NATIONAL TECHNICAL UNIVERSITY OF ATHENS
SCHOOL OF MECHANICAL ENGINEERING

“MODELING AND IMPROVING THE DISTRIBUTION PROCESSES OF A GREEK SUPERMARKET COMPANY UTILISING DMAEV METHODOLOGY AND DIGITAL TRANSFORMATION”

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Έχω διαβάσει και κατανοήσει τους κανόνες για τη λογοκλοπή και τον τρόπο σωστής αναφοράς των πηγών που περιέχονται στον Οδηγό συγγραφής Διπλωματικών Εργασιών. Δηλώνω ότι, από όσα γνωρίζω, το περιεχόμενο της παρούσας εργασίας είναι προϊόν δικής μου δουλειάς και υπάρχουν αναφορές σε όλες τις πηγές που χρησιμοποίησα.

Οι απόψεις και τα συμπεράσματα που περιέχονται σε αυτή τη Διπλωματική εργασία είναι του συγγραφέα και δεν πρέπει να ερμηνευθεί ότι αντιπροσωπεύουν τις επίσημες θέσεις της Σχολής Μηχανολόγων Μηχανικών ή του Εθνικού Μετσόβιου Πολυτεχνείου.

Ονοματεπώνυμο

Αγγελική Μπούσουλα

SYNOPSIS

The purpose of this thesis is to create an improved Model of the Distribution Processes of a leading Greek supermarket company using LSS methodology to implement new technologies in the Supply Chain and increse the Supply Chain digitalization to enable the implementation of future LSS Projects for process optimization. This study followed a qualitative research approach, a Case Study of a leading Greek Supermarket Chains Company and utilized the DMAEV designed for Lean Six Sigma approach to construct the model using Enterprise BPMN 2.0. collaboration diagram as a business modelling language in ARIS architect & disigner 10.0 software. The findings of this study are the two-way beneficial relationship of LSS methodology and new technologies in the Supply Chain, the iportance of including new technologies in the Supply Chain both for process optimization and future LSS Projects implementation and how DMAEV and LSS methodology is easy to use and beneficial when trying to implement changes in the Supply Chain Processes. This study made also clear the lack of LSS initiatives and usage of new technologies in the Greek Supermarket Supply Chain. The author's institution offers access to only three major publishers (Emerald, Elsevier, Taylor & Francis) and thus the academic papers used were the ones available by them. This thesis provides insights from both academia and the market and it is the first case study in Greek Supermarkets refering to LSS methods and new technologies.

ΕΠΟΨΗ

Ο σκοπός της παρούσας διπλωματικής είναι η δημιουργία ενός βελτιωμένου μοντέλου για τις διαδικασίες διανομής μίας μεγάλης Ελληνικής Εταιρείας αλυσίδων σούπερμαρκετ χρησιμοποιώντας την Lean-Six-Sigma μεθοδολογία για την εφαρμογή νέων τεχνολογιών στην εφοδιαστική της αλυσίδα και την αύξηση του βαθμού ψηφιοποίησής της ώστε να υποβοηθηθεί η εφαρμογή περαιτέρω Lean-Six-Sigma έργων για τη βελτιστοποίηση διαδικασιών. Η έρευνα ακοθούθησε την μεθοδολογία της μελέτης περίπτωσης, ποιοτικής ερευνητικής μεθοδολογίας. Η μελέτη περίπτωσης πραγματοποιήθηκε για μία μεγάλη εταιρεία αλυσίδας σούπερμαρκετ, η οποία δραστηριοποιείται στον Ελλαδικό χώρο και για την ανάπτυξη του μοντέλου ακολουθήθηκε η DMAEV μεθοδολογία της Lean-Six-Sigma και το μοντέλο παρουσιάζεται με τη μορφή Enterprise BPMN 2.0 collaboration diagram που δημιουργήθηκε χρησιμοποιώντας το λογισμικό πρόγραμμα ARIS architect & disigner 10.0. Τα ευρήματα της έρευνας είναι η αμφίδρομη θετική επιρροή της μεθοδολογίας Lean-Six-Sigma και των νέων τεχνολογιών στην εφοδιαστική αλυσίδα, η σημασία της εισαγωγής νέων τεχνολογιών στην εφοδιαστική αλυσίδα, τόσο για την βελτίωση των

διαδικασιών όσο και για τη μελλοντική πραγματοποίηση έργων βελτιστοποίησης με την Lean-Six-Sigma μεθοδολογία, και πώς η εφαρμογή της DMAEV μεθοδολογίας και γενικότερα της Lean-Six-Sigma μεθοδολογίας είναι επωφελής για προαπάθειες εισαγωγής αλλαγών στην εφοδιαστική αλυσίδα. Από την έρευνα, κατέστει σαφής η έλλειψη εφαρμογής νεών τεχνολογιών και έργων βελτιστοποίησης με την Lean-Six-Sigma μεθοδολογία στην εφοδιαστική αλυσίδα των ελληνικών σούπερμαρκετ. Το πανεπιστήμιο του συγγραφέα παρέχει δωρεάν πρόσβαση σε τρείς μεγάλους εκδοτικούς οίκους από τους οποίους χρησιμοποιήθηκαν τα δημοσιοποιημένα ερευνητικά άρθρα τους (Emerald, Elsevier, Taylor & Francis). Τέλος, η παρούσα διπλωματική παρέχει οπτική τόσο από ακαδημαϊκής πλευράς όσο και από την αγορά και αποτελεί την πρώτη μελέτη περίπτωσης στα ελληνικά σούπερμαρκετ αναφορικά με ψηφιοποίηση διαδικασιών, νέες τεχνολογίες και την Lean-Six-Sigma μεθοδολογία.

Contents

Figures

Tables

1. INTRODUCTION

1.1 Thesis Framework

The intense competition and rapidly changing consumer behavior and needs are pressuring consumer goods companies to innovate and adopt to the new environment. Hypermarkets, Supermarkets, Convenient stores, and Groceries stores are organizations strongly affected by these changes and in need to involve in order to keep up with the new market trends. In such companies Supply Chain Management plays a key role for the operational excellence and the competitive advantage of the company. Supply Chain Management is one of the most crucial and adding value business processes and at the same time a huge cost pool for the companies. In industries with fast moving products with short shelf life, Distribution Processes as a part of Supply Chain Processes are especially critical for the performance of the whole Supply Chain. Supply Chain Innovation is a trending topic for the whole retail industry. The need for disruption in the Supply Chain Management has led to various ways succeeding that such as digital transformation, new technologies inclusion, information systems, network design and business processes improvement and management practices. Leading Hypermarkets and Supermarket companies all over the world are incorporating these innovations in their supply chain to achieve business process optimization, cost reduction and to secure their competitive advantage. Implementing such changes is a major investment and hides many risks and is important to figure a way to balance the cost with the benefits of such investments. For example, including excessively new technologies in the supply chain can create high costs with little business processes improvement. The need and the willingness of the companies to apply new technologies and process improvement practices in the supply chain is clearer than ever. All these highlight the necessity to develop a specific methodology and strategy to transform and optimize the supply chain. Lean Six Sigma methodology is a widely used Continuous Improvement methodology in the manufacturing industry with indications of successful application in Supply Chain Management and Supply Chain Processes aiming to identify and eliminate wastes, errors, and issues, improve process performance, and add value to the end customer. On the other hand, industry 4.0 technologies i.e., IoT, Blockchain, AR etc. and supply chain digitalization with Cloud Platforms and software are used by major Hypermarket companies like Tesco and leading consumer goods companies to accomplish operational excellence and improve their supply chain processes. In this thesis is presented a model which demonstrates how LSS methodology can be used in the Distribution Processes of a leading Greek Supermarket company to improve the processes by including new technologies and increasing digitalization of the processes and how those enable future LSS projects, thus, creating an efficient and sustainable model to continuously implement innovations in the Supply Chain.

1.2 Aim, objectives, and research questions of Thesis

This thesis aims to develop a new Distribution Processes Model for a leading Greek Supermarket company by using LSS methodology and including new technological advancements to meet their demands, introduce improvements in the current processes and create a fertile environment for future use of LSS methodology for process optimization projects.

The objectives of the thesis are divided into two groups and are the following:

General Objectives:

- Prove that new technologies in the supply chain and supply chain digitalization can act as enablers for LSS projects
- Prove that new technologies in the supply chain improve supply chain performance
- Show that LSS methodology is useful when trying to implement changes in processes
- Highlight the two-way positive influence of Implementation of Industry 4.0 in Supply Chain – Supply Chain Digitalization and Lean Six Sigma Projects Implementation

Objectives specifically for the company:

- Decrease Distribution Processes Costs
- Increase process automation
- Decrease number of exchanged e-mails
- Increase number of LSS projects and set a CI mindset
- Improve processes documentation
- Include new technologies in Distribution Processes while keeping their expandability intact

This thesis also tries to provide answers to the following research questions:

- **RQ1:** How Lean Six Sigma Method can aid the application of new technologies in the Supply Chain and the Supply Chain digitalization?

- **RQ2:** How new technologies in the Supply Chain and the Supply Chain digitalization support the Lean Six Sigma Projects in it?
- **RQ3:** How these concepts can be used in a real case of a Greek Supermarket to create an improved Distribution Processes Model?
- **RQ4:** How can a company effectively include innovations in the Supply Chain Management?

1.3 Research demarcation

The thesis establishes the significant potential of Lean Six Sigma methodology, supply chain digitalization and industry 4.0 technologies for the whole supply chain and processes improvement. Although, the presented Case Study and the created model refer to the Distribution Processes specifically, as the Supermarket company requested improvement proposals for these processes only. Finally, the proposed model was developed taking under consideration this company's characteristics and needs.

1.4 Thesis structure

This thesis is structured as follows. First is the literature review and the theoretical background of the three important pillars of this thesis. The Lean Six Sigma overview outlines the importance of LSS as a CI method. The overview of Supermarket and Groceries supply chain and Industry 4.0 technologies outlines the importance of such technologies in the supply chain of the Supermarkets. This overview includes information from scholars and market and the used papers are from the academia, market research papers from consulting companies and information from market players. Then follows the overview of LSS in the Supermarket and the Supply Chain to outline the importance of LSS specifically in the SC and the significant importance of new technologies in the LSS. Final part of the theoretical background is the literature gap to highlight areas for potential research and the contribution of this thesis in this gap.

Second is the methodology section. In this section are described the research methods of this thesis and the used tools. It is also explained why each one was selected, and a methodology flowchart is selected.

The next section is the presentation of the Case Study which includes a short presentation of the company and the followed steps for the creation of the new Distribution Processes Model according to the selected methodology DMAEV.

Finally, the conclusion of this thesis describes the main findings and implications of this study. It also addresses the limitations of this study and provides suggestions for future research in this field.

2. LITERATURE REVIEW AND THEORETICAL BACKGROUND

2.1 Lean Six Sigma Overview

2.1.1 Introduction to Lean Six-Sigma

Lean Six Sigma (LSS) is a method for constant process optimization focusing on minimizing variations, improving quality and eliminating wastes. LSS derives from the combination of two major constant improvement methods, Lean Enterprise and Six Sigma (Furterer, 2014). Lean Enterprise as a term is used to incorporate the principles of lean manufacturing and lean production to the whole enterprise. The concepts of lean manufacturing and lean production are usually mentioned as “Lean”. Originally, “Lean” was introduced in the early ‘70s by Toyota Motor Corporation as the Toyota Production System (TPS), which was influenced by Fredrick Winslow Taylor and Henry Ford. The evolution of TPS and Just in Time (JIT) is what know is known as “Lean”. This methodology aims to achieve reduced cycle times with zero waste as well as adding value to the processes. On the other hand, there is the six-sigma method which is the evolution of Total Quality Management (TQM) and Business Process Reengineering (BPR) (Arnheiter and Maleyeff, 2005; Furterer, 2014). Six-sigma is a disciplined and data-driven approach and methodology for eliminating defects in any process from manufacturing to supply chain and so on and so forth (What Is Six Sigma?, 2020). This method was introduced in the early ‘80s by Motorola Corporation and adopted in 1995 by General Electric and the CEO, John Welch. The philosophy behind six-sigma is achieving the quality of 3.4 defects in one million opportunities (DMPO).

$$DPMO = (Defects \times 1{,}000{,}000) \div (Units \times Opportunities)$$

2.1.2 Six-Sigma Method and Tools

Six-sigma started as a problem solving approach to reduce variation in a product and manufacturing environment by using data-driven, decision-making and project management fundamentals (Hambleton, 2008). The evolution of Six-sigma transformed it to a method applicable in many different industries such as logistics, healthcare, finance etc. Six-sigma uses project-based methods to reengineer and optimize processes in every industry, from the private to the public sector, and in each step of the various methods different toolsets are applied. Every Six Sigma project requires as members of the project team, six sigma experts. The six sigma experts are certified consultants, and the level of their expertise is designated by their title and their part in the project is in accordance with their level of expertise. Next, the title and role of each expertise level is shown in table 2-1.

Table 2-1: Six-sigma experts and their role

Title	Role in a six-sigma project
White Belt	*White Belt indicates a basic knowledge of the six-sigma philosophy and fundamentals and has no active part in a six-sigma project*
Yellow Belt	*The Yellow belt certification indicates knowledge of the six-sigma application on projects, the specifics and how is applied. They are part of the project team and their role is to review the process improvements*
Green Belt	*The Green Belt certification indicates deep knowledge of the six-sigma and the tools. They perform the data collection and the analysis, the lead the project alongside the Black belts and they support them*
Black Belt	*The Black Belt certification indicates proficiency of the six-sigma methods. The Black belts are the project managers, they lead all the projects, they train, and they coach the members of the team. Usually, they are members of the company*
Master Black Belt	*The Master Black Belt is the mentor of the Black Belts and the Green Belts. To be certified as a MBB years of experience as a Black Belt is required*

Source: sixsigmacamp.com

The following table, table 2-2 presents the most common project-based six-sigma methods with the leading method being DMAIC method.

Table 2-2: List of Six Sigma Methods

Method	Full Method Name	Description
DMAIC	Define–Measure–Analyze–Implement–Control	Is a problem-solving method for an already existing process, product, service, identifying key requirements and is applicable to any problem with definable performance goals and measurable characteristics as it is data relied
DMADV	Define–Measure–Analyze–Design–Validate	The fundamental difference between DMAIC and DMADV the two most used data-driven, problem-solving methods is that DMADV redesigns the problematic process, product, service and it is considered result focused
DMEDI	Define–Measure–Explore–Develop–Implement	It is almost the same with DMADV but slightly faster
PIDOV	Plan–Identify–Design–Optimize–Validate	It is a very popular 5 step method to create new products with six-sigma standards
CDOV	Concept–Design–Optimize–Verify	This method is applied to product improvement projects and service, product new launched mainly, it is characterized by adaptability and flexibility
ICOV	Identify–Characterize–Optimize–Verify	This method is mainly used for products, to commercialize new technologies
IIDOV	Invent–Innovate–Develop–Optimize–Verify	This method is mainly used for products, to commercialize new technologies
UAPL	Understand–Analyze–Plan–Launch	This method utilizes cross-functional teams to commercialize, change services, launch new
IDEA	Identify–Define–Evaluate–Activate	This method is used in strategic marketing to strategically change an existing portfolio

Source: (Hambleton, 2008)

All methods are using statistical tools at every step, quantitative and qualitative tools. The tools are either aiming to visualize the data or to help draw conclusions out of them. Although there are approximately one hundred different six-sigma tools here are presented only the most important and commonly used ones. Furthermore, it's of utmost importance to know how and at which step every tool should be used. For the purposes of this thesis, we are focusing on DMAIC and DMADV methods, so only for those two is analyzed at which phase each tool is used. Before explaining the steps of each method and the corresponding tools, the most important six-sigma tools are shortly described (Furterer, 2014; Hambleton, 2008; James W. Martin, 2013).

Project Charter

A project charter is a short document with all the project's important information. The goal of the project charter is to define the problem and communicate it to all stakeholders such as team members, company's members, executives etc. Project charter aims to keep focused the team on the problem, clarify the expected output of the project and have all responsibilities are assigned. Moreover, such document includes an estimated project duration. Commonly, a company applying six-sigma projects for optimization has a project charter template including:

1. Project Name
2. Team Members, Responsibilities
3. Scope of the Project
4. Problem Statement
5. Objective/Goal
6. Project Schedule and Milestones
7. Customers / Stakeholders (internal and external people affected by the project)
8. CTS – What is Critical to Satisfy the customers / stakeholders
9. Financial or other Benefits

SIPOC Diagram (Suppliers – Input – Process – Output – Customer)

SIPOC Diagram is a qualitative tool describing the relationship between the processes, the suppliers and the customers and the inputs and outputs of the processes. The goal of this technique is to better understand the processes or the sub–processes of the product, service or process trying to optimize in order to understand what needs to be measured, what data to collect and who are involved to ask the proper questions.

Table 2-3 : Example of SIPOC layout

Supplier	Input	Process	Output	Customer
As a supplier is considered the person, mechanism, department feeding the input	Input is everything (information, material, data etc.) that is going to get processed	Is the procedure transforming the input into specific, valuable outputs	Output is the desirable outcome of the processed inputs	As a customer is considered the person, mechanism, department etc. who are going to use them

Boxplot Diagram

A boxplot diagram, also known as box and whisker diagram, is a basic data visualization graphic design visualizing different data sets and providing meaningful information about its set, such as centering spread, the distribution of the data. The boxplot is defined by six basic numbers, Q3, the top of the box which is the 75%, Q2, inner line of the box the median (50%), Q1, the bottom of the box (25%), the width of the box is the Inter Quartile Range (IQR) which is the difference between Q3 and Q1 and the min and max which are the upper and lower whiskers calculated as shown in the following figure. An asterisk represents an outlier. Although, it is a useful tool providing meaningful information about different datasets allowing to compare them because it only shows these numbers it can lead to misconceptions. Figure 1 provides an example of a boxplot diagram.

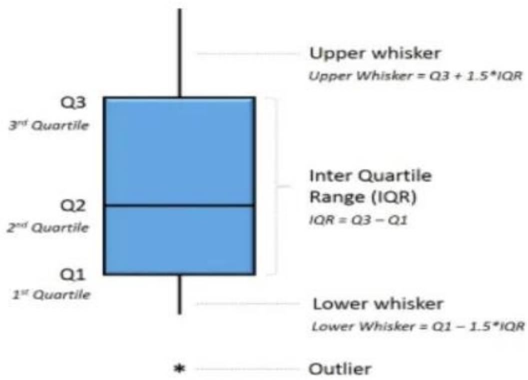


Figure 1, Graphic Visualization of a Boxplot, source: **(***Thinking Outside the Box…….plot!, 2020)*

Pareto Chart

The Pareto Chart is a bar graph showing the cumulative importance of the vital few against the trivial many, also known as 80-20 rule. The vertical axis of the pareto chart it could be the percentages of the inventory costs and the horizontal axis the different inventories held in the warehouse causing the costs from the most expensive to the less expensive. According to the pareto theory 20% of all inventories are causing the 80% of the cost. This tool is also used as a six-sigma tool to identify the processes causing the 80% of the problem that the project aims to tackle. The figure 2 is an example of a pareto chart.

Figure 2, Pareto Chart Example

CTQ

Critical to Quality is a tool translating the customer requirements into more specific and measurable characteristics for the process improvement. In most cases, the customer's requirements tend to be general and descriptive. For those requirements to be met in the project they should be translated into specific actions. To do so, multiple CTQ tools are used such as CTQ tree and CTQ matrix. Both tools are linked with the VOC (Voice of Customer) which is the requirements of the customers and in each requirement, they identify a key item and then they link it to an action with a measurable outcome. For example, in a project the requirement is a more user-friendly website for online purchases, a key item it might be the simplicity of finalizing your purchase and then a measurement is the average time for a customer to finish the purchase. The ultimate goal is the CTQs to be an accurate translation for the requirements. Figure 3 is an example of a CTQ Tree and Table 2-4 an example of CTQ Matrix.

CTQ Tree

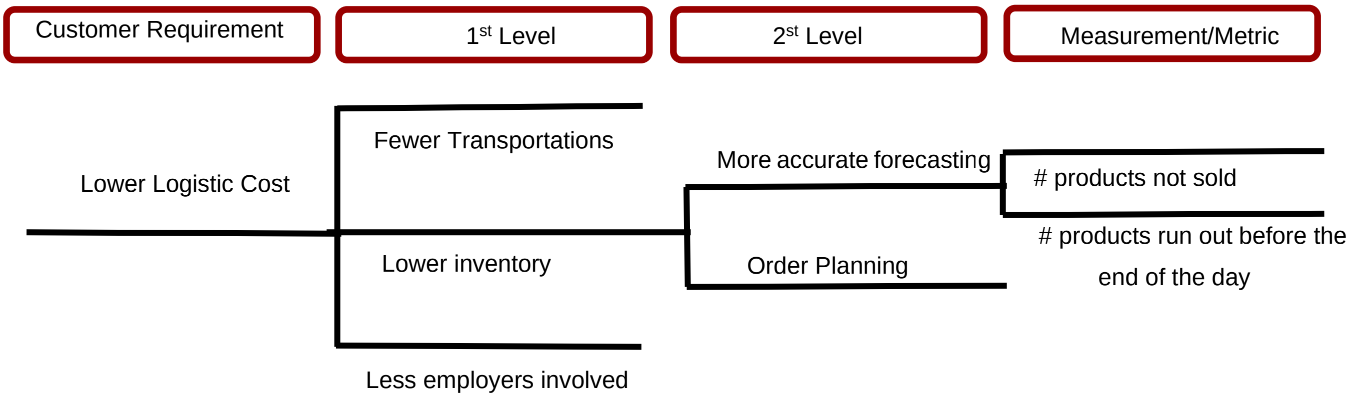


Figure 3, CTQ Tree example

Table 2-4: CTQ Matrix

VOC	Issue Translation	Key Item	CTQ	Measurement / Metric

Process Mapping – Flow Chart

Process map, flow charts, workflows are almost the same tools capturing the current structure of a process. Process maps are the documents depicting the breakdown of a process into sub-processes and their interrelationships, the flow of the sub-processes, the resources needed, the outputs, actions and document needed in each sub-process and the personnel involved. Process map is very essential not only to understand the current state but also to point out the sub-processes that add value, the ones they are not so essential, the ones might cause the problem, or can be optimized and so on and so forth. Figure 4 is an example of a process map.

