correct, as the onboarding kick-starts the inspection process by making sure the customer has a slot for inspection, and the inspection form and that they leave the car keys.

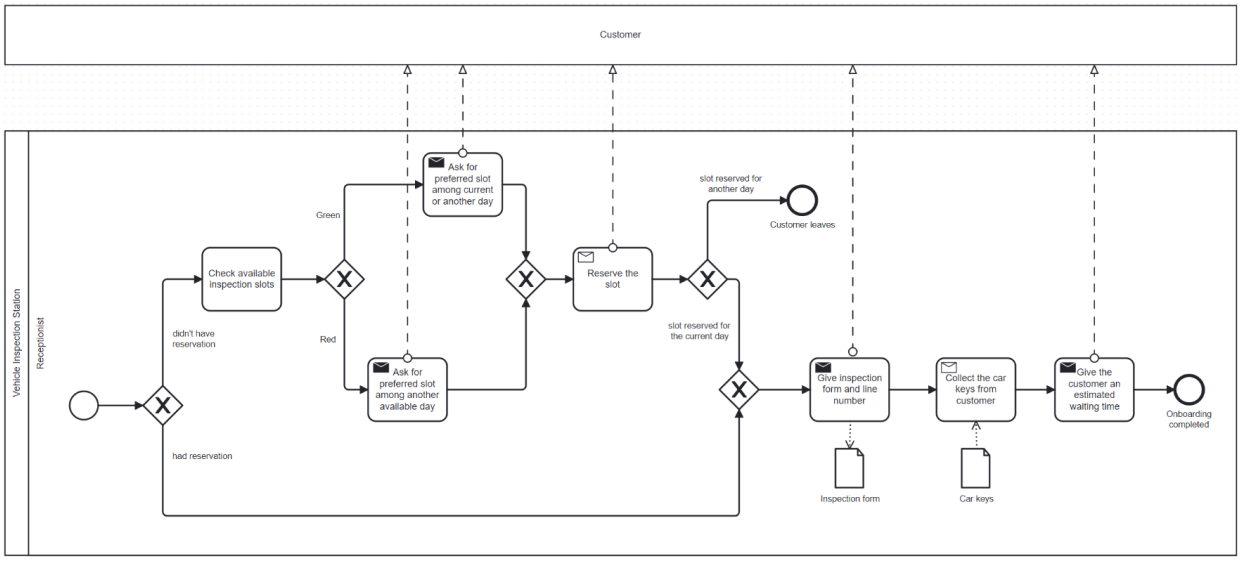

Figure 14 - Subprocess 2: Onboarding, To-Be Model.

The current subprocess starts with a gateway that will differentiate the receptionist's work, they either have to make the reservation for the customer or that reservation is already booked by the customer or by the receptionist on a previous time. The reservation for the day is

either free for the day, signaled by a “green” state, or it isn’t, signaled by a “red” state. If the slot is reserved for another day, the customer will leave and come back according to their booking.

When the customer has a reservation for the present day, the receptionist will provide them with the inspection form and will collect the car keys.

Subprocess 3: Inspection Lane Entry, Inspection, and Emissions Testing at Base 2

Subprocess 3 will now start with the inspector from Base 2 collecting the car keys from the receptionist and then driving the customer's car to the correct inspection lane at Base 2. This change happens in conformity with the solution present to mitigate issue 3, customers were forgetting to leave the keys and driving in the wrong lane at Base 2. This concludes the lane entering, avoiding now delays.

The Inspection and emissions test at Base 2 remains the same.

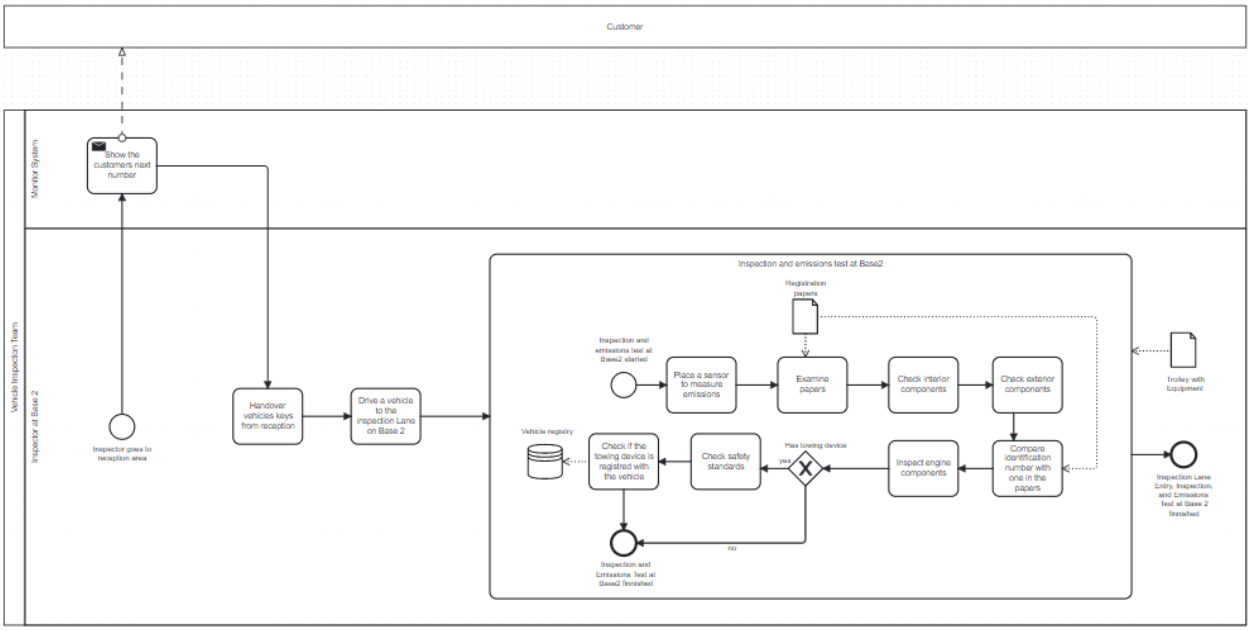

Figure 15 - Subprocess 3: Inspection Lane Entry, Inspection and Emissions Testing at Base 2, To-Be Model.

Subprocess 4: Inspection in Base 3

The changes in the To-Be Model for inspection at Base 3 subprocess are a simplification of the As-Is as it is assumed that with the implementation of issue’s 4 solution takes away any delays at the next subprocess that might influence the current one’s work flow.

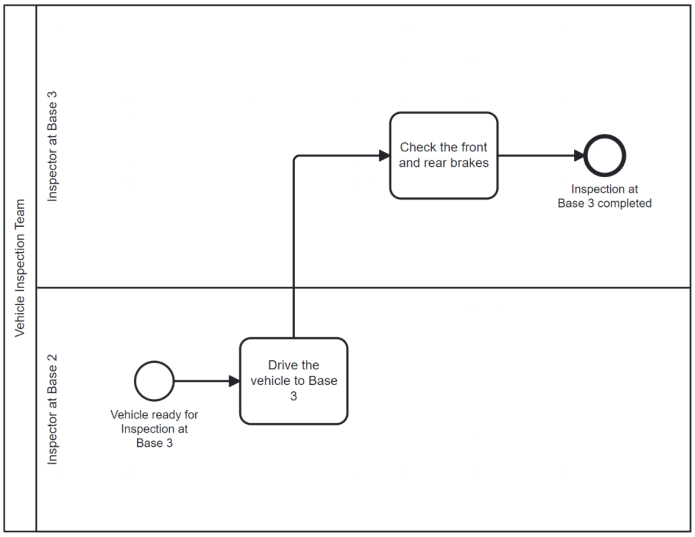

Figure 16 - Subprocess 4: Inspection in Base 3, To-Be Model.