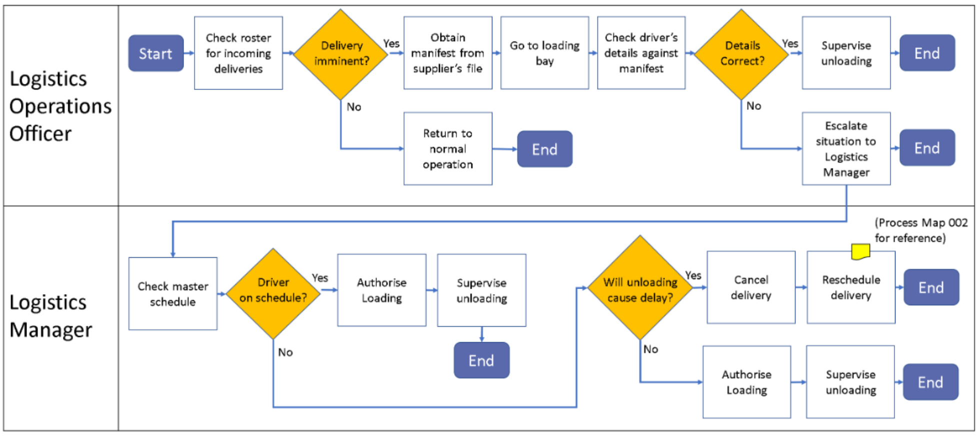


Figure 4, Process Map example, source: **https://www.resultland.com/process-mapping/**

Benchmarking

Benchmarking is a tool aiming to identify best practices from external sources, other industries, other organizations even different processes to analyze, innovate and creatively change them to further implement on the specific situation of the project. Benchmarking uses other tools as well to draw conclusions of the gathered data.

SWOT Analysis

SWOT Analysis is a strategic planning technique for an organization to identify its strengths and weaknesses and external opportunities and threats. Figure 5 is an example of a SWOT representation.

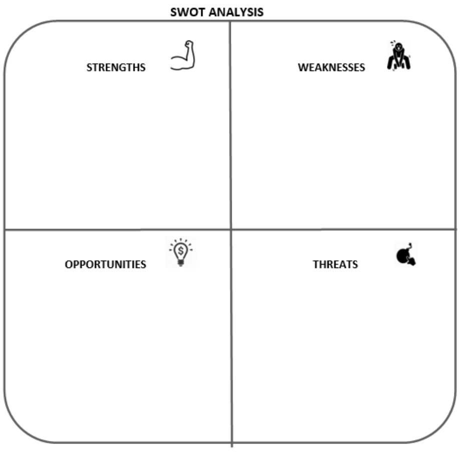


Figure 5, SWOT Analysis representation

Porter's 5 Forces

Porter's Five Forces analysis is more of a technique to analyze the external environment of a company and its competition. It's a tool for the company to create strategic approaches by analyzing its environment. The Five Forces are:

1. Competition in the industry
2. Potential of new entrants into the industry
3. Power of suppliers
4. Power of customers
5. Threat of substitute products

Surveys

Surveys are short questioners, well-structured and with very clear questions trying to gather data from a representative sample. Creating a survey is not as easy as considered as the questions must be structured in such way so they can be objectively answered. After collecting the surveys, they are statistically evaluated and after applying statistical tools, the data provide some conclusions. Another important thing is the size of the sample, and it should be representative.

VOC

Voice of the Customer is the tool used to define the project's goals by gathering the customers' requirements. VOC is actually talking and listening the customers to understand and gather their expectations and requirements for the project and usually is performed with surveys, interviews, focus groups, customer complaints, primary and secondary market research, data from CRM systems etc.

Why – Why Diagram

A why – why diagram is a qualitative tool boosting the analytical thinking aiming to break down a situation, problem and discover the root. The technique is to find a problem statement such as delays in the distribution and start asking why and the answers are the first level, then ask for each answer you gave again why and you repeat this until you have reached a level at which you have the root of the problem.

COPQ

Cost of Poor Quality (COPQ) are the costs arising by poor quality of products and services and defects. The underperformance, the wastes and the errors identified are translated in costs. This way COPQ helps understand business wise the impact of the underperformance and after implementing the changes the gains that they occur. In general, COPQ includes four costs, prevention, appraisal, internal and external failures, but strictly in six sigma only internal and external failures are considered as COPQ. Prevention costs are costs related to actions taken in order to avoid errors.

Appraisal costs are costs related to external inspections to approve and evaluate the procedures. Internal costs are costs directly related to the defects, errors, such as the cost of excess inventory, whereas the external costs are costs derived from the poor quality such as refunds, opportunity costs etc.

Failure Mode and Effect Analysis (FMEA)

Failure Mode and Effect Analysis is a tool for detection of sensitive to failure stages in a process. It is a score-based document prioritizing potential failure modes by assigning a Risk Priority Number (RPN) to sub-processes and activities. The RPN incorporates the severity of the occurrence of a failure, the possibility of occurrence of the failure and the easiness of detection of the failure.

$$RPN = S \times O \times D$$

Then a matrix is created and used to determine and validate root causes of a problem.

Quality Function Deployment (QFD)

Quality Function Deployment is a structured tool translating the customer requirements of VOP and the Critical to Satisfaction characteristics into technical terms and potential improvements and recommendations. Figure 6 is an example of QFD house.

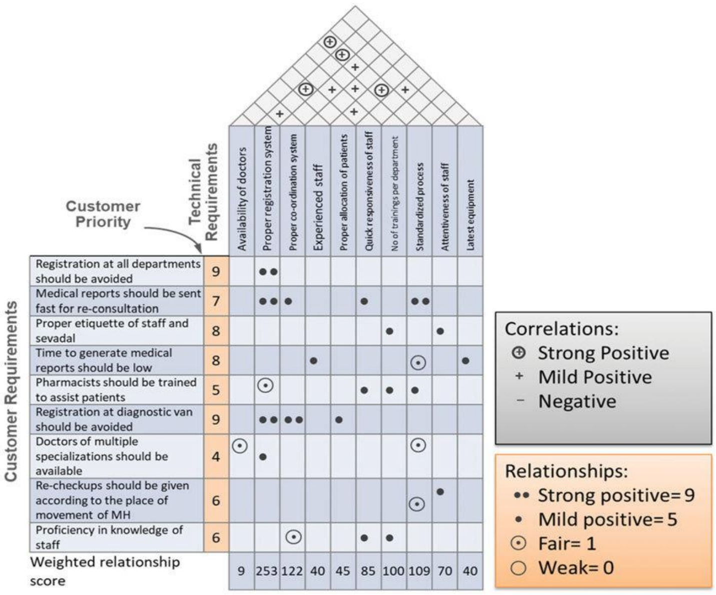


Figure 6, QFD House Example, source: (Sunder M et al., 2019)

Cost / Benefit Analysis

A Cost / Benefit Analysis is used to decide if the changes recommended to implement are a worthy investment. As an indicator for this decision is used the C/B Ratio which calculates the return of the benefits on the cost.

$$\frac{C}{B} = \frac{Present\,Value\,of\,Benefits}{Present\,Value\,of\,Cost}$$

Using this ratio and by estimating the benefits of all the implementation, the team can easily evaluate whether the benefits overweight the cost indicating a worthy investment.

Cause and Effect Diagram - Cause and Effect Matrix

Cause and Effect Diagram and Matrix are both brainstorming tools to generate potential causes of the effect or problem and an estimated relationship between the cause and the problem.

Cause and Effect Diagram

Cause and Effect diagram, known as Ishikawa's diagram or Fishbone diagram is one of the seven most important Quality Control Tools and it groups all potential causes of the problem into 6 groups, Manpower, Machine, Mother Nature, Material, Method, Measurement (6M). The figure 7 illustrates a Fishbone diagram. At the point of the line the problem is stated an at each group-branch the team documents potential causes of the problem.

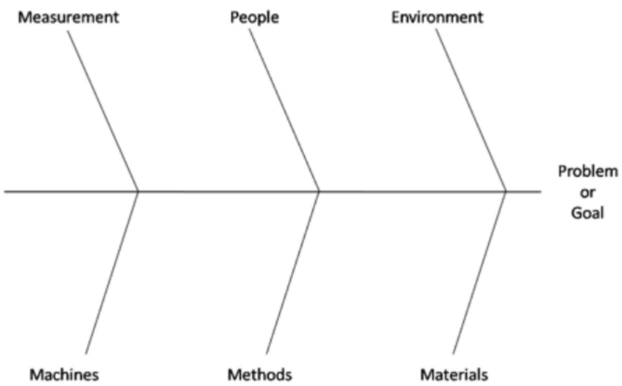


Figure 7, Example of Cause-and-Effect Diagram

Cause and Effect Matrix

The cause-and-effect matrix is used when there are multiple effects, problems requiring resolving. When multiple customer requirements need to be met cause and effect matrix allows to estimate which causes are more highly correlated to the effects. In other words, it provides an overview of how much each cause is rooted to each effect. In the Table 2-5 an example of the cause-and-effect matrix layout is presented.

Table 2-5: Cause and Effect Matrix Layout

Causes	*Effects*				
	Y1	Y2	Y3	Y4	Total Score
Priority Score					
X1	F1,1=Cor(x1,y1)*priority score(y1)	…	…	…	Sum(F1,i)
X2	F2,1	…	…	…	Sum(F2,i)
X3	F3,1	…	…	…	…
X4	F4,1	…	…	…	…

The priority score indicates the importance of the effects for the customer and the correlation score from 0, non-correlated to 9, highly correlated indicates the correlation of each cause to each effect.

Scorecards and Process Control Plans

Scorecards and process control plans are tools to monitor, standardize and control the implemented changes and establish that the new process is going to be maintained. These tools sometimes incorporate statistical tools.

Control Charts

Control Charts are one of the seven Quality Control tools known as Statistical Process Control Charts as well and used to measure, monitor and control a process as well as determining if it is stable. They are categorized in two large groups depending on the type of data plotted. The first group are the charts for variable data, mainly quantitative data called continuous because they are measured in a continuous scale, such as temperature. The second group are charts with attribute data, mainly qualitative data in a binary form (0 or 1, fail or pass). In both categories there are the limits to indicate an abnormal change in the data. More informative charts are considered to be the variable data charts and usually they use parameters such as standard deviation, mean variables, range etc. The Table 2-6 lists the most common used control charts for the two categories.

Table 2-6: Control Charts Examples

Variable Data Control Charts	Attribute Data Control Charts
✓ X-bar and R-charts ✓ X-bar and s-charts ✓ X and moving range ✓ X-MR charts	✓ P-charts ✓ NP-charts ✓ C-charts ✓ U-charts

Source: (Furterer, 2014)

Hypothesis Test

Hypothesis test is a technique using a set of different statistical tests such as chi-square and so on. This technique is used to determine if two data sets are statistically different or if the difference occurs because something influenced the process and to determine if there is a relationship between data sets. This test can be applied as a six-sigma tool to analyze if the changes indeed improved the process, product or service, to determine the correlation between the critical to satisfaction characteristics and the samples. Hypothesis test is a fundamental part of statistics and it starts with a statement trying to prove it or reject it. The methodology includes two hypotheses, the null hypotheses Ho and the alternative hypothesis. For the scope of this thesis no further analysis of the hypothesis test methodology is of interest apart from its application to a six-sigma project.

Histogram

Histogram is graphic tool for data visualization providing information for the data distribution such as shape, center, variance. It’s a very basic tool normally used to help decide the analyzing method for the data after providing the very first information about them.

Scatter Plot / Correlation Diagram

A scatter plot is a data visualization tool. Scatterplot or correlation diagram is a graph demonstrating the relationship between to variables X, the independent variable (horizontal axis) and Y, the dependent variable (vertical axis). A scatter plot can reveal the type of relationship between the variables, linear, non-linear (exponential, cubic, quadratic etc.) or non-existing and thus is used before Regression or Correlation analysis.

Regression Analysis

Regression analysis is a statistical tool for predicting a mathematical model that describes the relationship between the dependent variable and one or several independent variables. Different regressions exist for different types of data relationship, such as linear regression, multiple regression, logistic regression etc. The goal of this tool is to find the best line that fits to the data. The important characteristic of regression analysis is that can be applied in different data relationship types in contrast to the correlation analysis which is applicable only for linear correlated data. Based on data manipulation regression analysis provides understanding of any causality relationship. In a six-sigma project the regression analysis tries to identify a quantitative model for all the qualitative variables that are considered to be correlated to the problem. The goal is after converting the qualitative variables to quantitative to find how correlated they are to the problem.

ANOVA

ANOVA or Analysis of variance is a basic statistical tool helping identify an existing difference between two data sets. ANOVA is another hypothesis test, with a null and an alternative hypothesis, level of significance, alpha etc. and the most common Analysis of Variance types are the One-Way, the Two-way and the Analysis of Means. It determines if a data set is considered statistically different from another and in six-sigma projects can be applied to determine if the new implementations improved the process.

DMAIC Method

Define

Define is the first phase of the five-step method. In this phase the project team has to state the scope of the project, describe the problem, outline the expected accomplishments, set a specific goal and timeline and create the strategy of Six-Sigma Project. To meet all these tasks tools are applied. At this step, initially, the project chart is created to set the objectives and the SIPOC and a high-level process map to illustrate and clarify the processes. At the defining stage it's important to identify who is affected by this process, product or service and to whom is going the output of the project is going to add value or to have a positive or negative affect. In doing so a stakeholder analysis is incorporated and then financial measurements such as cost reduction etc. are shown. Finally, a Voice of Customer (VOC) and Critical to Satisfaction (CTS) are performed at a very high-level. After, doing all these the project plan is crafted, and all the next steps are programmed, and tasks are assigned. It's important to have a constant overview of the plan, monitoring at which stage the team stands and knowing the tools they should apply at each point.

Tools: Project Chart, SIPOC, Process Map, VOC, CTS, Project Plan

Measure

The measure phase is the stage at which the theoretical part must be transformed into a practical, from the qualitative to the quantitative. After realizing what is the problem the key questions that must be answered are what needs to be measured, how could be measured, what data should be collected. When measure, we measure the current state of performance. For measuring the current state of performance SIPOC and detailed Process Map and Flow Charts are used to help identifying relevant measures and metrics (wastes, inefficiencies, etc.) for the processes' performance, and areas that can be improved or they don't add value to the value chain. Furthermore, data from the stakeholders must be collected to ensure that the project tries to satisfy their requirements. All these data are collected from CRM systems, surveys, interviews, and even with observation. In the measuring phase everything that we think impacts the quality of the process, service or product and it has causality relationship with the problem is identified and translated into a metric or a measurable value and documented ready to analyze in the next step.

Tools: Detailed VOC, Detailed Process Map, Flow Charts, Data collection plans, surveys, pareto charts, histograms, CTQ, COPQ, Cause-Effect diagram – matrix, Why-why diagram

Analyze

Analyze is the phase at which we manipulate the data we perform different types of analysis with statistical and strategic tools to understand the way that all these influences the problem, how and how strongly. The objective of the analysis is to root the causes of the problem.

Tools: SWOT analysis, Porter's 5 Forces, Benchmarking, Hypothesis test, ANOVA, Regression Analysis, Correlation Analysis, Scatter plots, Boxplot diagram

Improve

Improve is the creative and most demanding phase. All the above stages exist to help find the specific areas you should focus on improving. At this stage brainstorm is required to create a plan, find, and implement a solution and then test its results. Before implementing the recommendations, a Cost/Benefit analysis is essential at this point to evaluate the investment and communicate the results with the stakeholders to approve the changes.

Tools: Brainstorming, C/B analysis, QFD, FMEA, Tests/Pilots, SOPs creation, Transition plan

Control

Six-sigma is a continuous improvement method and an important stage is the control. At this phase certain control systems are created to establish and maintain the changes, document the new processes, control the stability and keep track of everything that occurs for future problems or improvements. The objective is to standardize, sustain the new procedures and have a risk management plan.

Tools: Scorecards, SPC Charts

DMADV Method

The first three phases are the same with DMAIC method. The differences are observed in the two last steps, Define and Verify.

Design

Design in contradiction to improve is a stage that instead of improving an existing process, service or product to meet the project's requirements a completely new product, process or service is developed. It's a much drastic approach using again the same tools.

Validate

This stage is "validating that the process or product design meets targets for performance, robustness, and stability to ensure the overall requirement can be met over time"(Hambleton, 2008).

2.1.3 Lean Method and Tools

Lean Production and Manufacturing started in automobility in Japan after World War II to boost production efficiency and the last 30 years was implemented in various industries all over the word. In the western word "lean production" became popular from Deming, the well-known management consultant in the US starting from the automotive industry implemented as a way to improve quality and productivity. The important outcomes when "lean production" is established in industries are the reduction of reworked items, hours and cost, increase in quality and gains because of higher quality and stronger commitment, effectiveness and better work relationships among the employees of all levels (Huxley, 2015). The Lean methodology uses numerous tools to minimize wastes, remove non-value-added activities, increase constant flow and achieve constant improvement in processes. In this paragraph are presented and shortly explained the most common Lean tools (Furterer, 2014; James W. Martin, 2013).

Muda (Waste)

Waste is any cost adding but not value adding activity (Furterer, 2014). The waste analysis tool focuses on 7 different wastes and in many bibliographies an eighth is added. Muda means waste and the goal in "lean" is to minimize wastes and achieve zero losses. This tool identifies the eight sources of waste and it is a qualitative tool helping companies to focus on potential unnecessary wastes. The Muda wastes are:

- Transportation
- Motion
- Inventory
- Overproduction
- Over processing
- Delays
- Defects
- Talent / People not used

Just-In-Time (JIT)

Just in time is more of a method for creating a stable system using many different lean tools, such as takt time, standardized work, continuous flow and so on. JIT aims in creating a responsive production that minimizes inventory as it works with a pull system instead with a push, meaning that there is an equilibrium between the demand from the external customer and the units produced. Another characteristic of a JIT system is the constant flow of product and information through the system.

5S organization

5S is a tool for organizing the workspace to increase effectiveness and reduce wastes such as time. The 5S stands for:

- Seiri – Sort
- Seiton – Set in order
- Seiso - Shine
- Seiketsu - Standardize
- Shitsuke - Sustain

Poka – Yoke (Error Proofing)

It is an error detection and prevention tool for the processes aiming to eliminate defects in the process by preventing an error from occurring or by identifying sensitive areas for error, so it is not going to transform into a defect. It helps minimize the costs of inspection for defects and rework into later stages of the process.

Kaizen (Continuous Improvement)

Kaizen is a lean manufacturing strategy for continuous and incremental improvement of the processes and can be used as a strategy for any activity that needs improvement. It uses the Plan – do – check – act method and a kaizen event is a rapid improvement in a specific activity or process. In the Kaizen events all employees work collaboratively to analyze the problem and brainstorm for the appropriate action and usually it takes five days, but it can also be used for larger improvement projects.

Kanban (Pull System)

The Kanban systems is used for achieving JIT and is an automatic replenishment system. This pull system reduces inventory and overproduction by maintaining inventory levels and sending a signal when replenishment is needed. Furthermore, visibility for suppliers and buyers is added in the supply chain.

Visual Factory

The visual factory aims to a real time monitor and control of all processes. With visual factory enabled by automations, sensors, information systems etc. metrics at each stage can be gathered and processed improving information flow throughout the facility and enabling error, problem detection and processes in need of improvement.

KPIs (Key Performance Indicators)

Key performance Indicators is not only a “lean” tool. KPIs are quantitative metrics, set to provide an overview and monitor activities’ and processes’ performance. KPIs should be carefully designed and picked to represent critical goals.

Jidoka (Autonomation)

Jidoka is an effort for partial automation in the manufacturing process with two characteristics. When a defect is detected the process automatically stops. And the second characteristic is that jidoka workers are monitoring stations. The consequences of these characteristics are the quality improvement and the labor costs reduction.

Andon

Andon is a tool enabling visual factory and automation. It is a real time communication tool providing feedback for the production status and draws attention when problems occur. An Andon can include mistake proofing systems. This way when an abnormality occurs in the process, the process stops, and key metrics are constantly compared with the targets.

2.1.4 Integrating Six-sigma and Lean into the Lean Six Sigma Method

Both Lean and Six Sigma are the leading Continuous Improvement Methods (CI) in many industries. The integration of those two methods is the Lean Six Sigma method by many considered more of a philosophy rather than a method. Tony Bendell argued about the compatibility of those two methods stating, "*In reality there are practical examples of incompatibility and even conflicts between the approaches that have led to suboptimal processes and process improvement programs*"(Bendell, 2006). Six-sigma aims in the extinction of variations, boost of quality with a more sophisticated and structured approach with statistical tools and software, whereas "lean" has a more simplistic approach with more qualitative techniques and targets to minimize wastes and enables a more customer oriented point of view for the products, services and processes.(Bendell, 2006; Salah et al., 2010) The common ground of those two methods is the wastes and a cross-over of tools. This crossover is presented in the figure 8.

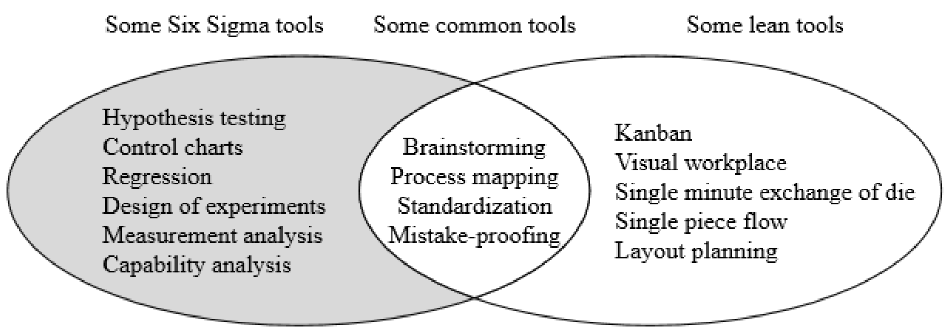


Figure 8, An example of Six Sigma and lean common tools, source:(Salim and Yadav, 2012)

Bendell's statement is argued by many, and several different approaches, theories and actual implementation have been proved and had successful outcomes. More and more companies are establishing LSS programs, and the complimentary relationship of those methods is acknowledged by academics and the market. Of utmost importance for the successful implementation of such integration is the simultaneous usage of both methods with the same importance instead of parallel, or an unequal mixture of those two. Otherwise, the danger of suboptimal solutions as Bendell realized, are more likely to occur. The most appropriate description of Lean Six Sigma is from the Salah's paper published at the International journal of Lean Six Sigma, *"LSS can be described as a methodology that focuses on the elimination of waste and variation, following the DMAIC structure, to achieve customer satisfaction with regards to quality, delivery and cost. It focuses on improving processes, satisfying customers and achieving better financial results for the business*"(Salah et al., 2010). The most suitable way to incorporate six sigma and lean simultaneously is by using the DMAIC approach from six sigma and mixing in all stages tools from both CI methods as needful. (Furterer, 2014; James W. Martin, 2013; Salah et al., 2010). Although, there are no indications of only one approach for the mix of the methods as the most recognized, this the most used. Thereinafter, an approach of integration of the methods is elaborated with the DMAIC method in the Table 2-7 (Arnheiter and Maleyeff, 2005; Furterer, 2014; Hambleton, 2008; Salah et al., 2010).

Table 2-7: Lean Six Sigma Method and Tools

LSS Project Phase	***Lean Six Sigma Tools***
Define	Development of project chart and financial and stakeholder's analysis takes place. Afterwards SIPOC is used to understand the VOC and the CTS. At this point is important to introduce the process mapping or the value stream mapping to identify wastes and potential spots of low performance. Decision for the appropriate tools and data to gather, while making hypothesis for value adding and non-value adding activities. Finally, a project plan is set.
Measure	The next step is to examine the current state of the process, identify wastes; venerable; problematic stages. Then translate the poor quality into financial measurements; selection of the needful metrics; gathering

	of data and measurement execution again using all tools of the measure phase of six-sigma.
Analyze	Analyze all metrics and data with the statistical tools; analyze non-value adding activities, steps and processes that can be removed and analyze wastes which can be minimized; analyze the current state of VSM and use kaizen method to spot opportunities for quick improvements
Improve	In the improvement phase the discussed solutions are tested and the most optimal one is finally implemented, sometimes even through kaizen events.
Control	In the control phase the main activity is monitoring the improved process to sustain the improvement and timely detect any disruption by using different SS statistical tools such as Control Charts and KPIs and Poka-Yoke from the lean toolset

2.1.5 Lean Six-Sigma applications and method limitations

The Lean Six-Sigma method is widely used in many different industries and over the years more and more companies are incorporating the LSS mentality into their companies, many times without even realizing it. The LSS projects are executed by project teams with Black Belts, Green Belts, Yellow Belts and other team members as the six-sigma projects. LSS applications are identified apart from the manufacturing industry and the production in the public sector, in the banking and financing sector, healthcare, shipping, and generally in the supply chain management. Applications have been implemented in the agriculture, construction and energy industries as well. Some of those companies, international and national are presented in the following figures 9 and 10. In the following chapter LSS in the supply chain management is examining in depth.

Figure 9, International Companies applying LSS projects, source: lssbei.com

Figure 10, Greek and International companies applying LSS projects, source: ivepe.gr

While the market demonstrates the beneficial results of the LSS philosophy when applied in companies across industries, researchers discuss about the methods limitations. The importance of identifying and understanding and even finding the limitations of the method lays on the fact that when knowing the vulnerabilities of a method you can find solutions to evolve it and increase its robustness. For this thesis is important to point out the methods limitations and critical success factors for LSS as the goal is to discuss how technological discoveries and applications of Industry 4.0 can be incorporated into the supply chain model of a company to enable LSS applications and integrate it even more. For the successful implementation of LSS as George, Rowlands and Castle (2004) defined four characteristics from which success factors for LSS application and LSS barriers derive.

- Data and fact-based decision making
- Extreme human resources exploitation and cross functional team working
- Improvements by waste, variation and defect reduction and boost of flow in the processes
- Customer demand satisfaction, speed and quality

In those four objectives and separately in the Lean, Six Sigma methods some challenges are reveled. As LSS is the integration of those two methods, it inherits both the abilities and limitations of each.

Starting with the Lean, it is considered to be an expensive method mostly because of the required human resources to implement such a methodology in a firm (Fullerton and Wempe, 2009). In addition to being expensive, it is also considered to be more suitable and applicable for high volume productions and internally into the firms. This implications for example create a problematic situation for the extended supply chain, implying that is unsuitable for such projects. Specifically, for the supply chain implementation the problem identified was the lack of trust between the various parties of supply chain. In other words, not only the low volume but also the lack of transparency played a key role in the unsuccess of the lean improvement. Moreover, lean approach is suitable for less volatile and more stable situations and markets (Cox and Chicksand, 2005). The limitations for the supply chain are thoroughly examined in further chapter.

On the other hand, six-sigma inherently carries limitations due to its very structured and data-oriented nature. Many researchers advocate the opinion that six-sigma techniques must be cautiously reformed to be implemented beyond manufacturing processes and that there is little proof of success in other fields. Six-sigma uses statistical measurements extensively and it is a challenge to transform in other fields quality characteristics in quantifiable and measurable metrics and data. Researches has also shown the low achievement of including all employers in the improvements, meaning that not all ideas are heard and innovation is diminished instead of accelerated (McAdam and Lafferty, 2004). Another limitation is that is a very structured method with expensive projects.

Finally, from understanding the four factors of success it easy to assume that limitations for an LSS implementation is the lack of data or access to them, unorganized data, or difficulty in translating information into manipulated data; the high cost of training Black, Green Belts and passing down to all employees the LSS philosophy and the way that improvements in processes are made with upper and lower limits and variation which might be difficult to implement in services and other industries.

2.2 Supermarket Supply Chain Management and Industry 4.0 technologies

2.2.1 Supermarket Supply Chain Management

2.2.1.1 Introduction to the Supermarket and the retail industry

The retail industry is the last stop of the supply chain. Retail is the process of selling commodities, products, and services to the consumers. Consumer Goods and Products is a sector of the retail industry with one of their main retail channels being the Supermarkets and the Grocery Shops. Nowadays, the retail industry is facing challenges with the need for agility being imperative for the industry's sustainability.

Supermarkets and Grocery Shops are selling a variety of products that can be categorized in perishable produces (i.e., fresh products, foods, dairy products, fish, meat, baked goods etc.), non-perishable produces (i.e., frozen food, canned items etc.), non-food items such as household products, cosmetics, over the counter products and other consumer goods. Each product has a unique identifying number called SKU and according to the Food Marketing Institute, on average a supermarket has 15,000 to 60,000 SKUs. Apart from the significant amount of SKUs which is already hard to handle, all these different products have different customer demands, vendors, expiration dates, values, maintenance requirements etc. But all products have one thing in common; they need to be available at any time for the customer in the best quality at the lowest cost. That is the objective of the supply chain management of a Supermarket.

2.2.1.2 Structure of a Supermarket Supply Chain

The Supply Chain is the cumulative network that incorporates all the steps from suppliers to the distribution until the products and services arrive to the consumer (end-user). It consists of different entities, people, information, processes, activities, and resources. From many the supply chain is considered as the combination of money's flow, goods' flow, and information flow between all stakeholders. The stakeholders involved in the supply chain of a supermarket are the producers, the manufacturers, the wholesalers, the vendors, the distributors, third party logistics companies and finally the retailers in which case are the supermarkets. The supply chain also involves warehouses, transportation, Distribution Centers, retailer's warehousing in the stock and shelves. To better understand the retail-supermarket supply chain there are several important definitions. Figure 11 presents a simplified multilevel retail supply chain.

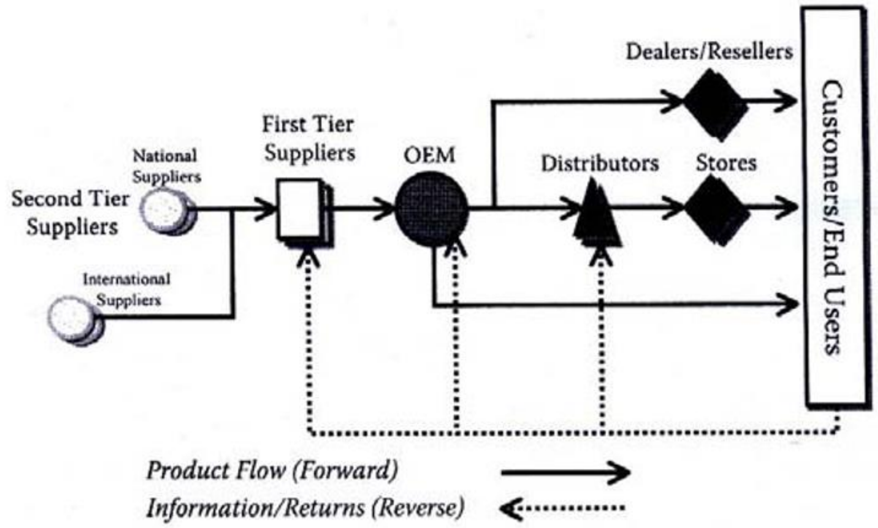
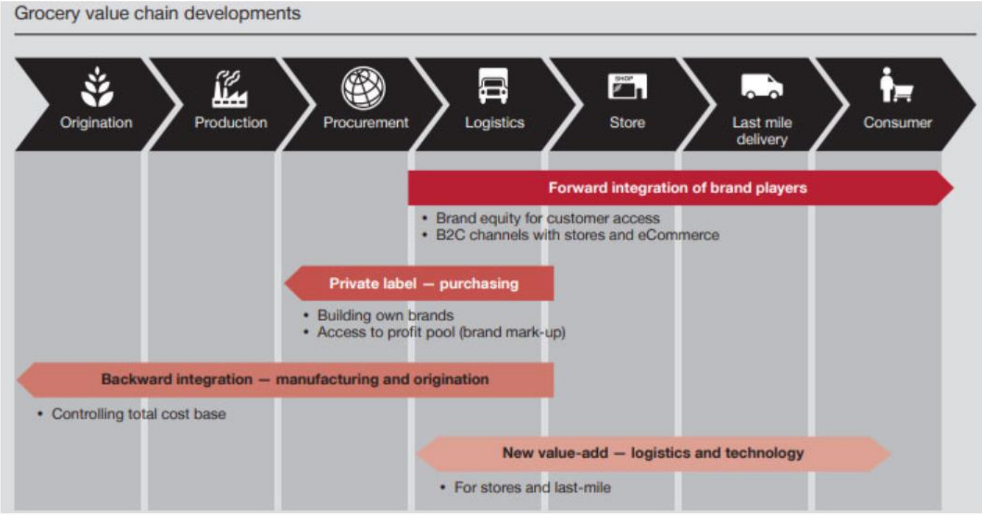


Figure 11, Overview of a Retail Supply Chain, source:(Ayers and Odegaard, 2007)

Each level of the supply chain is called echelon. All the operations proceeding an echelon are upstream operations, and all the following operations are downstream. A supply chain can be either vertically or horizontally integrated. Vertical integration can be forward or backward. Vertical integration is the merging of businesses that are in different echelon, different stages of the supply chain (Ayers and Odegaard, 2007). For example, a supermarket can acquire or participate in a private milk brand, in the sourcing or the production, that is a backward integration. Supermarkets are the ending point of the supply chain, thus can only become backwards integrated. Hence, backwards integration is the ownership or the participation in upstream operations of the supply chain and accordingly forward integration is the ownership or the participation in downstream operations of the supply chain. The combination of both types of integration is called balanced integration. For the supermarkets, the vertical integration of the supply chain provides transparency and better monitoring of the quality of products and reduces costs in the distribution. For example, Morrisons a UKgrocer has established a vertically integrated supply chain by obtaining a variety of fresh and chilled products (Ayers and Odegaard, 2007)(article, 2020).



Source: Strategy&, part of the PWC network

Figure 12, Examples of vertical integration in the supermarket supply chain

Every retailing company has its own supply chain, and the supply chain management is one of the most important business processes where many costs occur, and value is added to the products. In every step of the supply chain several processes and different activities is taking place. Through these processes the flow of product, money and information is realized, and resources are used such as employees, information systems, materials, equipment etc. The coordination, design, improvement, and strategy plan deployment such as the level of integration of the supply chain are part of the supply chain management.

Supply Chain Management

The Supply Chain Management is the task of designing, maintaining, improving, and operating the processes included in the supply chain to deliver value to the customers. Some of the tasks that a supply chain manager has to overview are presented below (Ayers and Odegaard, 2007; Nikoličić et al., 2015; Rana et al., 2014).The challenging part of the supply chain management of a supermarket is the combination of handling several stores and numerous suppliers and products. The supply chain management of a supermarket is very vital as it deals with highly perishable products, with very volatile demands and customer preferences on prices and tastes and at the same time it is in a very intensely competitive industry (Boyer et al., 2003).

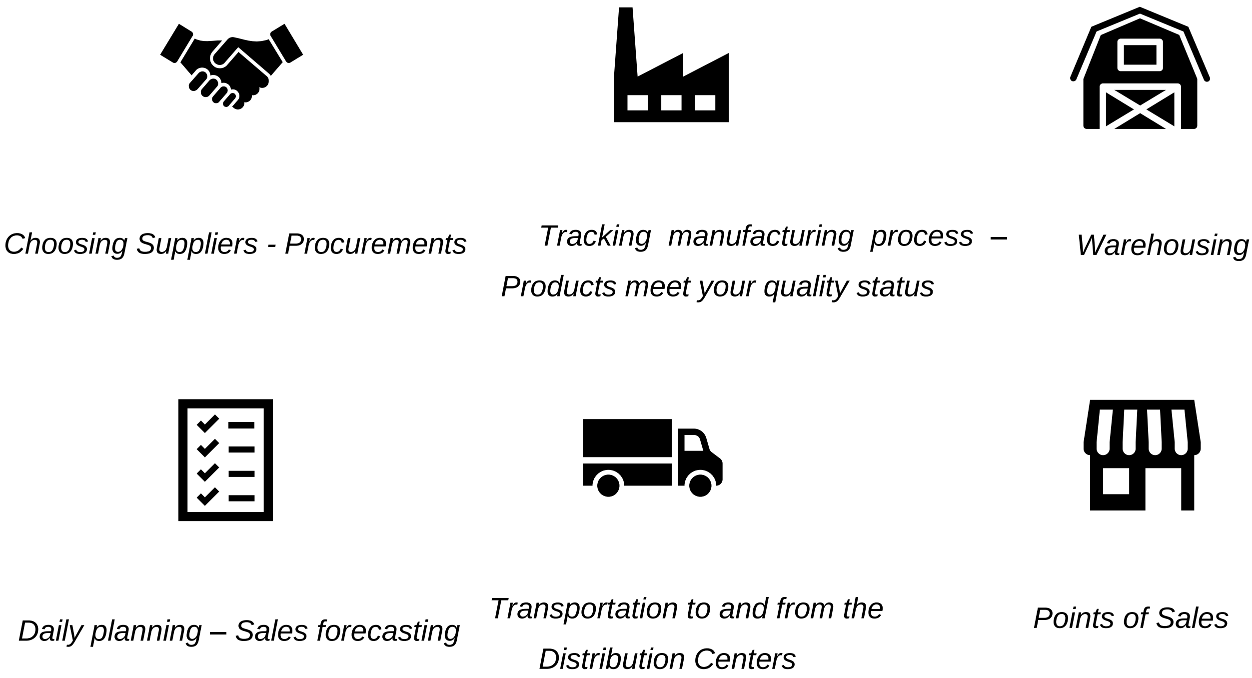


Figure 13, Basic Supply Chain Processes

The first step for an efficient and effective supply chain management is to create a clear picture of the existing supply chain and the process mapping. Figure 13 represents some basic supply chain processes. A common tool for capturing in a high-level image of the retail supply chain which spreads through various companies is the Supply Chain Operations Reference Model (SCOR). Then each supermarket chain designs its own Supply Chain Reference Model according to their business strategy. Figure 14 is an example of a basic SCOR for Supermarkets. The figure includes the basic stakeholders of the retail supply chain, the origination of the raw materials such as milk, which is the first tier, the processing, packaging, and labeling, which is the manufacturer, the distribution companies, which are the intermediaries between retailers and manufacturers such as vendors, the supermarkets and the end user, the customer. The supermarkets usually own distribution centers for the consolidation of the products. There are three main channels for distribution in the supermarket supply chain, the centralized delivery, the direct-store-delivery (DSD) and through a wholesaler (Pramatari and Miliotis, 2008) . The basic actions between the stakeholders are stock, order and produce. For example, there is the replenishment order from the store to the distribution center and the replenishment order from the distribution center to the distributor etc.

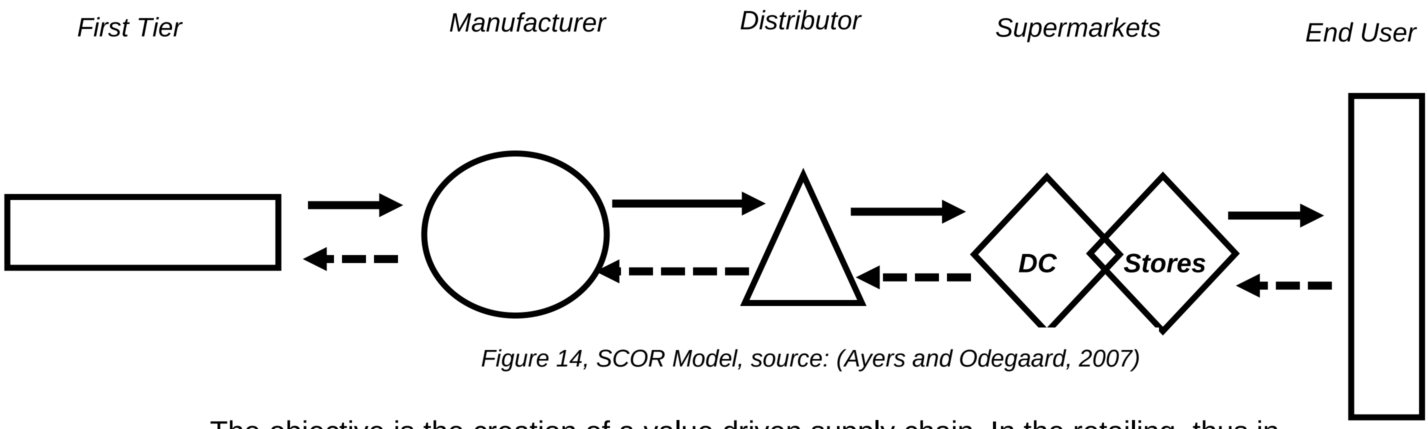


Figure 14, SCOR Model, source: (Ayers and Odegaard, 2007)

The objective is the creation of a value driven supply chain. In the retailing, thus in the supermarket there are different approaches on how a supermarket's supply chain should be built. The basic structure as shown in the previous figure. The supermarket collaborates with many vendors for an array of products. These products are collected in distribution centers and then transferred to stores, where customers buy them. This is the characteristic difference of the retail supply chain to a manufacturing supply chain. In the case of supermarkets, the end user visits the store, hence, the store and the way the products are handled in the store is a part of the retail supply chain. The procured supplies change ownership from the supplier to the retailer according to their agreement. In most case, the change of ownership occurs when the supplies arrive at the warehouse of the supermarket or the distribution center. Then, transfer to the points of sale is made by either third party companies or is managed by the retailer (Rana et al., 2014).

In order to design the supply chain reference model is important to understand all the parts of the supply chain. Often logistics are wrongly considered as the supply chain although they refer on the transportation and distribution of the products and it is one part of the supply chain. For many industries and specifically for the retail industry, the logistic processes although it is always linked to the supply chain, they are separately managed. By separately managed is meant that there is a whole team focusing on logistics, logistic strategies and logistic processes improvement. Logistic strategies incorporated by Supermarkets are Vendor Managed Inventory (VIM), Continuous Replenishment (CR) and Efficient Consumer Response (ECR). For the implementation of such strategies various initiatives and innovative methods are designed in the retail and supermarket industry (Ayers and Odegaard, 2007; Nikoličić et al., 2015; Rana et al., 2014)

The structure of the supply chain processes, and the logistic processes depends on trading characteristics (i.e. trading methods and products); geographic characteristics (i.e. distribution of stores in the country and morphology of the country); type and relationships with the products' suppliers and all supply chain participants and the level of IT deployment of each participant (Nikoličić et al., 2015). The supply chain model should include all these processes, resources and all the flows.

As mentioned before the objective of the supply chain management is to offer the customers high quality products, when needed at a high quality and low cost and at the same time offer the company a competitive advantage over the competitors. Hence, innovation and integration of the supply chain is required and to achieve this goal new technologies and trends are always investigated.

2.2.2. Disruptive Technologies, Trends and Industry 4.0 in SCM of Supermarkets

2.2.2.1 Consumer Trends in the Grocery Industry

The construction of a data-driven and consumer centric supply chain requires a profound understanding of the evolving consumer behavior and expectations. Although, the consumer behavior is still changing, expectations are rising from year to year (Begley et al., 2020). Consumers now are able to compare prices between retailer, drawn to low cost, discounts but at the same time are willing to pay higher prices for better quality and transparency (Kuijpers et al., 2018; Vallandingham et al., 2018). The last years, a shift has been observed to all natural, minimally processed, healthy products and overall wellness. Major food safety scandals also increased the expectations for traceability of the products life cycle from raw materials to processing and distribution and the provenance of goods. Other consumer preference and behavior is towards environmental impact, social responsibility of the Supermarkets and the products, sustainability and animal welfare (Begley et al., 2020; Franck and Nemes, 2018; Kuijpers et al., 2018; Vallandingham et al., 2018). The vast number of consumers can be grouped in two segments with distinctive characteristics, the millennials and the baby boomers. The millennials constitute the largest customer segment and according to UK surveys are tech-savvy grocery shoppers seeking for healthier choices, extra flexibility, seamless and online shopping. On the other side there are the baby boomers comfortable with technology, health, and wellness aware and preference in in-store customer services. Both categories are chasing convenience and faster delivery time (Kuijpers et al., 2018; Vallandingham et al., 2018). Market research from various consulting companies showed the rising trend for pre-packaged food and e-grocery. While, e-commerce altered consumer shopping behavior, e-grocery is still growing with projections expecting the percentage of e-grocery usage from 3% to greater than 10% by 2025 (Begley et al., 2020). The consumers expect all these requirements to be met while prices stay the same or even lower. Understanding the consumer behavior and preferences creates a clear picture for the future shape of the supply chain. The important part is discovering how the supply chain can be integrated to deploy the new strategies and new technologies are the main enabler for such transformation.

2.2.2.2 Enabling Technologies

Industry 4.0 is changing the shape and business model across industries minimizing costs, boosting effectiveness, quality, and productivity. Retail and more specific Consumer Goods and Products and Supermarkets are some of the industries that already are trying to adopt it. Industry 4.0 involves a holistic approach to a company's value chain and lean transformation.