Subprocess 5: Inspection in Base 4

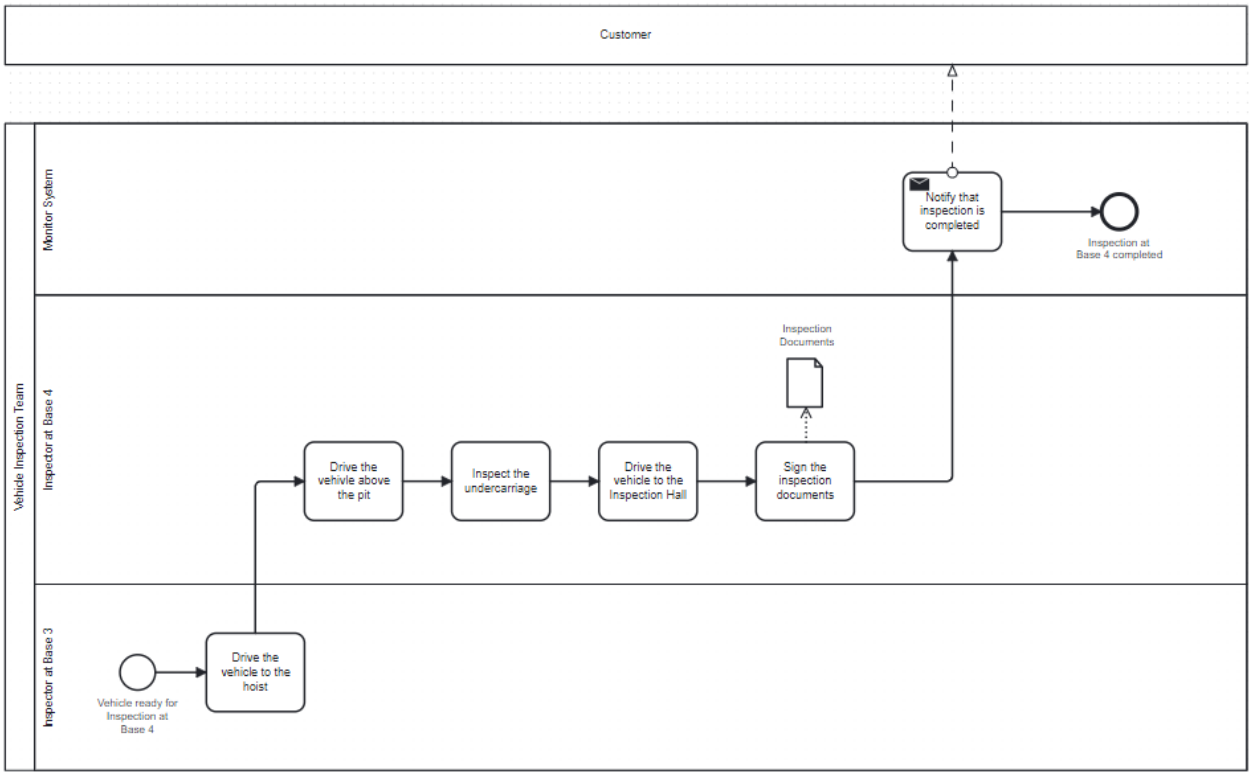

Figure 17 - Subprocess 5: Inspection in Base 4, To-Be Model.

In Inspection in Base 4, the solution suggested for issue 4 was implemented. With a new pit where the cars can just drive over and the inspection under the vehicle is on a lower level, there is no longer a need to rise and lower the pit with a car elevator. As such, those steps were removed from the subprocess.

Subprocess 6: Recording Results into the Database

The last subprocess will also remain the same in the To-Be Model as it was in the As-Is Model, with no changes registered.