Digitalization of Products and Services

- In store apps – Augmented Reality
- Data – Backed Decision Making
- Cloud Based Platforms
- Automated identification and data collection
- Ad hoc mobile planning
- Granular clustering of customers
- Personalized customer experience

Digitalization and Integration of the Supply Chain

- Smart Contracts and Smart Procurements
- Autonomous Logistics
- Smart Logistics
- Wearables
- Smart Warehouse
- Data – Backed Decision Making
- Cloud Based Platforms
- Intelligent Forecast
- Rout and freights cost optimization
- RFID

The implementation of Industry 4.0 in this industry involves two key parts, digitalization of products and services; and digitalization and integration of the supply chain. State-of-the art technologies such as Internet of Things (IoT), Cyber-Physical Systems (CPS), Information and Communication Technologies enable this transformation. In this section an overview of the main technologies that potentially can find applications and accelerate innovation in the supermarket supply chain is provided(Bag et al., 2018; Garay-Rondero et al., 2019).

Industry 4.0 is not a new concept, autonomous logistics, augmented reality and all the technologies that are incorporated in this era are not new concepts the technology needed to back them is what really has changed and now enables Industry 4.0 to become a reality and to be adopted in many industries. Smart contracts, seamless technologies, sensors all need the same infrastructure:

- ✓ Cloud Computing
- ✓ Fog Computing
- ✓ Internet of Things
- ✓ 5G Network
- ✓ Blockchain

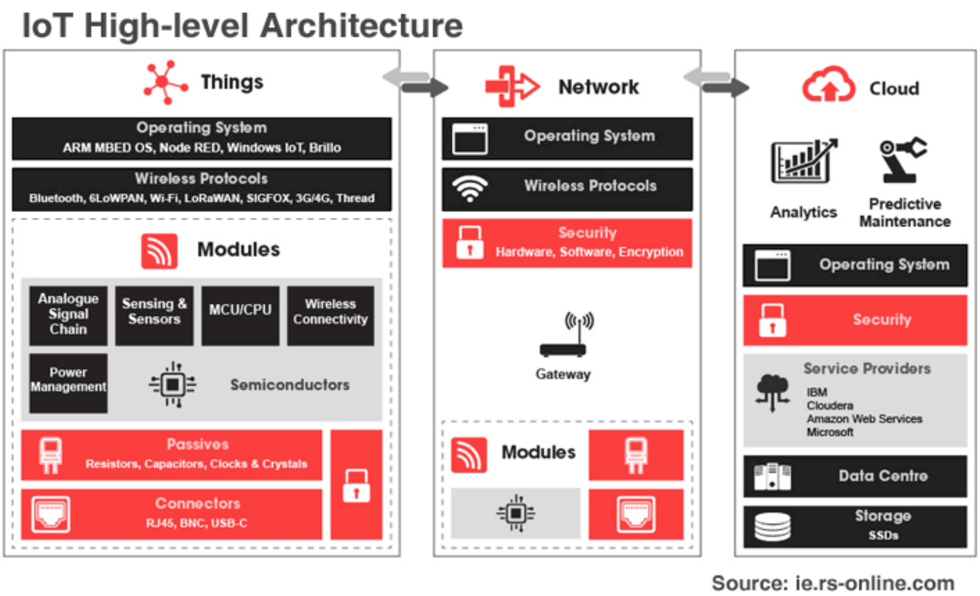


Figure 15, IoT high-level Architecture, source:ie.rs-online.com

There are still challenges in connectivity and information exchange among different machines, units, locations and across the various firms and entities involved in the value chain. Some of these challenges are security, trust, reliability, traceability, and better integration of the value chain but still these disruptive technologies are aiming to solve these problems and transform the traditional methods to the digitalized and automated ones. In figure 15 an IoT high-level architecture is presented. Table 2-8 provides a summary for the needed infrastructure and the described applications.

Table 2-8: Infrastructure for innovative application

Infrastructure Layer	Description	Application Layer
Cloud Computing	*Computer system resources for data storage and computing power without direct active management by the user, data centers over the internet with sometimes distributed functions*	• *Data-Backed decision making* • *AI* • *Forecasting*
Fog Computing	*Implies distribution of the communication, computation, storage resources, and services on or close to devices and systems in the control of end-users, data storage, complement to cloud computing to reduce latency*	• *Data-Backed decision making* • *AI* • *Forecasting*
Internet of Things	*A system of interrelated computing devices, mechanical and digital machines, objects, animals or people that are provided with unique identifiers (UIDs) and the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction*	• *M2M communication* • *Sensors* • *Smart logistics and warehouse* • *Augmented reality*
Blockchain	*Enables group of entities to reach an agreement on a certain activity and register that agreement without the need of a regulatory authority. Their agreed upon activities are registered, secured and shared among all parties using blockchain, it uses peer-to-peer networks and cryptography to support distributed shared ledger among the entities*	• *Cyber security* • *Smart contracts, smart procurement*
5G	*Advanced wireless technology*	*Supports the IoT*

From an extensive literature review, including journals and business articles, the most prominent technologies for further deployment in applications for the supermarket supply chain are presented below:

AI and Machine Learning

AI is defined as machines doing what humans do. In practice, AI refers to narrower tasks, such as pattern, speech, or image recognition, that once were processed through human intelligence. Machine learning (ML) is a discipline within AI research that deals with learning improvement based on data. (“Artif. Intell. Mach. Learn. to Accel. Transl. Res.”, 2018; Weber and Schütte, 2019).

Big Data Analytics

Big data analytics is the use of advanced analytic techniques against very large data sets that include structured, semi-structured, and unstructured data, from different sources, and in different sizes counting from a few terabytes to hundreds of thousands of petabytes or even zettabytes. Using these advanced analytic techniques organizations extract hidden patterns, unknown correlations, market trends, and customer preferences that can help make informed business decisions (Big Data Analytics - IBM, 2020)

IoT – Internet of Things

The Internet of Things (IoT) describes the network of physical objects - “things”-that are embedded with sensors, software, and other technologies for the purpose of connecting and exchanging data with other devices and systems over the internet. Simply put, IoT is devices that talk with each other over the internet (Ding et al., 2020).

CPS – Cyber Physical Systems

Cyber-Physical System has become the key infrastructure supporting the development of industry 4.0. Cyber-physical systems, or in particular, networked control systems (NCSs), are the feedback systems where the system components are spatially distributed and connected through communication networks. Examples of such NCSs include cyber-enabled manufacturing, smart grids, and water and sewage networks (Niu et al., 2019).

RFID

Radio-frequency identification (RFID) is a key technology that uses uses radio-frequency waves to transfer information between tagged objects and readers without line of sight, providing a means of automatic identification. In recent years RFID tags became more cost efficient broadening their application in the retailing (Bardaki et al., 2012).

Computer Vision

Computer vision is a field of Artificial Intelligence that allows computers to understand images and videos to extract valuable information. It is used in multiple industries varying from self-driving cars to monitoring the health of crops, or even in the health industry by using CT scans and MRI data to detect and analyze abnormalities and diseases (Vallandingham et al., 2018).

Wireless Sensor Network (WSN)

Wireless sensor networks have evolved from the idea that small wireless sensors can be used to collect information from the physical environment in different situations wirelessly transmitting this information toward a base station (Vasseur and Dunkels, 2010).

Machine to Machine (M2M)

Machine to machine describes the interaction of billions of devices and machines that are connected to the internet and to each other. These physical objects integrate computing capabilities that enable them to capture data about the world around them and share this with other connected devices, creating an intelligent network of 'things' or systems. Connected devices collect information about every point of business – from product development, manufacturing, supply chain right through to point of sale – which can be used to identify and eliminate points of inefficiency.

Augmented Reality (AR)

AR is the real time interaction between computer-generated objects and real-time environment. AR tries to replicate the sense of reality. Currently, AR technology is incorporated in AR devices and apps (Rese et al., 2017).

Robotics and Automation

Automation uses software, machines and other technologies to complete tasks that used to be executed by workers and it can be mechanical or virtual automation. Robotics is an engineering field creating robotic machines to execute tasks (Owen-Hill, 2017). Automation and Robotics Engineering is the use of control systems and information technologies to reduce the need for human work in the production of goods and services.

Refrigeration Technologies

Regarding refrigeration technologies, smart fridges and automations in conditions have been achieved the recent years. That enables a better energy usage for refrigeration and HVAC systems.

The constant changes in consumer behavior and the technology advances indicate an upcoming disruption in the retail business. The digital disruption is not leaving untacked any industry and that means that if the value chain needs to evolve. As mentioned before these technologies can accelerate the innovation and the transformation in the supply chain to make it more efficient, robust, and competitive.

2.2.2.3 Applications in the supermarket supply chain

The supermarket supply chain is constituted by many components and processes. All the advanced technologies find application in different areas of the supply chain. In order to provide a clearer picture of potential applications in the supermarket, they are presented for each area.

Many of the new concepts analyzed in previous sections are incorporated in many different levels of the supply chain. Considering that the logistics department could be break down into seven major processes:

- Purchase merchandise – Procurements
- Transportation – Distribution
- Warehousing
- Set up and Execute replenishment
- Forecasting – Goods ordering
- Goods Handling
- Serving Customers

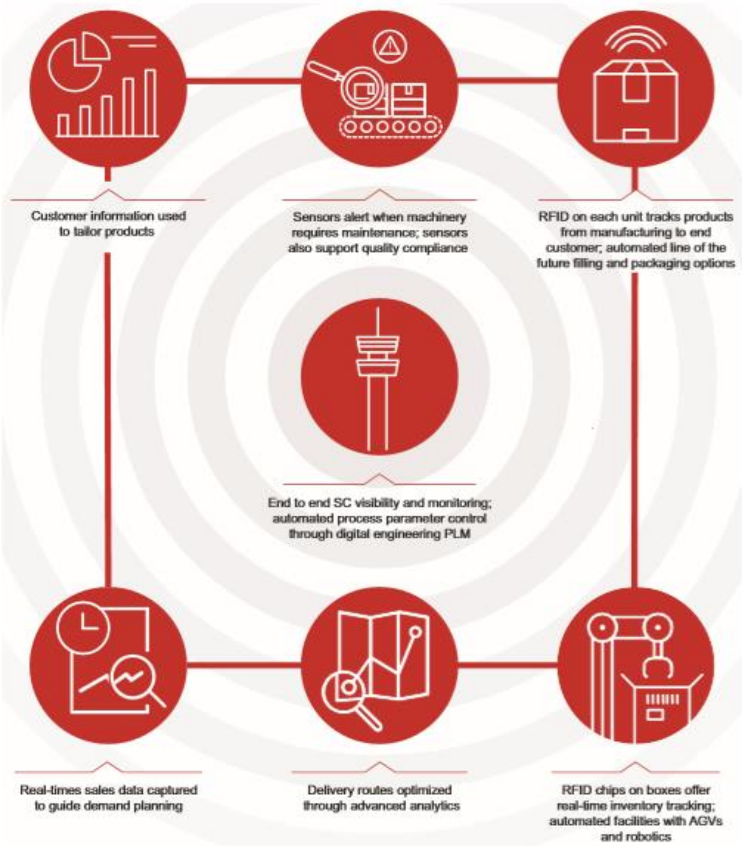
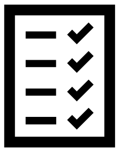


Figure 16, Enablers for digital supply chain, source:(Tompkins, n.d.)

Purchasing Merchandise – Procurement



Purchasing merchandise, fulfilling the procurement process and selecting suppliers is a time-consuming process in the supply chain management occupying personnel and hiding risks. New technologies improving this process by making e-procurements and smart contracts feasible. Especially, the blockchain technology enables the smart contracts providing transparency, accuracy and reliability between the stakeholders. With smart contracts a e-procurements the payment process is automated and when the contract requirements are met, and the products arrive at the distribution center or the warehouse at the quality agreed automatically the payment is settled. In case the quantities changed, or the requirements aren't met the payment is updated automatically, meaning errors and personnel intervention is reduced and contracts are executed digitally. At the same time all the participants are aware, and changes are visible, secured and authorized creating digital trust (Ding et al., 2020; Sheel and Nath, 2019; Wang et al., 2019). The adoption of web-based tools in the procurement process allows organizations to either reduce transaction costs or improve internal procurement process efficiency, or even increase collaboration with vendors (Nicoletti, 2013). Blockchain allows all trading parts to share documents, transactions data in a fast and secure way providing standardized and high-quality documentation (Sheel and Nath, 2019). In the supplier selection process, artificial intelligence and machine learning allows the organization to improve decision-making with real-time data, taking into account different factors and not only prices. For example, after considering weather conditions and perishable products origin and life cycle the supplier with the best product quality can be recommended (Irfan and Wang, 2019; Weber and Schütte, 2019).

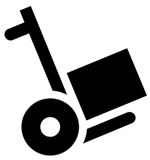
Transportation – Distribution

Transportation and distribution of the products is one of the main costs in the supply chain management. In recent years, efforts from various retailing companies managed to reduce these costs associated with the transportation process by incorporating several new technologies. Still, there are many logistic challenges and opportunities for the supermarkets for further exploitation of state-of-the art technologies (Kumar, 2008). Utilizing technologies such as IoT, blockchain, RFID, Big Data analytics, AI, Machine learning, GPS, WSN and cloud computing the field of smart logistics accelerated with new blooming capabilities and applications for Intelligent transportation and Smart freight. Intelligent transportation systems provide better transportation and traffic management empowering the rout planning with real-time traffic data, constant monitor and tracking, hence trackability, efficacy and optimization is added. Simultaneously, these systems increasing utilization of trucks with better planning and make last minute changes less risky. Smart freight includes rout tracking, conditions monitoring with sensors and the Electronic Product Code in the RFID with all product and transportation process information sharing real-time logistics information through cloud computing, shared data bases and software to distributors, logistic companies, and supermarkets. These systems transform the logistics processes to fully traceable processes, minimizing errors, deterioration of perishable products, labor time, discrepancies and guarantees products' quality (Ding et al., 2020; Vallandingham et al., 2018; Weber and Schütte, 2019).

Warehousing

Warehousing can be break down in the sub-processes, ordering fulfillment, storage, storage allocation, storage receiving, order picking and truck loading (Ding et al., 2020). Again, warehousing is an area with plenty potential applications, some of them already used in big retailing companies. Automation in warehouse has many applications reducing labor time, work accidents and improving cost efficiency. One of the automations is regarding loading and unloading activities which can be executed with robotics. Robotic transportations of products can execute the sorting, packing, storage and picking activities. A simpler method is via smartphone applications or smart glasses guiding personnel and speeding up the processes with the combination of RFID, sensors, IoT, M2M technologies. Wearable devices for employees can boost ergonomics and provide accurate data to further understand vulnerabilities of the processes. Everything in the warehouse is integrated in an intelligent entity and creates a M2M communication network feeding the Warehouse Management System with real-time data, high accuracy and visualization creating strong fundamentals for Replenishment, Ordering and Inventory Management. Temperature, humidity, light sensors monitor the storage conditions and then storing and sharing these data to control centers. The conditions can be altered if needed either automatically or with human intervention from the control centers. Furthermore, big data analytics can manipulate these data sets and provide useful intel for the products' quality and help to expand the shelf life of the products. These technologies apart from efficiency they provide standardization of the storage environment and detailed documentation (Ding et al., 2020; Garay-Rondero et al., 2019; Vallandingham et al., 2018). The automated short-halt delivery service with driverless trucks with GPS tracking, drowns and sensors is the future of distribution, while wearable devices can not only improve the safety of the employees but also their effectiveness by telling the exact spot of the storage unit and providing hands free guidance and much quicker training (Ding et al., 2020; Garay-Rondero et al., 2019; Vallandingham et al., 2018; Weber and Schütte, 2019).

Replenishment



Replenishment optimization is another area that has drawn the attention and several strategies are facilitated by supermarkets to balance inventory, transportation costs with the risk of being out of stock. As mentioned before there are three different distribution channels with the centralized delivery having the lower lead times but low order accuracy at the same time. Replenishment strategies such as Continuous Replenishment and collaborative planning forecasting and replenishment (CPFR) are already used in the supermarkets but not fully efficient. New breakthrough technologies can improve drastically these systems (Pramatari and Miliotis, 2008). New applications with smart shelves and electronic shelf labels are developing aiming to provide knowledge on when goods need replenishing, how many goods are on the shelf. Shoppers can scan the products triggering inventory alerts for replenishment even before they arrive to POS. Alongside RFID and software real-time inventory management and visualization for stock and orders running will be available at all times. Moreover, shelf space improvements are implemented to reduce shelf replenishment. The main breakthrough for efficient replenishment is due to machine learning and AI by analyzing huge data sets while considering multiple factors instead of only historic data. With AI just in time, pull replenishment is almost achieved. Apart from the fact that predictive applications have higher rates of success in forecasts and orders accuracy, they also are able to make decisions based on strategic goals of the chain and KPIs while also can generate recommendations on capacity planning and staff scheduling in the distribution centers. (Glatzel et al., 2016; Hübner and Schaal, 2017; Kumar, 2008; Vallandingham et al., 2018; Weber and Schütte, 2019).

Forecasting – Goods Ordering

Increased access to data and computational capabilities improved decision making. Dynamic pricing of goods in another application already applied in services such as booking airplane tickets etc. Now it can be applied in groceries. Dynamic price in groceries can be implemented either by changing prices according to demand or product quality. For example, with machine learning it is easy to predict demand changes on certain products in hot or rainy days and price them or order them accordingly. Same thing applies with all the information for the origin, transportation and conditions for the products, thus determine their quality and price them to reflect that. Forecasting can be used as well to understand consumer preferences and create projections for the demand. Artificial Intelligence, cognitive solutions and machine learning models can effectively analyze and use the large amount of data providing accurate and realistic solutions. After fully modeling the entire network, analyzing all data from cloud platforms, social network trends they can provide what if scenarios about potential risks, inventory, orders and so (Garay-Rondero et al., 2019; Weber and Schütte, 2019).

Goods Handling

Certain technologies brought new ways in goods handling, in-store and in reverse logistics. Refrigeration technologies, sensors providing continuous monitoring and adjustments for reducing the energy consumption and set the appropriate conditions to expand the shelf life especially for perishable product (Kumar, 2008). Intelligent cameras measure fruits and vegetables and with machine learning the decide for the quality status and life expectancy of the products (Vallandingham et al., 2018). Regarding reverse logistics which mainly apply for non-food, non-perishable products, green procurements measure the carbon footprint and environmental impact of the company while tracking the product history from raw material to recycle motivating companies to adapt reverse logistic strategies (Rane and Thakker, 2019a) (Begley et al., 2020; Vallandingham et al., 2018). Another area if good handling which can be optimized with new tech-applications is the manual planning of the layout in the store and the shelf which very time consuming. McKenzie characteristically states, " *The typically tedious practice of drawing planograms across different store formats and floor plans can be swapped for smart planograms that adjust for microsegments, which will enable faster and more granular inventory management* "(Begley et al., 2018).

Serving Customers

In store experience and service is the last mile of the supermarket supply chain. By optimizing this experience, customers are converted into loyal customers and their purchases are increased. Creating a smart store is a new trend alongside e-grocery. Customer interfaces, applications, electronic shelves labels, self-checkout, usage of the smart phones and online delivery services are some implementations of various companies not only for better customer services, data collection but also for better forecasting and replenishment. One application is floor sensors identifying and analyzing customers' walking habits, for example how fast the walk in certain aisles, where they stop, what they avoid. All these data can support better in-store layout. Smart carts with in-cart scanners provide self-check-out. Smartphone applications with customers profiling combined with augmented reality creates new capabilities for customers, such as informing them while walking in an aisle for sales, suggesting them items according to items already picked and even helping them create a shopping list for perishable products. For instance, with mobile applications and machine learning when a customer buys milk according to previous patterns on how often he purchases this item an automated list is created and ready for him to submit it and then go to the store to pick-up the items. Future usage of the state-of-art technologies can incorporate drones for last mile delivery for customers that prefer online shopping of their daily products (Begley et al., 2020; Garay-Rondero et al., 2019; Kumar, 2008; Weber and Schütte, 2019). Finally, e-grocery and omni-channel strategies is the new trend in retailing and grocery to provide customers with premium customer experience (Cain and Paratore, 2019).

2.2.2.4 Market Trends and Innovations

Many applications, initiatives for digital transformation and other innovations in the retail supply chain are already implemented by many companies and have surpass the conceptual level.

Most consumer goods companies, Supermarkets and Grocery shops (as much as 88%) are thought to be already experimenting with at least one of these technologies, recognizing that they will likely form a core part of their businesses in the post-digital era. In the figure 17 retailing companies experimenting with AI solutions are shown.

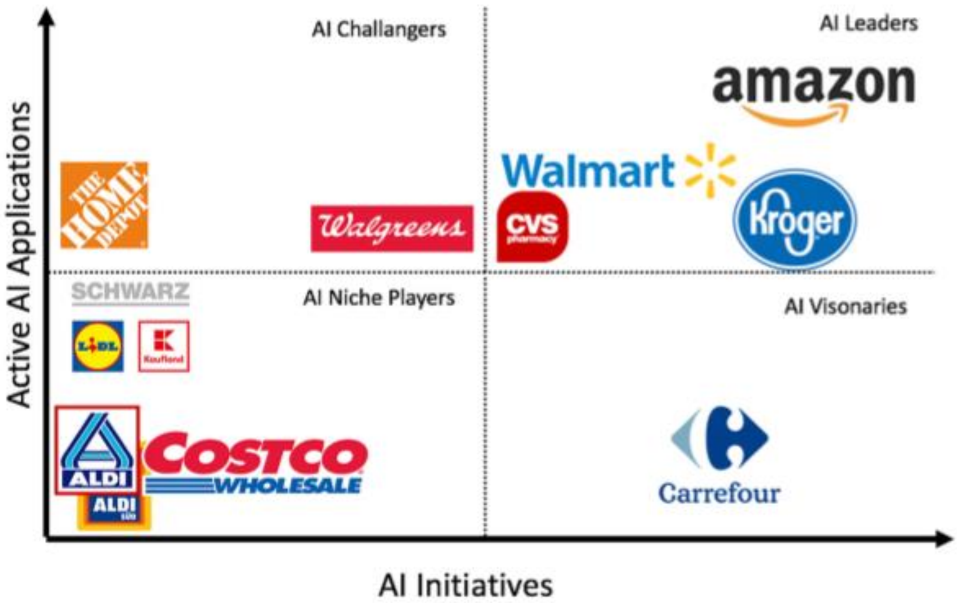


Figure 17, AI adoption in retailing, source: (Weber and Schütte, 2019)

The most innovative companies that have already started working on reforming the supply chain are Walmart, Alibaba, Amazon, IBM, Warbly Parker, UPS, Ahold Delhaize, Grabango and others.

By observing retailing initiatives around the globe and articles regarding the industry it is clear that the market trends surrounding it are efforts for in-store experience, multi-channel disruption, data analysis and prediction and efficiency and control. In the previous sectors enabling technologies and potential application were discussed. This section is focused what is already happening primarily in the grocery and supermarket industry and secondarily in the retail industry.

Major supermarket chains such as Tesco, ASDA, Sainsburys, Kroger, Ahold-Delhaize are striving for increased efficiencies through greater deployment of technology in all areas of supply chain. At the same time tech companies and startups and consumer good and retailing companies are trying to redefine the supply chain.

In-store experiences

Grocery and Supermarket chains are focusing on providing an in-store advanced experience for the consumers. Retailers are testing no-checkout models (smart carts, smartphone check outs etc.) such as Amazon Go, Ahold Delhaize's "tap to go," China's BingoBox and Tesco (Campus, 2015; Kuijpers et al., 2018). Grocery apps, help consumers compare and research prices with the competition, deliver coupons and loyalty points and allow them to redeem them in-store or online. Many supermarkets have already launched such apps like Kroger, Target and ASDA (Cain and Paratore, 2019; Campus, 2015). The Chines superstores Youghui launched an application for online purchases, feedback (read and provide feedback), scan products barcodes and find information for them, share their food to WeChat, find discounts, download coupons and they can have their purchases delivered or the can pick them up in store. Furthermore, Tesco worked alongside IBM to launch an augmented reality mobile app for customers to provide an even more personalized experience. Kroger also, recently launched an app called OptUP, which helps consumers make more health-conscious purchases while shopping in stores through personalized recommendations generated from their shopping history (Cain and Paratore, 2019). ASDA, on the other hand uses the beacon technology, a small transmitter connected via Bluetooth or internet with close by smartphones and informing them about hidden beacon nearby meaning products at discount. They also use the Enacto TM software to monitor energy usage and manage the in-store consumption and they offer free Wi-Fi to employees and customers and the use the data to understand customer behaviors (Campus, 2015). Understanding the consumer preference for fresh food and products supermarket chains offer ready-to-heat and ready-to-eat meals, in-store restaurants, meal kits, and even vending machines for fresh products (Begley et al., 2020). For instance, Tyson Foods created a Deli Division in the Supermarket providing customers with the ability to create their own salads, breakfast and lunches with product from local producers announcing every day the exact origin of each product (farm name and location). In the same mindset, BreadBot is an automated bread maker that can produce up to ten loaves an hour and is used in grocery shops (retail-insight, 2020). Another trend is tracking products origin in store. Morrison, the fourth bigger supermarket, launched a farming app “Texting Cow” deploying new technologies, electronic identification and DNA tags to enhance food safety and traceability (Campus, 2015).

Data Analysis and Prediction

Data analysis and prediction is already used by retailers mitigating risks in the supply chain, understanding customer behavior, predict the demand, dynamic pricing and optimizing routes for trucks. Retailers now need different and better algorithms for forecasting demand; figuring out delivery vs. pick-up requirements; establishing stocking points (location and size), stock levels, reorder quantities and rules; and determining whether or not to price for delivery options (Borchert and Pratap Mukharji, 2016). In dynamic pricing many supermarkets are using a software, Eversight that predicts potential price variations across the chain and suggests several different alternatives for a given item like cooking oil (Matthew Boyle, 2019). PepsiCo started using artificial intelligence as a trend predictor machine, which tracks and analyzes online conversations to help determine what products, ingredients, brand extensions or other innovations it might introduce in the future (Gurski, 2019). IBM is a strong player in the transformation of the supply chain already offering solutions to companies. IBMs Watson Supply Chain Fast Start Program worked with Lenovo digitalizing the Supply Chain complete three AI-driven use-case analyses using supply chain data from its production system. Lenovo is using IBM Watson Supply Chain Insights to rapidly predict, assess and mitigate the risk of disruptions to its supply chain. With an AI-powered approach to risk management, Lenovo can shrink its average response time to supply chain disruptions from days to minutes—up to 90 percent faster than before (IBM).

Efficiency and Control

Grocery and Supermarket chains and huge retail companies as well are working towards minimizing wastes, boosting efficiency and control of daily processes. One of the stages were efficiency and control is tried to be achieved is in warehousing. Kroger working alongside Ocado tries to automate warehousing. Ocado claims to have the world’s most sophisticated automated grocery warehouses and the two companies announced they will open three new warehouses that are run by robots and powered by ML algorithms to navigate and pick products (Weber and Schütte, 2019). Kroger has also forged a partnership with Cimcorp to bring an automated storage-and-picking system to its dairy facilities. Amazon, Walmart, Kroger and many other grocery players invest in project regarding customer experience, picking, and delivery like Kiva

Systems for picking center robotics (Begley et al., 2020). DHL recently conducted tests on an augmented reality system at a warehouse in the Netherlands owned by Ricoh, the Japanese imaging and electronics company. Equipped with smart glasses containing software from Ubimax, employees navigated through the warehouse along optimized routes via the glasses' graphics display, enabling them to find the right quantity of the right item much more efficiently, and with reduced training time (Schrauf and Berttram, 2016). At the same time DHL facilitates AI for optimizing transportation between warehouses (Wang et al., 2019). Another interesting innovation is by a startup Tally, who has developed a robot for automatic shelf control, scanning shelves for missing or misplaced items (Wang et al., 2019; Boyle, 2019). This shows the trend for in-store automations. Many other initiatives such as chatbots and robotic guidance to customers show the same trend. Walmart launched Eden a software which enables employees to estimate freshness of perishable products (Wang et al. 2019). Walmart was always an innovator with the supply chain being the first to introduce RFID and many other innovations. During 2019 alongside IBM they introduced the first digital supply chain with IDM's Watson supply chain and Blockchain. Walmart's inventory management now funnels information from stores such as point-of-sale data, warehouse inventory and real-time sales into a centralized database. The data is shared with suppliers who know when to ship more products. The retailer also instituted cross-docking at its warehouses, a method that moves inventory directly from arriving or departing trucks. Products are taken from an arriving truck and packed in a truck bound for a store without lengthy storage in the warehouse lowering costs for inventory storage (tradegecko, 2019). Food waste is another growing concern for retail. Many grocery retailers are beginning to implement techniques and partner with sustainable brands in order to help tackle the issue. Ahold-Delhaize has also partnered with digital solution provider UST Global and they are using AI to identify movement of products from the shelfs. Tesco introduced the Broccoli Cam an overhead digital cam identifying empty trays in the vegetable aisle. Secondly, they use Smart Badge, a GPS sized computer for employees to scan products and answer customer questions accordingly. Another innovation is the shelf edge label technology that allows alterations to prices in a more effective way. Efficiency and control is a goal with so many innovative application and strategies implemented to succeed this goal.

Multi-Channel Disruption

Multi-channel or Omnichannel in retail and particularly in grocery is a greatly discussed issue. Grocery and Supermarkets tend to create e-grocery apps. Amazon's Echo and Echo Dot are voice enabled devices and through Alexa and with smart fridges they can fulfill auto-ordering. Again, Samsung's smart fridge and smartphones allow customers in stores to check what runs low in the fridge and buy it or order it online. Amazon also has created Dash, a button for ordering Amazon products by just pushing it. Walmart tries to patent to a virtual- reality shopping feature that would better replicate the physical advantages of a store; shoppers would don VR headsets and sensory gloves to "feel" product. Walmart generally invests on broadening its omnichannel capabilities adding pick up services for online orders to many shops. Moreover, a German grocery chain uses integrated multichannel offerings to combine online and offline shopping (Schrauf and Berttram, 2016; T. Stock, 2016). Figure 18 shows the new structure of retail with the multi-channel approach.

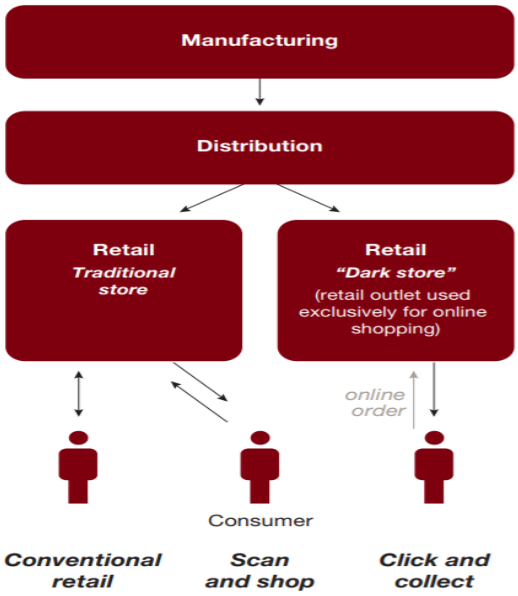


Figure 18, Omnichannel retailing, source:(Schrauf and Berttram, 2016)

There are so many articles and discussions in blogs for the future of retailing with omnichannel discussions always being the center of the attention.

2.2.2.5 Impact of applications and limitations

The goal for the supermarket supply chain is to change in a way that can meet the evolved consumer requirements and minimize all costs and eliminate wastes in all processes. The facilitation of the enabling technologies and the applications can be proved successful.

"Disrupt or Be Disrupted"

Figure 19, Supply Chain Impact, Source: Supply Chain Management

So, what really all these innovations and technologies has to offer?

The overall impact is the creation of a data-driven, customer centric, agile, resilient supply chain, with standardized processes, high quality documentation, control and planning systems with a simultaneous reduce in labor times, operational costs, inventory levels, product wastes, energy consumption and an increase in transparency and an incremental ability for continuous improvement (Kumar, 2008; Vallandingham et al., 2018). In Table 2-9 the impact for the supermarket supply chain processes is illustrated. Figure 20 shows the automation impact in core merchandising activities.

Table 2-9: Impact of breakthrough technologies on Supply Chain processes

Supply Chain Processes	Technologies	Impact
Procurements	*Blockchain, IoT, advanced analytics, Smart Contracts*	The establishing of standardized documentation and process while the ability to choosing based on various factors suppliers. With the technologies and applications in the procurements, errors are minimized, labor time is reduced, transactions are automated, and the right amount is available at the right time in the

		right place and changes can be done easier and transparently.
Transportation	*RFID, EPC, WSN, M2M, AI, QR codes, barcodes, 4G, wireless communication networks, Cloud Platforms*	Again, standardization of the process is succeded with high visibility and traceability and product quality control and standardization. At the same time route optimization, less transportations and truck utilization is achieved reducing transportation cost and CO2 emissions
Warehousing	*RFID, EPC, WSN, M2M, AI, IoT, wireless communication networks, cloud computing, wearable devices, robotics, AR*	Warehouse management becomes more automated, employee's safety is boosted, better warehousing condition are achieved and monitored. Furthermore, inventory accuracy is advanced while warehousing costs are reduced and the processes are speed up
Replenishment	*RFID, EPC, WSN, AI, IoT, wireless communication networks, cloud computing, robotics, integrated ERP systems*	Impacts of new technologies in replenishment is the integration of inventory management and replenishment strategies such as VMI, CR and CPFR. Automation in replenishment minimizing human interaction, thus error, labor time and costs. Standardized processes, real-time information sharing, better inventory monitoring. Capability of generating dynamic online reports, allowing statistical analysis of those parameters down to store level resulting lowering of inventory levels and costs. At the same time off-stock incidents are minimized and sales are increased.
Forecasting & Ordering	*AI, advanced analytic, IoT platforms and software*	Important impact is the data-backed decision making after analyzing data from sensors, social network trends, weather etc. using machine learning, AI and advanced analytics techniques. Better estimates for distributions of the expected demand volume instead of a single

		forecast number; better understanding of the supplier performance; dynamic pricing; risk management and targeting. Human intervention is less needed as another impact it that risks are spotted and only then there is need for the managers to decide the proper action. AI systems and machine learning can provide sales teams with recommended next-step actions when interacting with customers and, increasingly, directly with consumers. Real time data and daily operational metrics are available to act upon them instead of previous days performance allowing people to make more proper decisions for the specific situation, especially with fast moving products. Data-backed decision making transforms all processes to more agile.
Goods Handling	*Computer Vision, IoT, blockchain, RFID, refrigeration, HVAC technologies*	All these applications have great impact on goods handling throughout the supply chain. Particularly in perishable products the controlling and monitoring of the conditions in distribution, warehousing and in-store expand the shelf life of products resulting in higher qualities and more accurate pricing while minimizing wastes and housing and in-store utilities.
Serving Customers	*Smartphone application, WSNs, RFID, smart – store, predictive algorithms, AR*	Consumer and customer relationships are now digital-centric. Consumers find value in knowing all the data about the products they decide to purchase and in being able to verify them. At the same time, they want to save time and have a more personalized experience. That’s exactly what the digitalization of services and products offers. In store apps, mobile apps, self-check-out and augmented reality shares with them everything they need to know about products, special

		offers, guidance for their purchases. Granular clustering for customers offers them more suited products and more personalized experience and at the same time helps the company and the suppliers with forecasting, marketing and product evaluation and development. Even store positioning and products assortment can be improved with advanced analytics, customer profiling and market data

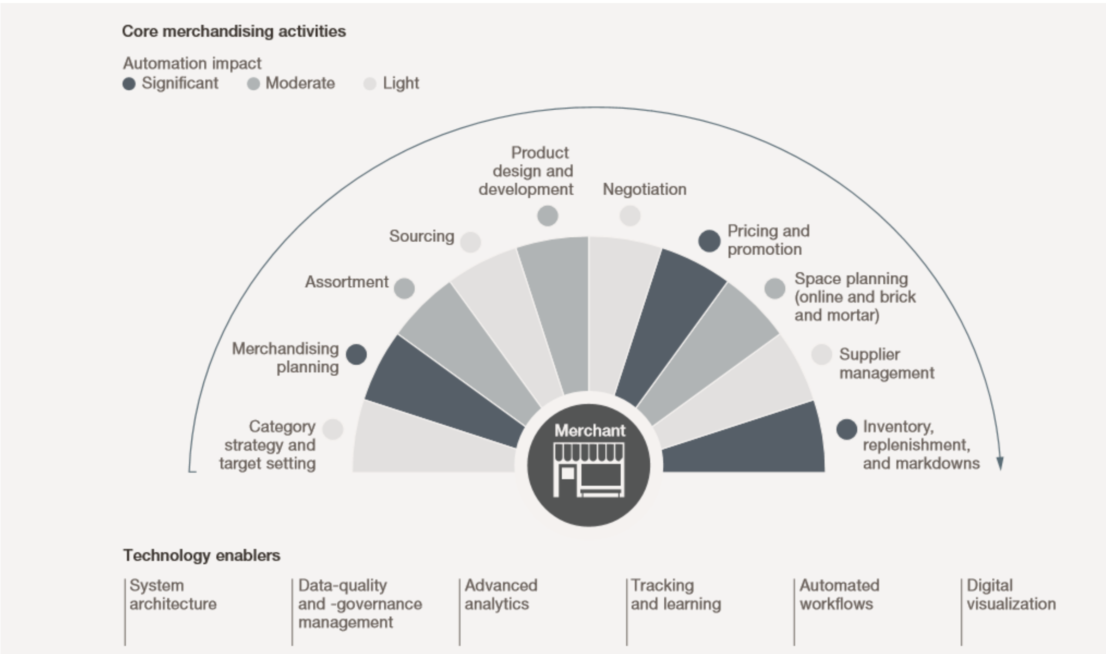


Figure 20, Impact of automation, source:(Begley et al., 2018)

In the last couple of years Industry 4.0 is becoming a reality with more and more companies starting to apply all changes needed to transform their processes and investing in that. Although this cannot be a two-year project it has a timeframe of ten years and there are different stages to the implementation and that due to many constrains that must be resolved. The three main constrains are:

- Technological Constrains
- Resistance to Change
- External Partners

Technological Constrains

The digitalization of the supply chain, products and services, IoT collaboration and data analytics are the core values of Industry 4.0 and all of them they are very sensitive to one thing **Cyber Security**. Cyber Security is still a work in progress with blockchain technologies trying to overcome the issues but still they are involving. Augmented Reality, Driverless Trucks, Robotics and Drones are very innovative concepts not yet tested and fully developed (Ding et al., 2020; Wang et al., 2019; Weber and Schütte, 2019).

RFID technologies are not fully developed either with many inefficiencies and difficulties in transmitting the data due to electromagnetic interferences. Sensors is another technology needed for the transformation which faces challenges with bandwidth, communication protocols, battery life, conflict with other signals etc. In addition to that most applications are IoT based and at the moment IoT has multiple limitations such as compatibility, connectivity and capacity issues (Ding et al., 2020).

Resistance to Change

Changing a process in a company requires a change of mentality as well. Supply chain especially in the retail industry is far more than just a simple process and it requires much more than s change in mentality. Shifting to digitalization and implementing high technology features requires extreme training, different skillset so it's something intimidating for companies to jump in. As research has already shown, 25% of logistic and transportation companies do not have a digital strategy in place and 48% of businesses involved in product distribution rely on traditional technology and legacy software to communicate with partners and manage workflows.

External Partners

The vertical integration of all corporate functions is something that can easily be achieved as it depends only on the corporation itself. The horizontal dimension is the more complex part as it formed from thousands relevant players and partners throw-out the network. The tricky part is to integrate several systems and components that may not always be owned by a single entity, some easier to absorb and intergrade and some much more difficult. For example, if your supplier is a small farmer it is very hard to make him a part of the digital supply chain.

All these constrains does not mean that it's not yet the era for the digitalization it just means that the implementation must be carried out in stages and all stages must be compatible with each other to compose the overall goal at the end. Companies that want to get ahead in the race for supply-chain superiority must build the systems, processes, and infrastructure today that will enable them to meet the customer expectations of tomorrow.

2.2.3 How the COVID-19 outlined the need for the Supply Chain Transformation

In March 2020, the COVID-19 was spread around the globe and apart from lives, it threatened the economy as well. The COVID-19 crisis changed the daily lives, reshaped consumer behavior and disrupted many industries, retailing industry included. Numerous articles regarding the acceleration of digitalization in retailing, the need of resilience in the retail supply chain and the rapid changes in the consumer behavior were published from consulting companies such as McKenzie, Bain &Co and many others, indicating these were pressuring matters that the crisis brought in the surface. According to some of these articles digital transformation in business is needed and a surveys from McKenzie showed that 70% of the CEO in companies in Germany, Switzerland and Australia believe that after the crisis digital transformation in businesses will be facilitated much faster (Blackburn et al., 2020). In the same context, the need for agility, transparency, digitalization and resilience in the retail supply chain was outlined and proposals for reformation were illustrated.

First and foremost, which are the new consumer behaviors and expectations pushing the supply chain to transform. According to McKenzie articles the habits that became stronger are lower prices seeking consumers, wellness and hygiene awareness, seeking for digital and seamless solutions and social distancing. For example, during the coronavirus crisis in the UK. Market share for e-grocery faced a raise more than 30% (Buck et al., 2020). Specifically, in Greece usage of supermarket electronic services was increased and ordering online groceries increased by 1% between 3rd of April and 25th of March (Communications, 2020). On the other hand, the rapid shift on demand for products and the inability of retailers to meet the demand showed the vulnerabilities of the supply chain such as the inefficiency in seizing and responding rapidly in demand pattern changes (Aull et al., 2020).

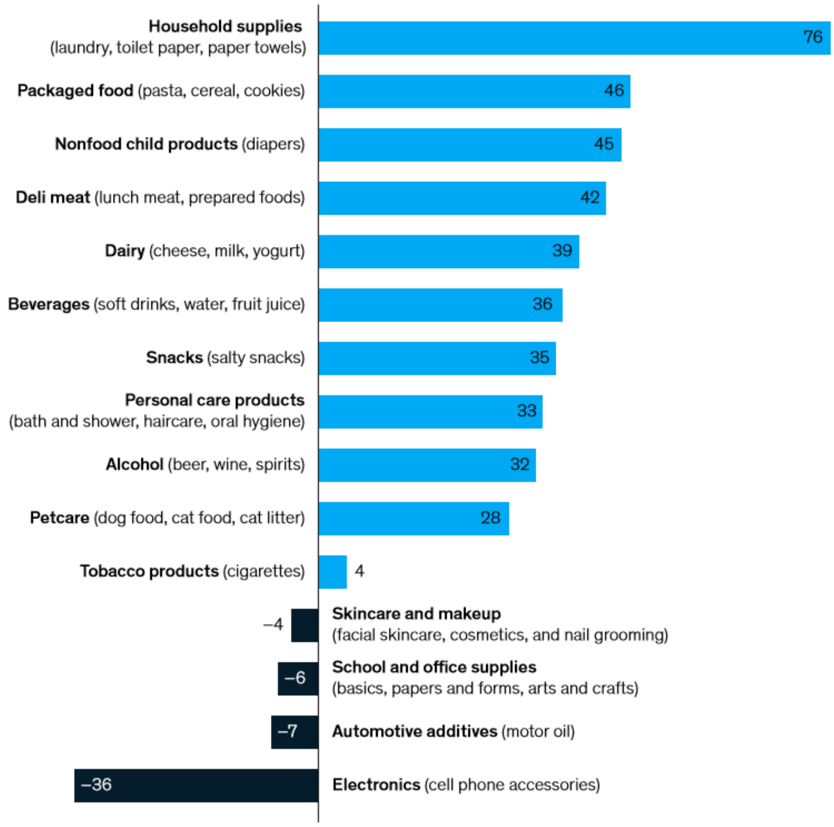


Figure 21, Impact of covid-19 in retail sales

The inability of the supply chain to respond successfully in the situation alongside the fact that digital ready retailing companies endured profits instead of losses during the crisis made clear to the retailers the need to incorporate new technologies and reshape the supply chain. Technologies and innovations discussed in the articles (Aull et al., 2020; Blackburn et al., 2020; Buck et al., 2020; Packaged and Practice, 2020) are:

- Advanced analytics, predictive algorithms, end-to-end and visualization in planning and management systems
- Machine learning in forecasting for spotting abnormalities for quicker realization and adaptation to any changes
- Creation of omnichannel
- Cashless, virtually cashless stores or seamless self-check-out models
- Automated Replenishment
- Real-time on shelf visibility
- In-store robots for transactional tasks such as inventory management (checks, replenishment, order fulfillment)

This proves that the implementation of the applications and technologies discussed in previous chapters is in the short-term future and it's a matter of time to stop existing only in a conceptual level, or just in big retailing companies.