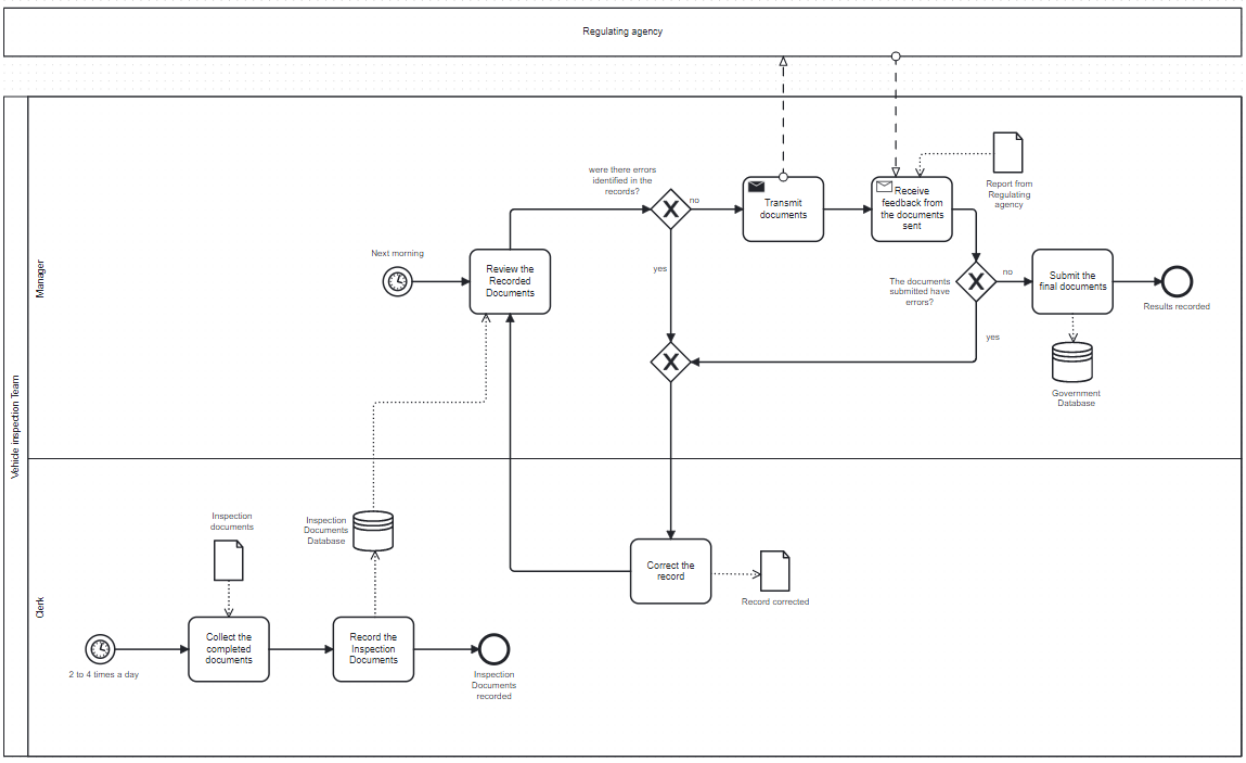

Figure 18 - Subprocess 6: Recording Results into the Database, To-Be Model.

6. Implementation Strategy

For every identified issue, a proposed solution was presented in order to mitigate the time and financial losses associated with each of them in the vehicle inspection process at Frumherji. These form the basis for the development of the "To-be" Process Model.

Some of the suggested changes come at no cost, specifically, the improved and more efficient allocation of resources proposed to address issues 1 and 3. On the other hand, certain changes do involve financial investment. This includes the establishment of an online appointment system to tackle issues 2 and 5, as well as the acquisition of new equipment to address issue 4. Furthermore, these proposed changes are poised for swift implementation, ensuring enduring advantages for both stakeholders in the process - namely, the company and the client. These benefits encompass continuous improvement, greater operational efficiency, enhanced convenience, flexibility in scheduling, as well as savings in time and resources, among other positive outcomes.

The time savings associated with the strategies proposed for implementation are notable when simulating the "To-Be" Process in the Bizagi tool. The steps from checking documentation to receiving payment tasks were simulated again, in order to again calculate how much time the check-in will take in the "To-be" Process. The simulation results for the related steps are available for consultation in the figure below.

Name	Type	Instances completed	Instances started	Min. time	Max. time	Avg. time	Total time
Vehicle Inspection Station	Process	75	75	0	2h 54m	1h 4m 34s	3d 8h 43m

Figure 19 - Simulation data from Bizagi, total check-in time, To-Be Process.

From the comparison of the simulation results presented above with those in subchapter 3.1.2., it is observed that the implementation of an online booking system with pre-payments reduces, on average, the check-in time from 6 hours to approximately 1 hour and 40 minutes, revealing the success of the proposed strategy.

The total inspector working time was also simulated for the “To-Be” Process. The new simulation results are the ones presented below.

Name	Type	Instances completed	Instances started	Min. time	Max. time	Avg. time	Total time
Main Process	Process	90	90	2h 31m	9h 56m	6h 13m 30s	23d 8h 15m

Figure 20 - Simulation data from Bizagi, total inspector working-time, To-Be Process.

From the comparison of the simulation results presented above with those in subchapter 3.1.5. it is possible to observe that the implementation of a new ticket system regarding the inspection area reduces, on average, the inspector working time from 9 hours and 34 minutes to approximately 6 hours and 13 minutes, so, with the implementation of the proposed strategy there is no need for the inspectors to work overtime, revealing, once again, the success of the proposed strategy.