2.3 Lean Six Sigma in the Supermarket Supply Chain Management

2.3.1 Applications of Lean Six Sigma in the Supply Chain

In the first chapter it is mentioned that LSS method is applied in Supply Chain Management Project in many different industries. After an extensive literature review of articles from many LSS associated and leading databases such as Taylor and Francis, Emerald, Elsevier, Google Scholar, Science Direct and ResearchGate, it was observed that multiple studies are referring on how LSS can be deployed by the SCM to measure, monitor and improve its performance but there is absence of implementation models for the various industries and a clear picture of the pre-implementation, implementation and post-implementation requirements of LSS projects. The most used research methodologies are conceptual, qualitative, empirical, descriptive and few case studies with surveys or interviews(Gamal Aboelmaged, 2010; Raval et al., 2018; Singh and Rathi, 2019).

"We cannot solve problems with the same thinking we used to create the problem"-Albert Einstein

To understand how LSS projects can be applied end-to-end in the supply chain we should be able to answer three questions:

- In which processes LSS projects are most used
- How can the 8 types of waste can be translated in the Supply Chain Management, and which are the most important performance metrics
- Which are the most common steps and approaches when executing LSS Projects

In which processes LSS projects are most used

The supply chain differs from corporation to corporation and in the various sectors, but the same principles apply, and main processes remain the same. Lean six sigma projects aim to identify and eliminate issues across the supply chain improving process performance and adding value to the end customer and lowering the costs. Major opportunities for LSS projects are revealed in all the basic supply chain processes i.e., Procurement Processes, Distribution & Transportation, Warehousing, Replenishment, Forecasting & Ordering, Goods Handling and Customer Services.

In the Procurement Processes potential projects of LSS methods are optimizing the number of suppliers, changing sale policies and procedures, minimizing material and suppliers' expenses, purchasing errors, excessive documentation, applying to the suppliers lean and six sigma tools and mentality to spread the LSS supply chain to the extended supply chain (Das, 2005; Gutierrez-Gutierrez et al., 2016; James W. Martin, 2013; Mishra and Sharma, 2015; Yang et al., 2007). James W. Martin suggests that only by integrating the Lean Six Sigma supply chain to all upstream and downstream suppliers the procurement process will realize the full benefits of the method such as 90% improvement on orders received on-time etc. On the other hand, a major innovation of the Samsung Group in the supply chain management, the introduction of a six-sigma based methodology for constant improvement of all supply chain management operations has brought to the surface three issues in the procurement processes for LSS projects to resolve. These issues are the gap in planning and execution of inventory consumption, lack of standardized plan for inventory reduction and discrepancies in raw materials purchasing and actual product sales. These issues were dealt with the DMAEV (Define, Measure, Analyze, Evaluate and Verify) approach. The case studies of Das and Gutierrez proved respectively that delays in materials' procurement can be reduced almost 15% and that the payment process of a logistics company can become more transparent with zero errors by implementing the DMAIC method. Nicoletti addressed at his technical paper on how LSS method can be implemented in the procurement processes by developing a framework for using the "LSS and digitalize method" to streamline, digitize and reduce waste in procurement processes (Nicoletti, 2013).

Distribution and Transportation is another area with handful opportunities for LSS Projects and many proven successful applications. Many projects have been performed with subjects such as the number of shipments, product transfer between facilities, distribution centers to stores, traffic routing and transportation scheduling, fleet management, quality control of products transferred and on-time delivery. Especially, in the food supply chain and perishable products that are fast-moving, and they have short shelf life the distribution processes are playing key role to the performance of the whole supply chain. A research in the UK in Six sigma for Food Distribution in SMEs concluded that six-sigma is a reliable method for performance improvement of the food supply chain. They also executed two case studies indicating the remarkable impact of DMAIC methodology in the food distribution highlighting also the high data requirements of the methodology (Shokri et al., 2014). Another case study with DMAIC methodology in a LSS Project succeded in minimizing the order cycle time. The conclusions of this research were the positive results of the implementation of LSS in process improvement and lead time reduction, the DMAIC method's flexibility and the importance of an organizational CI infrastructure for the successful implementation (Gutierrez-Gutierrez et al., 2016). Farhad Nabhani suggests that LSS is a better approach as an improvement methodology particularly in the food distribution and for reducing delivery time (Nabhani and Shokri, 2009) . James Martin in his book addresses potential process breakdowns of the supply chain that LSS projects can be applied suggesting that usually they are related to lead-time and demonstrates the implementation of LSS projects for minimizing the schedule changes in a distribution center, the over-time expenses of a distribution center and the reduction of transportation cost and increase on-time delivery. S. Salah addressed once again the inefficient logistics operations of a DC and following the DMAIC methodology Salah accomplished improvement of three KPIs greater than the initially targeted improvement. Specifically, the DC realized the reduction of receiving period from two weeks to the same day, an increase in the retailers' fill rate from 80% to 94% and in the picking rate from 60 line picks per operator per hour to 70 line picks per operator per hour (Salah et al., 2011).

Warehousing includes numerous sub-processes and over the last decades LSS projects have been implemented in those. Continuous improvement projects often aim to improve the picking process, the warehouse layout, purchase receiving, loading and unloading and reduce lead-time, utilities expenses, over-time expenses and better handle employee training, workload management and maintenance scheduling (James W. Martin, 2013; Lee et al., 2013; Shokri et al., 2014; Yang et al., 2007; Zhang et al., 2016). Yang describes the case study of Samsung using DMAEV methodology to decrease surplus inventory by introducing a web-based early warning system for surplus inventory succeeding a 37 percent reduction in surplus inventory (Yang et al., 2007). Another case study for a UK Food Distribution SME implemented LSS project to reduce the delivery lead-time. They identified as CTQ-Y variable the loading time and the vital few causes Xs the poor warehouse layout. Prior implementing the chosen solution, moving the picking area for fast moving products next to the loading area, they constructed a loading index Li which after the implementation of the solution reduced from 1.97 to 1.13. Apart from reducing the lead time the LSS project also improved the internal flow of goods in the warehouse (Nabhani and Shokri, 2009). Martin also discusses applications of the method to minimize accident rates in the warehouses, to reduce DCs' schedule changes and improve line-item availability. Some root causes for these processes' breakdowns are the lack of standardized order picking and replenishment processes, misplaced inventory, poor employee training and utilization(James W. Martin, 2013).

The replenishment process is tightly connected to the warehousing and the distribution processes. It is not easy to distinguish the LSS applications as it is very likely a project aiming to improve a performance metric of the replenishment process to implement alterations to distribution or warehousing sub-processes and the other way around. Replenishment optimization project mainly deal with optimizing shelf-replenishment, store replenishment, achieving better pull-replenishment or constantly sustaining sufficient products (James W. Martin, 2013; Kumar et al., 2013; Takeda Berger et al., 2018; Wei et al., 2010; Yang et al., 2007). Amway Taiwan, a direct selling company through Independent Business Owners used the DMAIC methodology at the logistic center to supply the service centers adequate inventory and to reduce the shortage rate. The results were the decrease of the replenishment frequency alongside the emergency replenishments with half a million-dollar annual transportation savings and indications of the increased satisfaction of the Independent Business Owners (Wei et al., 2010). Applications of LSS projects to reduce emergency replenishment are also described by Martin James. Another major implementation of the DMAIC framework occurred by a US telecommunication product company which implemented Lean Sigma Pull Replenishment and managed to meet customers' demand whilst reducing lead-time, inventory, and cost. Characteristically, they enjoyed the reduction of the average lead time from 16 to 5 days and the customer service level increased from 64 to 89 per cent (Kumar et al., 2013). Lean inventory management and the pull-replenishment strategies are crucial for the LSS Supply Chain transformation and many conceptual models exist to prove the benefits from the different strategies (Takeda Berger et al., 2018).

LSS Projects in the forecasting and ordering process are dealing mainly with order accuracy, emergency orders elimination, demand estimation and abnormalities as well as with new products and number of SKUs. There are limited references to actual methods applications but there are numerous implications and suggestions for implementing LSS projects alongside advanced analytical tools and IT applications to improve forecasting and ordering processes while minimizing non-optimum forecasts. To improve forecasting LSS projects determine the root causes of poor forecasting or the errors of the forecasting systems. Other potential applications of LSS projects are identified in goods handling processes and reverse logistics. Especially, when it comes to products with limited shelf-life and the transportation of expired products back to the suppliers or to damaged items (James W. Martin, 2013).

Finally, customer services can benefit from LSS projects. From literature review papers it is proven that many applications have been implemented in the service sector. The last part of the retail supply chain are the in-store experience and customer services. In this last part several LSS applications have been observed with objectives such as reducing customer complaints, call center's management, average customer handling time and turnover per customer. James W. Martin, 2013 illustrates two examples of the DMAIC method used to reduce the average waiting time of a call center to 90sec and reduction of the average call handling time. Another succesful implementation was conducted in an Amway's Tawain logistic center aiming to simplify the product refund process and shorten the refund process time to provide higher customer satisfaction. Once again the DMAIC methodology was followed and in order to meet the project's objectives they reengineered the proccess and improved the using Information System achiving not only to reduce drasticly the proccess steps and proccessing time but also NT$ 1,200,000 in annual savings. Finally, by implementing control systems they reduced the error rate in the refund process to almost zero (Lee et al., 2013). Kumar Sameer used the DMAIC approach alongside service blueprints to advance the quality of customer services of Best Buy a major consumer electronics and appliance retailer in the USA (Kumar et al., 2008).

Although the benefits from implementing LSS principles and projects through out the supply chain are undoubtable and very often disscused there are only few papers focused strictly on the supply chain mangement (Gutierrez-Gutierrez et al., 2016; Knowles et al., 2005; Panayiotou and Stergiou, 2020; Raval et al., 2018; Salah et al., 2011; Senthilkumar et al., 2012; Singh and Rathi, 2019). There is evidence of successful implementation on the food supply chain and retail supply chain but there is lack of articles focusing on the grocery, supermarket and hypermarket supply chain (Nabhani and Shokri, 2009; Perez et al., 2010; Shokri et al., 2014). There is also limited review on applications on the logistics industry and logistic services and the critical success factors of the industry and the services (Zhang et al., 2016). Zhang's survey research showed that 21.9% of the logistic companies use LSS approaches, 15.6 use Lean only approaches and 62.5 use none of these methods and that 100% of the companies using LSS realized cost savings, 66.7% reduced process cycle time, improved delivery performance, improved employee productivity, 58.3% identified and eliminated/reduced wastes in their business processes and 41.7% were able to improve inventory turnover. Combining Lean principles with data-driven Six Sigma creates a sustainable approach towards operatinal excellence, process improvement and supply chain transformation. The supply chain should be as lean as possible in order to provide clarity for the implementation of six-sigma techniques and later expand further to supply chain integration agility and digitalization (Pepper and Spedding, 2010). Table 2-10 some typical lean benefits in the Supply Chain as James W.Martin has captured them.

Table 2-10: Typical Lean Benefits, (James W. Martin, 2013)

Category	Improvement
Process Development	25%–75%
Labor	15%–50%
Floor Space	25%–50%
Errors	25%–90%
Excess Capacity	25%–75%
Throughput Time	25%–95%
Delivery Time	25%–80%

How can the 8 types of waste can be translated in the Supply Chain Management and which are the most important performance metrics

The penetration of the LSS approach as a Continuous Improvement method in the supply chain management can enhance SCM performance and quality and reduce waste. The 8 types of waste from the Lean approach have been analyzed in a previous chapter. While implementing LSS methodology in the Supply Chain the translation of these 8 categories of waste to supply chain notions is very helpful for potential projects identification.

Table 2-11: Examples of 8 wastes' types in Supply Chain

8 Types of Waste (Muda)	SCM notions
Defect	Missing / wrong supplies, damaged products
Overproduction	Excessive warehousing

Waiting	Order / delivery delays
Non-utilized skills	Under-utilizing space, capabilities
Transportation	Small quantity deliveries, emergency deliveries
Inventory	Overstocked supplies
Motion	Poor warehouse layout
Excess Processing	Excessive documentation

Prior to implementing process improvement projects is vital to set up and analyze key performance metrics and indicators. Key Supply Chain metrics help in identifying operational breakdowns and later to act as targets for improvement. The metrics and the KPIs are divided to financial and operational metrics. Some of the most discussed and used metrics are presented below (Dasgupta, 2003; James W. Martin, 2013; Yang et al., 2007).

Financial metrics:

- Inventory investment
- Profit and Loss (P/L)
- Excess/Obsolete inventory
- Profit margin
- Transportation expenses
- Increase in sales

Operational metrics:

- Inventory turnover
- On-time delivery
- Forecast accuracy
- Lead time
- Unplanned orders
- Schedule changes
- Data accuracy
- Product Availability
- Utilization rate
- Customer service target

Those metrics are used for the supply chain performance measurement, and it is safe to assume the importance for an organization to be able to measure these metrics effortless, accurately, constantly and with no cost.

Which are the most common steps and approaches, tools and techniques when executing LSS Projects

LSS composes the robustness of Six Sigma through systematic approach to problem solving and speediness of Lean through smooth flow of processes. They both incorporate methodology, philosophy and tools/techniques to assist organizations improve their business results (Raval et al., 2020). Different methodologies can be used to implement LSS applications. Especially in the supply chain management the methodology that is most commonly used is the DMAIC approach. Other approaches are DMADV and the DMAEV, constarcted by Samsung Group as an alteration of DMADV (Yang et al., 2007). The DMAIC methodology generally is most prefered across industries as many literature review papers observed as well(Panayiotou and Stergiou, 2020; Raval et al., 2018; Shokri, 2017). The second most prefered is DMADV. Some reasons for the distinction of the DMAIC methodology against the others are the flexibility of the methodology as it is not used in a strict manner and that promots reengineering of a process instead of designing a new one (Panayiotou and Stergiou, 2020).

Major companies have used LSS in the supply chain including DHL, Wal-Mart, FedEx, Dell etc. Samsung Group utilized a modified approach of the DMADV (define-measure-analyze-design-verify) methodology for designing new processes which is the 75% of CI projects they implement whereas the remaining 25% are reenineering processes with DMAIC methodology. The modified approach is the DMAEV (define-measure-analyze-enable-verify). In the define phase the overall project is determined and through the VOB and VOC the CTQ-dependent variable (Y) is determined. Folllowing in the measure phase, the current state of the Y is measured and a new target is set up. Then in the analyze phase, potential Xs, causes of the problem are genereted and evaluated with respect to Samsung's 5 design parameters. Quantitative and qualitative tools of SS such as VSM,CE diagram, ANOVA etc. are used to select the vital few Xs. In the eneable phase, they come up with proposals to improve the as-is and develop to-be scenarios. Finally, in the verify phase pilot test are taking place and the verification of the results. Once the optimization is proven the optimal solution is put into operation with constant monitoring of the results and sharing through the Group's repository for projects (Yang et al., 2007). Du Pont, on the other hand, combines Six Sigma principles with the SCOR (Supply Chain Operations Reference) model, which scopes five core management processes, including plan, source, make, deliver, and return. Du Pont's Six Sigma approach utilizes a quality function deployment (QFD) tool – a method for converting customers' requirements to products, processes or services (Kumar et al., 2008). SCOR is widely used in organizations to support CI projects and Supply Chain integration with technology investments and ties the supply chain metrics with processes and practises (APICS, 2021).

The book "Lean Six Sigma for Supply Chain" by James Martin provides insights for the implementation of LSS in the supply chain from the author's consulting experience and he provides a 10-Step Solution Process based on LSS for CI projects througtout the Supply Chain. He suggests that by using the proposed solution, Lean and Six Sigma improvement projects are identified and deployed to systematically improve supply chain performance.

Table 2-12: The 10-Step Solution Process, (James W. Martin, 2013)

10-STEP SOLUTION PROCESS
1. Align project with business goals
2. Ensure buy-in from process owner, finance, and others
3. Communicate project results
4. Prove causal effect Y = f(x)
5. Improve measurement systems
6. Develop detailed improvement plan
7. Integrate countermeasures to their root cause analysis
8. Standardized procedures
9. Implement training and audits
10. Apply control strategies

In the selected papers and from the literature review papers it is clear that from the SS and Lean toolset the most used tools are the CTQ, VOC, Cause-Effect diagram, Pareto Analysis, ANOVA, VSM, 5S, SIPOC, hypothesis testing and histogram. Both quantitative and qualitative tools are exploited to accomplish succesful implementation and sustain the results. The qualitative tools are used mainly to define the problem and identify potential causes whereas, the quantitative tools requiring data are use to prove and measure the correlation bewteen cause and effect and later on to test the solution and sustain the optimization.

2.3.2 Success factors and barriers for LSS in the Supply Chain

The success factors and the barriers for the application of LSS projects have captured the interest of many scholars and the academia. It is important to point out the Critical Success Factors (CSFs) and the barriers aiming to find methods, practices and applications that might help overcome the barriers and achieve the CSFs.

Tsironis identified as CSFs having a clear, strategic, and customer-oriented objective for the LSS applications alongside committed leadership and quality based organizational culture. He also pointed out the imperative need of documented procedures, available resources and possession of technical knowledge of the tools and soft skills (Psychogios et al., 2012; Tsironis and Psychogios, 2016). Tsironis and Phsychogios are not the only ones identifying these areas as success factors. Well-organized, clear and documented business processes and information based management are two CSFs usually examined (Alblooshi et al., 2020; Lande et al., 2016; Laureani and Antony, 2015). Another widely discussed area as a CSF is regarding project selection. Determination of the proper criteria for project selection, project prioritization and project selection are listed in many papers and books as common CSF for the LSS method (Akbulut-Bailey et al., 2012; Alblooshi et al., 2020). Due to the systemic and data-driven nature of the method, five more CSF have arisen associated with that. First comes the access to quality data and information and second comes the access to external information sources. Following to access to quality data is the capability for correct and advanced analysis, to achieve better data manipulation and draw correct conclusions from them (Alblooshi et al., 2020; Lande et al., 2016; Raval et al., 2018; Zhang et al., 2016). Monitoring and evaluation of the performance measurements is the fourth success factor associated with the nature of the LSS method (Lande et al., 2016; Raval et al., 2018; Singh and Rathi, 2019). In the same mentality constant reviewing and tracking of previous and current LSS projects is another CSF (Antony, 2015). Finally having a coherent communication plan for all LSS projects is considered a very critical success factor (Forcellini et al., 2018; Lande et al., 2016). With that in mind Samsung Group hold a LSS projects' repository and it is shared through-out the company(Yang et al., 2007). A couple of other distinguished factors influencing the implementation of LSS are closer suppliers' relationships, linking LSS to suppliers and customers (Antony, 2015; Sabry, 2014; Timans et al., 2012). Additionally, some intensely investigated critical success factors with strong impact to the accomplishment of LSS projects are the awareness of LSS (Lande et al., 2016), the IT support and existence of supportive IT systems (Lande et al., 2016; Tsironis and Psychogios, 2016), supportive internal infrastructure (Alblooshi et al., 2020; Psychogios et al., 2012) and innovative organizational climate (Alblooshi et al., 2020). These are some of the key aspects that can accelerate and support the successful implementation of LSS projects.

On the other hand, multiple barriers, and challenges for the implementation of LSS method have been investigated in the reviewed papers. There are specific barriers most frequently mentioned and they can be separated in 4 categories, impending factors deriving from the data-driven nature of the LSS method, impending factors deriving from the process oriented and continuous nature of LSS method, barriers deriving from the resources required from implementation of such projects and barriers related to the Supply Chain Management specifically. In the first category the most noticeable ones are the insufficient usage of IT, insufficient existence of new technology and initiatives, lack of IT implementation, effective communication, transparency and traceability (Forcellini et al., 2018; Kumar et al., 2015). In the same category very frequently mentioned as well is the deficiency of quality and advanced data (Forcellini et al., 2018; Kumar et al., 2015; Raval et al., 2018; Singh and Rathi, 2019; Zhang et al., 2016) causing as well improper identification of areas/activities requiring improvement (Kumar et al., 2015; Singh and Rathi, 2019). Kumar also refers to the absence of intergraded communication between firm and suppliers as an obstacle of LSS successful implementation. In the second category are summarized the impending factors that are in regards to processes with the first one being lack of process thinking, process controls and ownership (Raval et al., 2018). Another barrier is the low degree of standardization and formulization of the processes and the issues that might occur (Forcellini et al., 2018). The fruitful adaptation of LSS projects must also overcome the lack of performance measurements, the lack of statistical and effective visual controls implementations and feedback and results. These deficiencies in checking, audits and visual management and standardization of process improvements are the root causes of another barrier the lack of sustainability of the LSS impacts (Albliwi et al., 2014; Alblooshi et al., 2020; Forcellini et al., 2018; Gutierrez-Gutierrez et al., 2016; McLean and Antony, 2014; Raval et al., 2018; Singh and Rathi, 2019; Zailani, 2015). In the third category, some easily noticeable barriers from the literature review are the lack of resources such as financial, human, time etc. (Manzouri et al., 2013; Raval et al., 2018; Singh and Rathi, 2019) and lack of infrastructure which can be either organizational, technological etc. (Albliwi et al., 2014; Singh and Rathi, 2019). Finally, often discussed as a barrier of the implementation of LSS is the high cost and complexity of such implementation alongside the poor cost controls and safety management (Forcellini et al., 2018). The implementation of LSS in the Supply Chain Management faces some extra barriers due to characteristics of SCM. Some identified barriers are the lack of supply chain integration, the insufficient monitoring and control of the suppliers' delivery time, lack of visibility in marketing activities and the reluctance to exchange information between the counter parties of the supply chain. Additionally, supply chain management encounters technical barriers and lack of clear responsibilities of roles within the supply chain management. Market competition and uncertainty is another extensively discussed barrier of LSS projects in the supply chain (Manzouri et al., 2013).