The full tables with Simulation data from Bizagi tool regarding the “To-Be” Process are available for consultation in the Appendix Section, appendixes 3 and 4, respectively.

7. Conclusion

By comprehensively examining Frumherji Ltd.'s vehicle inspection process in Reykjavík, the group meticulously dissected the existing procedures to uncover inefficiencies and bottlenecks. The analysis, encompassing a diverse array of stakeholders, illuminated the intricacies involved in ensuring compliance with regulatory standards and vehicle safety and emissions requirements.

Key Insights:

The investigation underscored the pivotal need for optimization within Frumherji Ltd.'s operational framework. The symbiotic relationship between efficiency, cost-effectiveness, and overall organizational effectiveness is emphasized. The journey through the current vehicle inspection process, meticulously mapped using BPMN modeling, revealed a nuanced interplay of roles and responsibilities among inspectors, administrative staff, management personnel, and customers.

Issues and Shortcomings:

The report diligently cataloged the issues and shortcomings embedded in the current vehicle inspection process, shedding light on areas where improvements are not only advantageous but imperative. This thorough examination forms the foundation for our strategic recommendations.

Strategic Recommendations:

The proposed 'To-Be' process model is a refined blueprint designed to rectify the identified shortcomings. It encompasses strategic alterations, innovative solutions, and judicious automation, all aimed at elevating operational efficiency and streamlining the inspection process. The recommendations range from cost-neutral improvements, such as enhanced resource allocation, to strategic investments, including the establishment of an online appointment system and the acquisition of new equipment.

Implementation Strategy:

The implementation strategy is meticulously crafted to ensure enduring advantages for both Frumherji Ltd. and its clients. Emphasizing continuous improvement, operational efficiency, and enhanced convenience, the proposed changes offer flexibility in scheduling and result in

significant time and resource savings. The implementation strategy is not just a series of modifications but a calculated investment in the future resilience and competitiveness of the company.

Validation through Simulation:

To bolster the credibility of our recommendations, each proposed change underwent rigorous simulation to ensure efficacy. This validation process adds a layer of confidence to the transformative potential of our suggestions.

In summation, this report serves as a roadmap for Frumherji Ltd., providing not only insights into current practices but a clear and actionable path towards heightened operational efficiency in the vehicle inspection process.

8. Appendix

Appendix 1 - Simulation data from Bizagi, total check-in time, As-Is Process.

Scenario information

Name	Scenario
Time unit	Minutes
Duration	030,00:00:00

Name	Type	Instances completed	Instances started	Min. time	Max. time	Avg. time	Total time	Min. time waiting resource	Max. time waiting resource	Avg. time waiting for resource	Standard deviation waiting resources	Total time waiting resource	Total fixed cost
Vehicle Inspection Station	Process	74	75	5h 36m 30s	6h 13m	5h 54m 45s	18d 8h 19m 30s					18d 2h 6m 30s	0
Payment confirmed	Intermediate event	0	0										
ExclusiveGateway	Gateway	75	75										
Analyze if customer payed insurance	Task	75	75	1h 15m	2h 29m	1h 52m	5d 20h	1h 14m	2h 28m	1h 51m	21m 38s	5d 18h 45m	0
ExclusiveGateway	Gateway	75	75										
Check documentation	Task	75	75	2m	2h 30m	1h 16m	3d 23h	0	2h 28m	1h 14m	43m 17s	3d 20h 30m	0
Customer takes number	Start event	75											
Approves paperwork	Task	74	74	1h 14m	1h 15m	1h 14m 13s	3d 19h 33m	1h 13m	1h 14m	1h 13m 13s	25s	3d 18h 19m	0
Solicit customer to pay insurance	Intermediate event	1	1										
EventBasedGateway	Gateway	0	1										
Payment declined	Intermediate event	0	0										
Check-in finished	End event	74											
Receive payment	Task	74	74	37m	37m	37m	1d 21h 38m	36m 30s	36m 30s	36m 30s	0	1d 21h 1m	0
Solicit payment	Task	74	74	37m	1h 13m 30s	55m 15s	2d 20h 8m 30s	36m 30s	1h 13m	54m 45s	10m 40s	2d 19h 31m 30s	0
Check-in aborted	End event	0											
Wait for feedback	Intermediate event	1	1										

Appendix 2 - Simulation data from Bizagi, total inspector working time, As-Is Process.

Scenario information

Name	Scenario 1
Time unit	Minutes
Duration	030,00:00:00

Name	Type	Instances completed	Instances started	Min. time	Max. time	Avg. time	Total time	Min. time waiting resource	Max. time waiting resource	Avg. time waiting for resource	Standard deviation waiting resources	Total time waiting resource	Total fixed cost
Total Inspector working time	Process	90	90	7h 38m	11h 30m	9h 34m	35d 21h					34d 10h 30m	0
NoneStart	Start event	90											
Inspection lane Entry and inspection at Base 2	Task	90	90	12m	6h	3h 6m	11d 15h	0	5h 48m	2h 54m	1h 43m 51s	10d 21h	0
Inspection at Base 3	Task	90	90	1h 30m	5h 51m	3h 40m 30s	13d 18h 45m	1h 27m	5h 48m	3h 37m 30s	1h 17m 53s	13d 14h 15m	0
Inspection at Base 4	Task	90	90	1h 35m	4h	2h 47m 30s	10d 11h 15m	1h 27m	3h 52m	2h 39m 30s	43m 16s	9d 23h 15m	0
NoneEnd	End event	90											

Appendix 3 - Simulation data from Bizagi, total check-in time, To-Be Process.

Scenario information

Name	Scenario
Time unit	Minutes
Duration	030,00:00:00

Name	Type	Instances completed	Instances started	Min. time	Max. time	Avg. time	Total time	Min. time waiting resource	Max. time waiting resource	Avg. time waiting for resource	Standard deviation waiting resources	Total time waiting resource	Total fixed cost
Vehicle Inspection Station	Process	75	75	0	2h 54m	1h 4m 34s	3d 8h 43m					3d 5h 49m	0
Payment confirmed	Intermediate event	0	0										
ExclusiveGateway	Gateway	29	29										
Analyze if customer payed insurance	Task	29	29	58m	58m	58m	1d 4h 2m	56m	56m	56m	0	1d 3h 4m	0
ExclusiveGateway	Gateway	29	29										
Customer takes number	Start event	75											
Approves paperwork	Task	29	29	29m	57m	43m	20h 47m	28m	56m	42m	8m 21s	20h 18m	0
Solicit customer to pay insurance	Intermediate event	0	0										
EventBasedGateway	Gateway	0	0										
Payment declined	Intermediate event	0	0										
Receive payment	Task	29	29	14m 30s	14m 30s	14m 30s	7h 30s	14m	14m	14m	0	6h 46m	0
Solicit payment	Task	29	29	14m 30s	28m 30s	21m 30s	10h 23m 30s	14m	28m	21m	4m 10s	10h 9m	0
Check-in aborted	End event	0											
Check documentation	Task	29	29	2m	58m	30m	14h 30m	0	56m	28m	16m 43s	13h 32m	0
ExclusiveGateway	Gateway	75	75										
ExclusiveGateway	Gateway	75	75										
Check-in finished	End event	75											
Wait for feedback	Intermediate event	0	0										

Appendix 4 - Simulation data from Bizagi, total inspector working time, To-Be Process.

Scenario information

Name	Scenario 1
Time unit	Minutes
Duration	030,00:00:00

Name	Type	Instances completed	Instances started	Min. time	Max. time	Avg. time	Total time	Min. time waiting resource	Max. time waiting resource	Avg. time waiting for resource	Standard deviation waiting resources	Total time waiting resource	Total fixed cost
Main Process	Process	90	90	2h 31m	9h 56m	6h 13m 30s	23d 8h 15m					22d 6h	0
NoneStart	Start event	90											
Inspection Lane Entry and Base 2	Task	90	90	11m	11m	11m	16h 30m	0	0	0	0	0	0
Base 3	Task	90	90	1m 30s	2h 15m	1h 8m 15s	4d 6h 22m 30s	0	2h 13m 30s	1h 6m 45s	38m 58s	4d 4h 7m 30s	0
Base 4	Task	90	90	2h 18m 30s	7h 30m	4h 54m 15s	18d 9h 22m 30s	2h 13m 30s	7h 25m	4h 49m 15s	1h 30m 55s	18d 1h 52m 30s	0

9. References

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