2.3.3 How the technological advancements can enable LSS projects throughout the Supply Chain

The penetration of industry 4.0 technologies in the Supply Chain and the digitalization era is a fact. Digitalizing the supply chain involves the adaptation of sophisticated and smart technological capabilities to make supply chain more efficient, connected and collaborative (Haddud and Khare, 2020). Adaptation of such technologies it is clear that is a way to improve supply chain performance and it can be impactful in process improvement as well (Banerjee and Mukhopadhyay, 2016; Hong et al., 2010). Although, technology should not be the goal but the instrument for achieving operational excellence (Martinez, 2019). There are implications that LSS methodology and technological advances intergrade and mutually enable each other. Literature for the correlation between supply chain digitalization, lean and lean six sigma is limited and there is also lack of empirical studies that investigate the successful implementation of lean or lean six sigma and industry 4.0 technologies and how they act as an enabler for LSS projects in the supply chain (Haddud and Khare, 2020; Panayiotou and Stergiou, 2020). Incorporation of technology advances and supply chain digitalization can act as an enabler for LSS projects by securing the existence of some critical success factors of LSS, helping overcome barriers of LSS implementation, supporting LSS project phases and finally by boosting supply chain's leanness for better six sigma tools implementation.

Upcoming technologies such as blockchain have wide use in the supply chain. Blockchain databases provide supplier data for the selection and development, storing them and allowing them to be analyzed for quality and performance (Rane and Thakker, 2019b). Also, projects and investments can be monitored, and information can be used for performance measurement. BCT records transactions, tracks assets, provides a system for managing documents in logistic processes(Jain et al., 2020; Rane and Thakker, 2019b). Everything is well documented including procedures avoiding excessive documentation while all documents are standardized and shared across the supply chain members (Sheel and Nath, 2019). At the same time blockchain increases the retailing transparency. For example, foodstuff origination is documented, and their supply chain is displayed on a ledger, so damaged products, expiration dates, product and supplier data are available and easier to track (Jain et al., 2020). Thus, the blockchain capabilities improve decision making and secure that critical success factors for the implementation of LSS projects such as documented procedures and business processes, acquisition of external information and closer supplier relationships are established. Another critical success factor for the LSS projects which is better established with blockchain is the ability to linking the projects with the suppliers and the customers, as blockchain's main achievement is linking the whole supply chain all together (Sheel and Nath, 2019).BCT provides aid in overcoming LSS barriers such as the ineffective monitoring and transparency of the supply chain and the lack of visibility in the marketing activities.

Information sharing, effective communication, constant monitoring, performance measurement, external information and quality data capturing is also achieved by new technologies such as RFID, IoT and Cloud Computing. All these critical success factors and challenges are established and handled only by those few technology advances. Cloud-based technologies are capable of capturing all the important information of the critical supply chain processes and enable easier, faster and cheaper monitoring of performance measurement and information sharing (Sundarakani et al., 2019). IoT devices are also used for data collection and immediate information sharing. RFID technology constantly and automatically captures data, making data acquisition less costly and provides answers to what, when, why and where for the occurred events (Rane and Thakker, 2019b; Singh and Jenamani, 2020). RFID offers monitoring of events of interest such as sudden changes in critical performance measures and it reacts to them instantly (Mehrjerdi, 2013). Additionally, to all these RFID busts traceability and provides better quality control and an online information system for end-users (Singh and Jenamani, 2020). Once again linking suppliers and customers to LSS supply chain projects is becoming easier.

Industry 4.0 technologies are huge assets for collecting, storing and analyzing huge streams of process and supply chain data (Ghobakhloo and Fathi, 2020). Tesco is an example of how companies use supply chain analytics as a tool to collect and analyze customer data from loyalty programs and mobile apps and draw conclusions (Irfan and Wang, 2019). These data can be used for VOC and thus effectively include customers to LSS projects and offer more customer-based objectives for such projects, yet another factor for successful implementation. Supply chain analytics also give real-time insights for unfulfilled orders, high fulfillment lag orders, order backlog due to inventory unavailability and other supply chain problems that are frequently approached with the LSS methodology (Zhu et al., 2018). Emerged technologies not only enable LSS projects due to the improved monitoring and tracking of processes, upstream and downstream supply chain operations but also from the rapid detection and respond to process disruption, material waste, machine and system failures and anomalies (Ghobakhloo and Fathi, 2020; Irfan and Wang, 2019; Zhu et al., 2018). So, proper project identification is also established. Linking suppliers to LSS projects, transparency, corporate communication, and employee's involvement is also improved by these technologies. Several sources underline the pivotal role of IT in the internal and external integration of the supply chain. IT can increase organizational capabilities and interaction of all firm-level resources securing process improvement (Ghobakhloo and Fathi, 2020). Collaboration and communication between the internal function units and across supply chain partners is achieved through IT systems and the digitalized supply chain (Hong et al., 2010; Irfan and Wang, 2019; Zhu et al., 2018). AR applications are usually used to simplify maintenance and accelerate employee training making their involvement easier and with less cost (Ghobakhloo and Fathi, 2020). Ghobakhloo also suggests that there is evidence for the importance of IT for the in-depth implementation of defect prevention activities, statistical control and CI of processes. Finally, lack of resources, time, budget, and human resources is another barrier that technology advance help overcome. Through these technologies cost of quality is reduced by creating smart quality management. Data collection and processing, performance measurement and monitoring are requiring much less time and human resources at a lower cost (Bag et al., 2018). Thus, the cost of implementing an LSS project is reduced.

The industry 4.0 and digitalization era apart from helping overcome LSS barriers and establish some CSFs also act as an enabler by supporting the implementation phases of an LSS project. The most used LSS methodology is the DMAIC approach which is tremendously supported by the technology advances. Big data analytics is one of the most sophisticated tools that can be used to enhance all DMAIC phases. Descriptive analytics address the questions what happened and why, while prescriptive analytics help to determine the cause-and-effect relationship among consequences and predictive analytics try to predict what is going to happen. Data mining techniques from descriptive and prescriptive analytics are used in the define, analyze, and measure phase when predictive analytics' techniques such as machine learning, artificial intelligence and flow diagrams are used for optimizing the parameters for the improvement phase. In the control phase, big data analytics are used to monitor the process improvement in a continuous basis and control process mining is used to identify potential failures impacting the improvement (Gupta et al., 2019).In general from the industry 4.0 technologies the define phase is improved as project selection is more accurate due to the large datasets, the supply chain visibility, the well-documented processes, the efficient communication through-out the supply chain. Tools such as VOC and VOB are better utilized and CTQ variables are better determined. Even data regarding waste management and energy utilization are monitored and shared through blockchain advancing the problem identification phase (Rane and Thakker, 2019b). Data mining techniques, ML, BD enable organizations to identify the root-cause of disruption in supply chain operations and processes and select the vital few Xs (Haddud and Khare, 2020). Measure and analyze phase are supported not only with the advanced tools but also from the quality data. For example, RFID technology provides accurate data for examination of past demand data and for forecasting the demand for the future (Rane and Thakker, 2019b). On many occasions the implementation of these technologies and the gradual digitalization of the supply chain is indeed the improvement that the LSS project will apply. The improve phase is enabled in two ways. Firstly, by optimization algorithms, visual and prediction tools to assess the solutions and find the optimal one to be implemented. And secondly, by using them as the solution which not only will improve the current situation but also will fuel future improvement projects. Potential improvements could be the incorporation of blockchain and electronic logging devices to improve the transportation process by providing real-time-routing using traffic data, weather data, rout data and driver behavior data (Jain et al., 2020; Sheel and Nath, 2019) or RFID-enabled items for minimizing waste from improper product handling, transportation and infrastructure conditions (Singh and Jenamani, 2020) and thus applying more sophisticated solutions. Final phase is the control phase. In this phase is the critical task of sustaining the improvement. Control, monitoring and supply chain planning are benefited from big data, cloud-based systems and real-time SPC software. Especially the latter can create automatically control charts, X-bars, Pareto Charts, and other SS tools and simultaneously evaluate the control charts based on real-time data processing data with high speed saving time, cost and human resources when SS tools are applied(Bag et al., 2018; Ghobakhloo and Fathi, 2020). Evidence from research papers shows the significant decrease of defect rates due to such technology (Ghobakhloo and Fathi, 2020).

Supply Chain digitalization increase Supply Chain leanness by positively improving the adaptation of lean practices such as JIT (Just-In-Time), VM (Visual Management), TPM (Total Productive Maintenance), CI (Continuous Improvement) and automation and Poka-Yoke (Haddud and Khare, 2020). When Supply Chain is lean it is easier and more effective the usage of SS for process improvement (Pepper and Spedding, 2010). Therefore, SC digitalization is an important enabler for the LSS initiatives. Many authors have underlined the need of digitalization and automation technologies for achieving leaning processes (Haddud and Khare, 2020; Nicoletti, 2013). The ability to acquire and process information and extracting meaningful results, effectively include suppliers in projects and processes, sharing results and information with internal and external stakeholders, timely identify performance gaps, errors and abnormalities in the supply chain processes and increased speed in making improvements are some of the results influencing the lean practices (Haddud and Khare, 2020). JIT strategy is supported by innovative technology applications such as EDI (Electronic data interexchange), VMI (Vendor-Managed Inventory), RFID solutions which greatly improve inventory management, on time delivery, forecasting accuracy and allow the organizations to act upon real-time data achieving pull-inventory strategies (Mehrjerdi, 2013). Visual Management or Visual Factory aims to make work actions and processes visible in order to identify performance gaps and errors by using a variety of visual tools (Kurpjuweit et al., 2019). Digitalization trends tend to succeed VM as digitalization of the supply chain is actually the visualization of all processes, the effort to automate them and the constant data collection, storing and sharing. Continuous Improvement (CI) is one of the lean tools and it focuses on the elimination of waste through the continuous and incremental improvement of processes with all level employee involvement (Haddud and Khare, 2018). Digitalization offers the means for error identification and all employees involvement and collaboration positively influencing CI. Advanced technologies have a positive impact on automation and Poka-Yoke. Blockchain eliminates manual processes (Hasan et al., 2020) and RFID is a supporting tool for automating processes (Mehrjerdi, 2013). Process abnormalities are visible and errors detected quickly through advanced monitoring technologies (Haddud and Khare, 2018). In figure 22 is presented how new technologies can influence the SC.

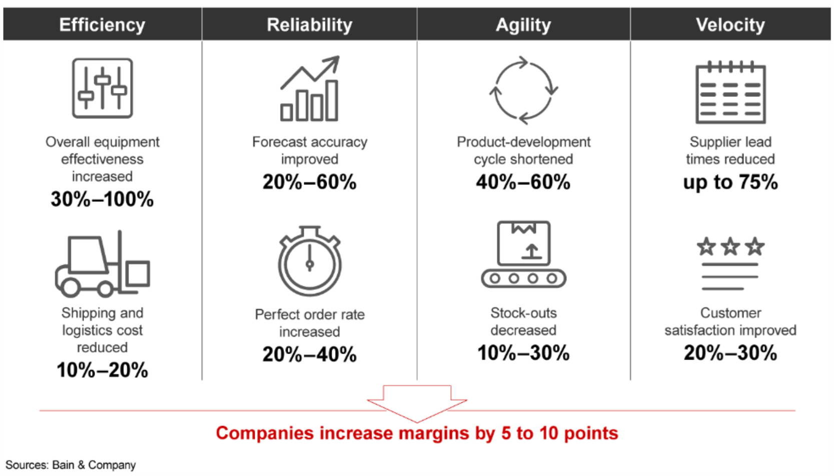


Figure 22, How new technologies influence the supply chain, source: Bain & Company

Table 2-13: Summary of how new technologies enable LSS projects in Supply Chain

How the Industry 4.0 technological advancements and the supply chain digitalization enable LSS projects' implementation in the supply chain

Ways of enabling	What is enabled	How is enabled
Establishing CSFs	Customer-based objective	Mobile applications for customers, Smart stores
		Advanced analytics in customer behavior
	Documented procedures & Business processes	Blockchain Technology
		E-procurements, e-contracts
		IoT platforms and software
		EPC, WSN, M2M
		RFID technology, QR codes
	External Information & quality data	Cloud ERP Systems
		Blockchain Technology
		IoT platforms and software
		RFID technology, QR codes
		Big data analytics (mining techniques)
	Closer suppliers' relationships	Cloud ERP Systems
		Blockchain Technology
		IoT platforms and software
	Linking to suppliers and customers	RFID technology, QR codes
		Mobile applications for customers, Smart stores
		Blockchain Technology
	Corporate communication and all level employee involvement	EPC, WSN, M2M
		IoT platforms and software
		Mobile applications, AR applications
Overcoming barriers	Inefficient visibility, monitoring and control of the supply chain	Blockchain Technology
		E-procurements, e-contracts
		RFID technology, QR codes
		EPC, WSN, M2M
		IoT platforms and software
		Mobile applications for customers, Smart stores

	Lack of visibility in marketing activities	Advanced analytics in customer behavior
		E-procurements, e-contracts
	Lack of transparency and communication	Cloud ERP Systems
		RFID technology, QR codes
		Blockchain Technology
		IoT platforms and software
	Lack of resources and high LSS projects' cost	Big data analytics
		Real time SPC software
		AR applications
	Difficulty in sustain the projects	Big data analytics
		Real time SPC
		Blockchain technology
		RFID technology
	Ineffective statistical and visual control implementations	Big data analytics
		Real time SPC
		RFID technology
Supporting LSS Project phases	Define Phase	All technologies which provide quality data
		Big data analytics
	Measure Phase	Big data analytics
	Analyze Phase	Real time SPC
		Big data analytics
		Predictive analytics, AI, ML
	Improve Phase	All technologies which provide quality data
		Big data analytics
	Control Phase	Blockchain Technology
		RFID technology
		IoT platforms and software
		Real time SPC software
		Big data analytics
		Wearable devices
	Just-In-Time (JIT)	EDI, VMI applications

Increasing Supply Chain Leanness		Cloud ERP Systems
		Mobile applications for customers, Smart stores
		RFID technology, IoT platforms and software
	Visual Management (VM)	Mobile applications for customers, Smart stores
		EPC, WSN, M2M, Wearable devices
		IoT platforms and software
		Cloud ERP Systems
		AR, AI, ML
	Continuous Improvement (CI)	Big data analytics
		RFID technology
		Blockchain technology
		IoT and Cloud software
	Automation & Poka-Yoke	Blockchain Technology
		AR, Robotics and ML
		Advanced analytics
		EPC, WSN, M2M

As mentioned before there is lack of literature linking LSS in the supply chain with industry 4.0 technologies. One of them is a paper blending LSS with big data with a provided case study (Zwetsloot et al., 2018). It is interesting the existence of three articles which are providing a framework for implementation of such technologies and supply chain processes digitalization using LSS projects (Martinez, 2019; Mehrjerdi, 2013; Nicoletti, 2013). Implementing disruptive technology solutions in LSS projects in the supply chain establishes the wanted process improvement and at the same time they provide a fruitful environment for further process improvement initiatives (Martinez, 2019). Nicoletti also supports that “the Lean and Digitalize Project is the beginning of an interactive cycle that generates CI” (Nicoletti, 2013).

The beginning for any improvement project, redesigning of a process such as the digitalization of the supply chain has as a prerequisite to have a clear view all the processes. Mapping all automated and manual processes can be done with a creation of a Reference Model. SCOR model is reference model created by the non-profit organization Supply Chain Council which now is merged with APICS Foundation called APICS Supply Chain Council. A SCOR Framework is presented in figure 23. SCOR model consists of 4 major components Performance, Processes, Practices and People linking them with another. Processes break down in 3 levels and the first level consists of 6 macrolevel SCOR processes which are depicted in the following figure, Plan, Source, Make, Deliver, Return and Enable. Performance breaks down in performance attributes, customer and internal related and metrics for each attribute. SCOR model is an excellent reference model for capturing the As-Is state and develop the To-Be (Chelariu et al., 2014; Gawankar et al., 2016; Mazzola et al., 2007; Mishra and Sharma, 2014; Moazzam et al., 2018; Zhu et al., 2018, APICS 2017). Once all processes are written, their relationships drawn and the responsible employees included in a supply chain reference model, it is pivotal to identify adding and non-adding value activities and then find ways to minimize the non-adding value activities and detect performance gaps in adding value activities. All that is the preparation for either an LSS project in the Supply Chain or a digitalization project of parts of the supply chain. Following principles of LSS projects implementation of supply chain digitalization can be achieved. When including new technologies or redesigning a process or a cluster of processes to digitalize them it is important to determine what are the CTQ points and translate them into variables as these projects are high-cost investments and should always be to the point instead if blindly introducing them. LSS tools such as VOC, VOB, Brainstorm and other can help to succeed that. Next step is to determine which are the causes and what affects and how the CTQ variable. Measure the current state and multiple performance measurements and set a targeted one. After that process experts alongside technology experts should work on redesigning the processes and should create a pilot test. Then statistical test of the results should take place with the help of SS tools. Once the optimal solution is selected, it is applied in full. When applying such project, the goal apart from performance improvement is to facilitate more LSS projects. So, the selected solution always targets to overcome LSS barriers, make supply chain leaner and better establish the CSFs for an LSS project. Finally, the Reference Model is updated, and future initiatives better supported.

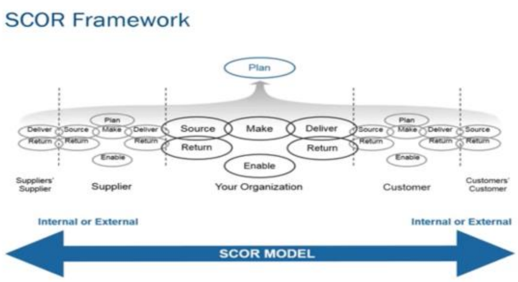


Figure 23, SCOR Framework

2.4 Literature Gap

After an extensive literature review the importance and the potential of LSS as a CI method is established. So, is the applicability of LSS in various sectors, the significance of the CSFs and the LSS barriers, and the wide use of the DMAIC approach. It is also observed that there is lack of papers using DMADV or DMAEV method for LSS improvements although there are constantly referred as reliable and effective methods.

From the literature review it is outlined the successful implementation of LSS in FSC, RSC but there is lack of papers referring to specifically Hypermarket, Supermarket, Convenience stores and Groceries supply chain and generally there is still ground for papers focusing on LSS in Supply Chain. The majority of published papers for LSS in the Supply Chain are case studies and there is huge potential for quantitative research.

There is also a gap in the literature regarding the correlation between SC digitalization, Industry 4.0 technologies in the SC and LSS. There is lack of either qualitative, quantitative or empirical studies that examine the successful implementation of lean or LSS, Industry 4.0 technologies and how they act as an enabler for LSS projects in the SC. Although, the connection between technological advancements and LSS is obvious there is lack of research to prove, support it and highlight the potential contribution of such technology in the LSS initiatives.

Finally, another observation is regarding the lack of existence of reference and real case models both for guiding the SC transformation according the LSS principles and demonstrating business processes constructed under LSS principles in specific industries and operations namely Supply Chain Management of the Consumer Goods Industry.

3. METHODOLOGY

This thesis aims to demonstrate how LSS method can be used to create a new Business Process Model in the Supply Chain including new technologies in the supply chain and digitalize supply chain and how simultaneously those two can support future LSS projects in the Supply Chain. It is tried to provide a model for effective Supply Chain transformation and optimization.

Figure 26 is the flow chart of the followed steps in this thesis to reach to the final goal, the creation of the improved model.

After establishing the topic of the thesis which is Supermarket Supply Chain Optimization with LSS and new technologies, finding the aim of this thesis, setting the objectives and the research questions is selected the most appropriate research method to provide the answers and a profound analysis of the topic, the qualitative case study approach. The selected research method is a qualitative approach, a case study approach. The case study approach is selected in order to provide in-depth analysis of the discussed concepts and offer answers to the research question. According to E.Baxter, S.Jack and Yin, the case study approach is suitable for research papers with "how" research questions and when contextual conditions are relevant to the phenomenon under study (Baxter and Jack, 2015; Rashid et al., 2019). Both conditions apply to this thesis, thus case study was selected as a research method.

The next step is the selection of the company for the Case Study. To gather data for the research three qualitative research tools were selected, interviews, questionnaire and on-site visits. Interviews were selected aiming to gather information from different level employees and capture their needs and requirements. On-site visits were performed in order to collect data from personal observation and offer a different side of view. Finally, the questionnaire was created in order to collect very specific data from all over the industry. Although, the official goal for the questionnaire was that we weren't able to execute a sector research, but it is included for future research. From the gathered data the company's needs and requirements were identified which are extensively discussed on the corresponding section.

Having in mind this company's specific expectations and needs for their Supply Chain the literature review was executed for the Lean Six Sigma, the Supermarket Supply Chain and the new technologies, and the LSS in the Supply Chain. From this research were derived the new technologies which are incorporated in the model. The selected LSS methodology for the construction of the model is the DMAEV and the LSS tools are VOC, CTQ, SWOT, Project Charter, Process Mapping, and KPIs. The tools were selected according to the available data from the company. As a Lean Six Sigma methodology DMAEV was selected after the literature review. From the literature review it was outlined that the most used methods are DMAIC, DMADV and DMAEV which is an alteration of DMADV from Samsung Group. DMADV is selected when the goal is not just to implement improvements but also to redesign/reengineer a process. In this thesis redesigning processes is needed thus, DMADV is more suited than DMAIC. On the other hand, the aim for the new processes is to enable future LSS Projects and to create a circle of Continuous Improvement among the processes which is exactly what the altered DMADV, DMAEV succeeds. All, these approaches are flexible as mentioned in the literature review section and so, DMAEV was finally selected between those three approaches.

For the Processes Mapping and the final improved model, the Enterprise BPMN collaboration diagram is selected. For the construction of the Enterprise BPMN collaboration diagram ARIS architect & design 10.0 software is used.

Business Process Model and Notation is a standardized language for Business Modelling created by the Object Management Group in 2006 widely used due its expressivity, simplicity and sematic richness (OMG, 2021;Lopez-Campos et al., 2019; Zarour et al., 2020). The most used Business Processes modelling techniques and languages are flow diagrams, event-driver process chain (EPC), role diagrams, Perti-nets, UML and BPMN. The most standard used are UML and BPMN (Zarour et al., 2020). UML is designed for software engineers (Zarour et al., 2020) whereas BPMN acts as a communication bridge between IT staff, managers and low level process implementers (Lopez-Campos et al., 2019) and it is used from both academia and industry (Milton and Johnson, 2012). BPMN is used as the basis for process representation, simulation and automation (Milton and Johnson, 2012) and has a diagrammatic way to represent process and information flow, decision points and involved roles (Zarour et al., 2020). BPMN is distinguished among the BPM techniques and languages due to four characteristics. First, BPMN can be translated into software process components (OMG, 2021) and has an increased vendor and IT services (SAP, IBM) involvement and compatibility (Milton and Johnson, 2012). IT Systems are also actors in the BPMN, very important for more automated processes with high IT Systems involvement. Especially, BPMN 2.0 includes an extension mechanism allowing additional representation of concepts and elements making BPMN extremely useful for specific domains. For example, BPMN 2.0 has an extension for a domain including interconnection of physical entities via a network i.e., IoT (Zarour et al., 2020). Finally, BPMN 2.0 involves choreography for inter-unit and inter-organizational processes (Milton and Johnson, 2012). So, BPMN is a very important tool to represent, analyze and improve processes and for all these reasons it is selected for this thesis. Figure 24 represents all the category elements of BPMN.

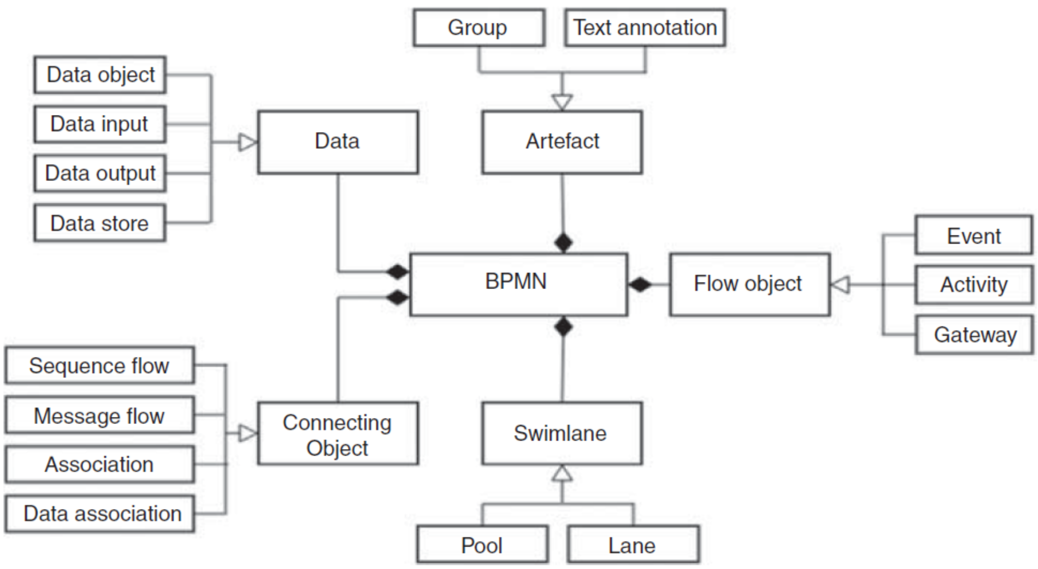
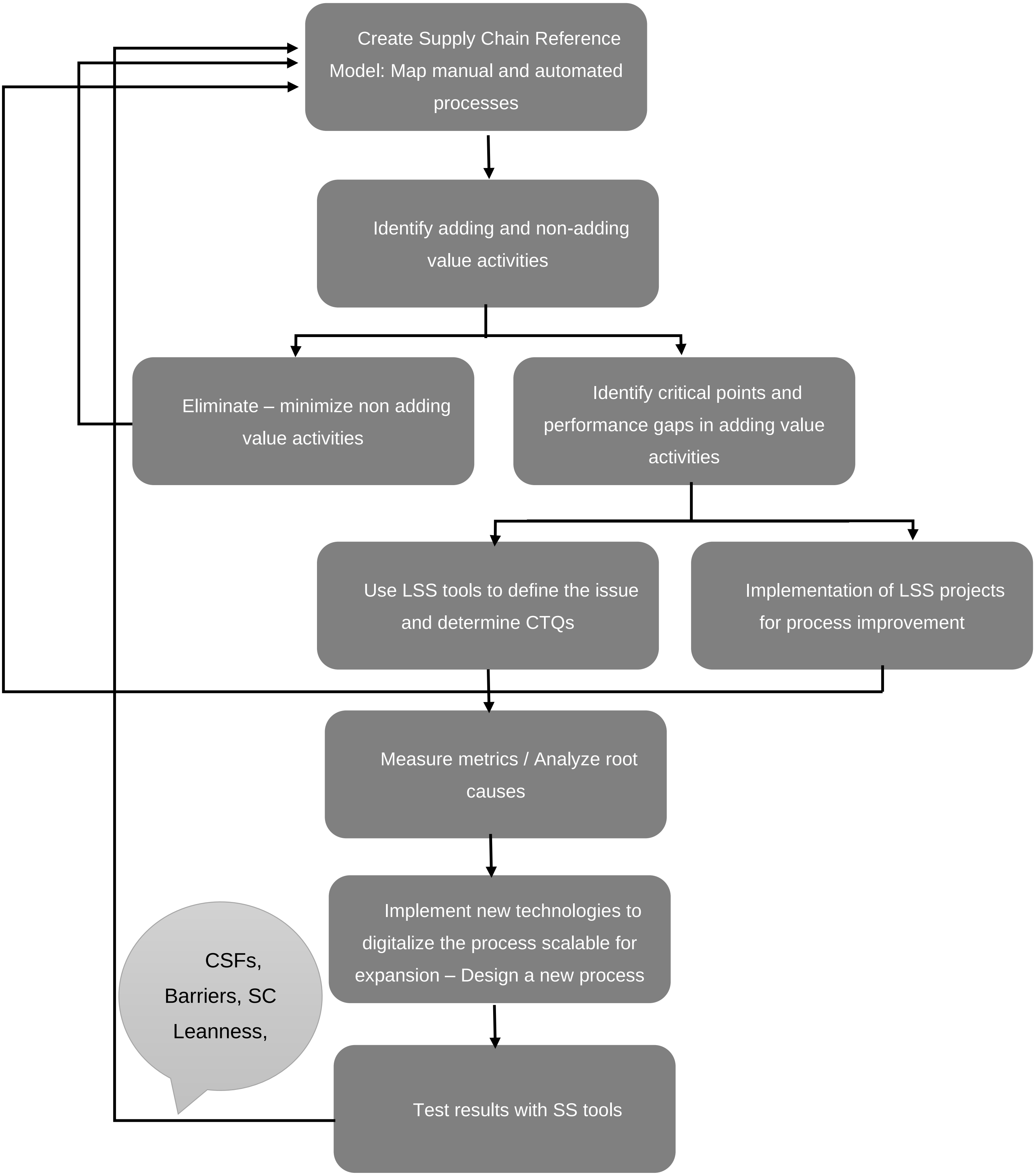


Figure 24, BPMN elements structure according to each category (Zarour et al., 2020)

Architecture of Integrated Information Systems (ARIS) is a business process analysis (BPA) tool for analyzing, designing, documenting, and optimizing processes. ARIS manages business processes from an analytical perspective (Software AG, 2021, Cheung and Hidders, 2011). ARIS architect & designer are two ARIS tools for process modeling and optimization. It is selected as it is user friendly, it aligns processes with IT, it supports both BPMN and UML and it has various features for potential future use such as Analysis, reports & macros which evaluate processes in terms of quality and use resulting Key Performance Indicators (KPIs) to optimize processes etc.

Figure 25 represents a framework influenced by all the mentioned authors in the literature review to achieve both supply chain digitalization and enable future LSS projects avoiding excessive and unnecessary digitalization and establishing a nurturing environment for other LSS projects in the supply chain. The following figure depicts a simplistic diagram describing that framework.



Each time the circle is completed these are improved and every new improvement initiative better supported and other LSS projects enabled

Figure 25, Framework for LSS projects and digital transformation

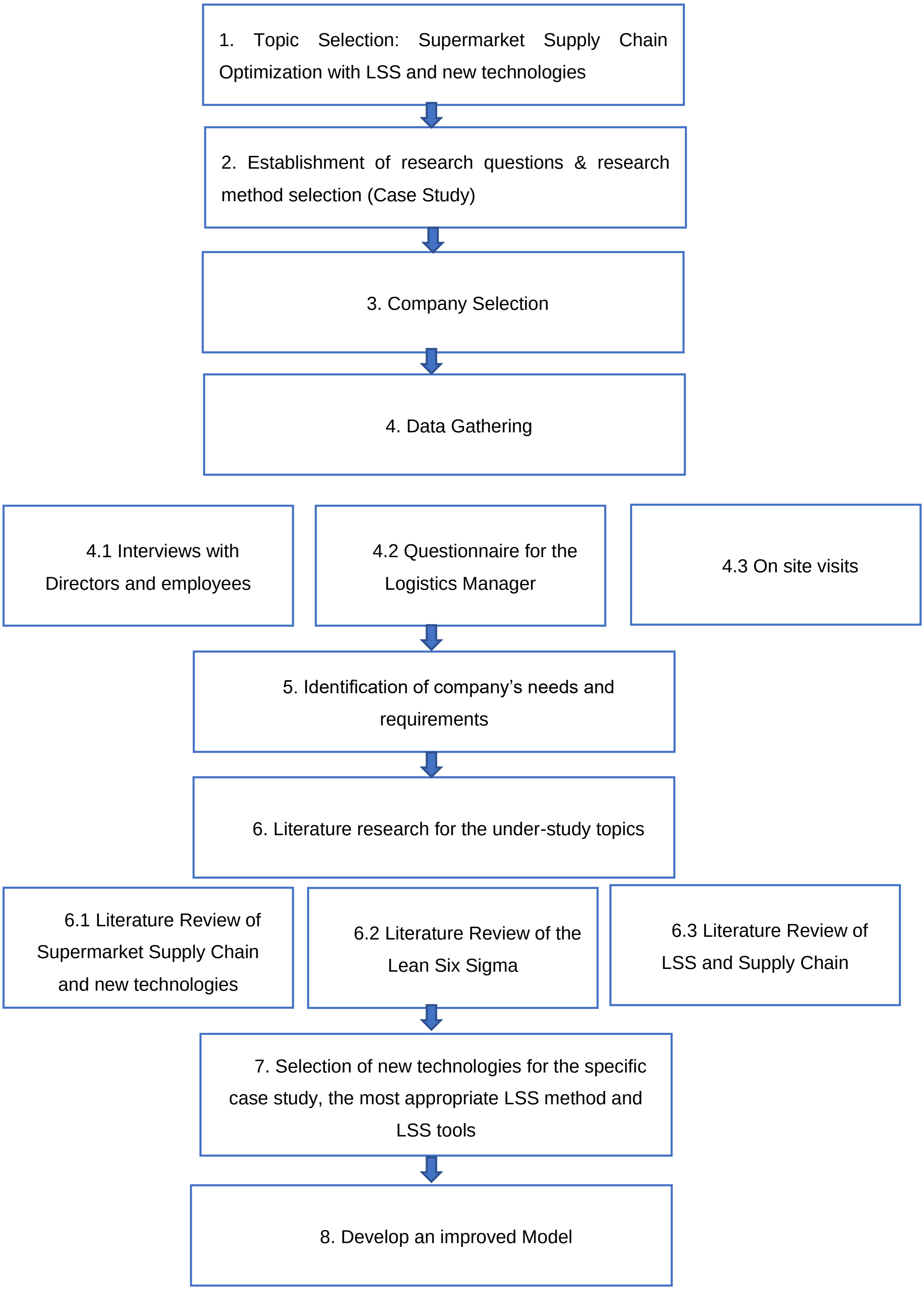


Figure 26, Thesis flow-chart

4. CASE STUDY: DIGITALIZED DISTRIBUTION PROCESSES MODEL OF A GREEK SUPERMARKET ENABLING LSS PROJECTS

4.1 Introduction of the Company

The targeted company is a leading Greek supermarket chain company with 510 (in 2021) Supermarkets, Convenience Stores, Cash and Carry and online shop in Greece. According to the square meters the store it is categorized into four different store formats, Large, Medium, Small and City. More than 80 are Franchises and some are also partner stores. The company has three Distribution Centers. One DC is in Thessaloniki for the northern Greek stores distributions and two in Attica for the Greek Islands and the rest of the continental country. The headquarters and the offices are located in Athens and employs more than 14,000 people. The company is a subsidiary of a Dutch/Belgian multinational retail company with presence in 10 countries worldwide and experience in the industry for more than 150 years.

Until February 2020, the company had presence in 13 regions in Greece with 449 stores, 128 of them were franchise stores, 5 hypermarkets, 51 mini-markets and 15 cash &carry.

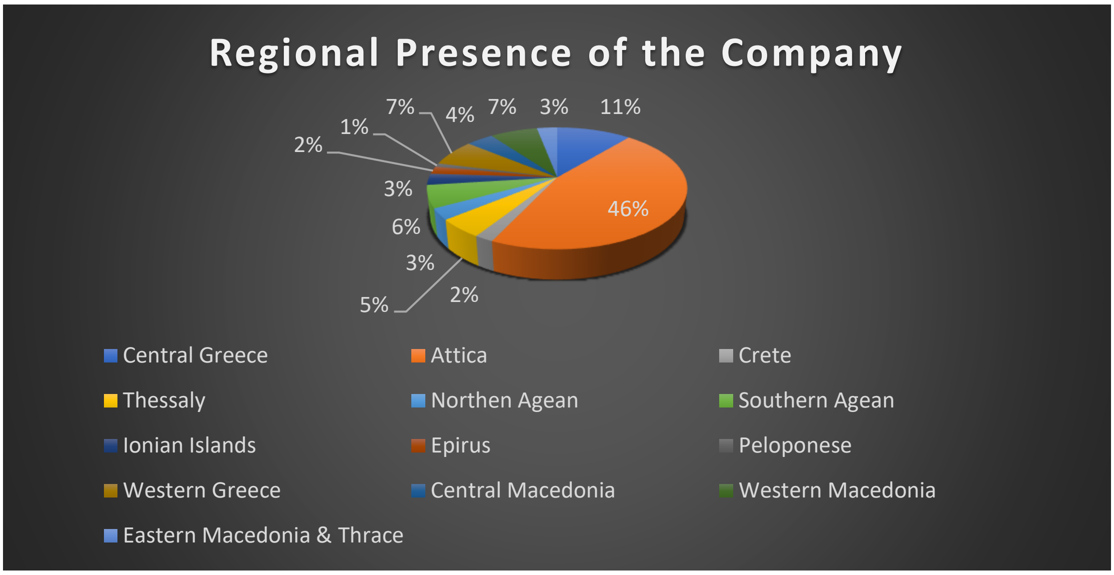


Figure 27, Pie Chart-Regional Presence of the company, source:(Hellenic Competition Commission,"ΕΝΔΙΑΜΕΣΗ ΕΚΘΕΣΗ Κλαδική έρευνα στον κλάδο παραγωγής , διανομής και εμπορίας βασικών καταναλωτικών ειδών και ιδίως ειδών διατροφής , καθώς και ειδών", n.d.)

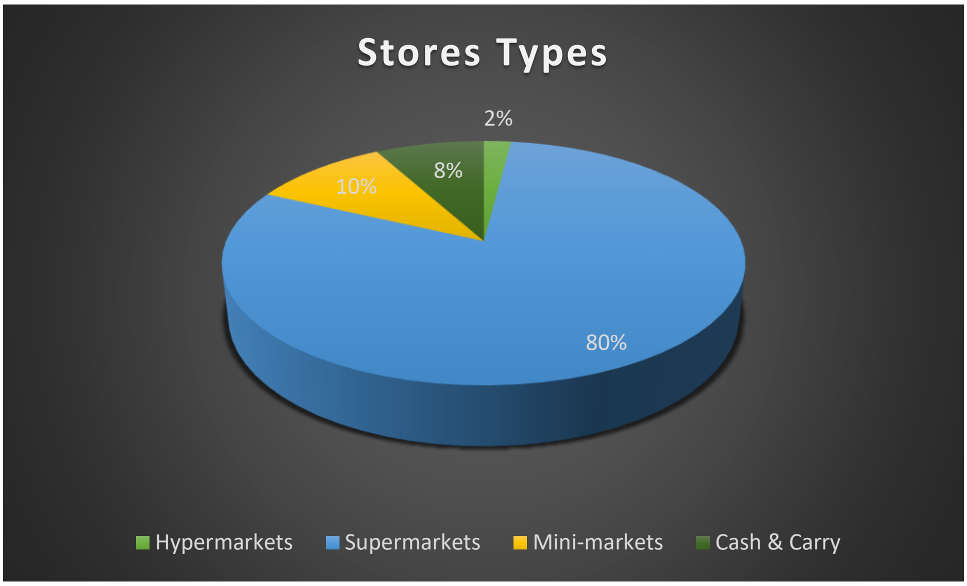


Figure 28, Pie Chart, Store Types, source:(Hellenic Competition Commission,"ΕΝΔΙΑΜΕΣΗ ΕΚΘΕΣΗ Κλαδική έρευνα στον κλάδο παραγωγής , διανομής και εμπορίας βασικών καταναλωτικών ειδών και ιδίως ειδών διατροφής , καθώς και ειδών", n.d.)

4.1.1 Historic Background

The company is established since **1939** by three brothers. From **1971-1989** the company establishes a supermarket chain. The company enters the Athens stock exchange in **1990**. Two years later, in **1992** the company partners with the Belgian retail company. In **1994**, the company shows its innovative character by being the first Greek supermarket to introduce scanning counter machines, private labeled products and the company invests in the first DC. The next big step is the creation of a franchise network between **2000-2003**. In **2008**, the company acquires another Greek supermarket chain and constructs their second DC in Thessaloniki. The next year, **2009**, the company continuous with another acquisition and another investment in logistics, the third DC. The first Green Store for the company opens in **2010**. The company has the first BREEAM-certified 'green store' in Europe. Until **2016** the company continuous to open new stores, franchises and to renovate stores. In **2016**, the company becomes a member of the multination Dutch/Belgian retail company. The following years until **2019**, the company invests in growing their network of stores, franchises, and partners. In **2020**, due to the covid pandemic the company introduce their online shop and created a central distribution center for the online orders investing more than 10M euros in this initiative.

4.1.2 Mission and Vision

The company's mission as they state is "to give their best self to make a difference in people's life". The mission for the mother company is their "great local brands to share a passion for delivering great food, value and innovations, and for creating inclusive workplaces that provide rewarding professional opportunities". The mission for the company is to provide customers with high quality and nutrition products accessible to everyone while always innovating to meet the customers' constantly changing needs. The company has a very customer centric approach emphasizing that each customer is unique and a very innovative character trying to make the shopping experience unique as they state, "same as our customers". The vison of the company is to be the first and best choice of the consumer, to create the best working place and be the best neighbor in our society.

The company invests in two pillars, employees, innovation aiming to create a combination of exceptional employees, high quality services and systems to support them to achieve their mission and the first two parts of their vision. Finally, the company takes upon several SCR initiatives to achieve the third part of their vision.

"Eat well. Save time. Live better"

- the multinational company's motto

4.1.3 Organizational Chart, Management and Employees

The company focuses extremely on their workforce trying not only to provide a great working environment but also opportunities to evolve. The Company employs 14,550 people and offers a variety of programs for their constant development and aquation of new talents.

Employees Programs:

- ✓ New talents acquisition programs
- ✓ Support employees with special needs programs
- ✓ Programs for diversity acceptance and involvement
- ✓ Special employees benefits
- ✓ Health and wellness programs

The following diagram represents the organizational structure of the company's departments.

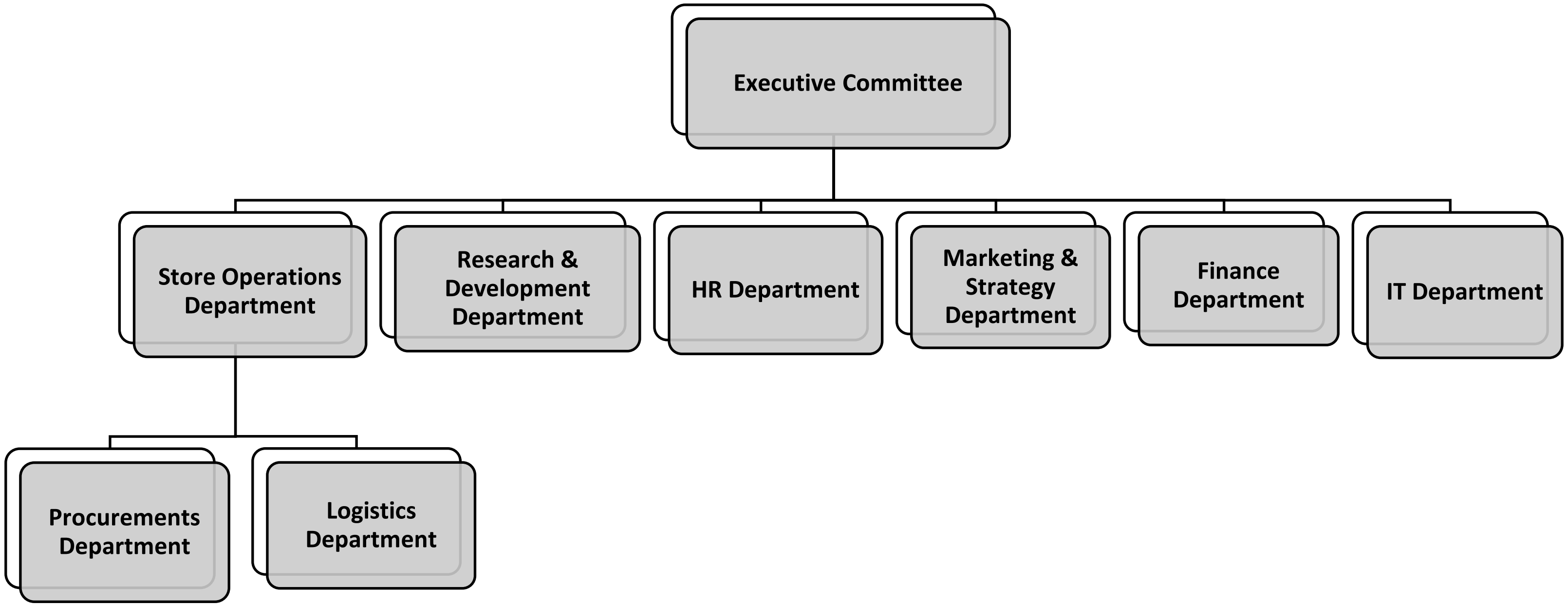


Figure 29, Organizational Chart of Departments

The company is subsidiary of a multinational retail company as mentioned. Hence, the management structure of the company consists of an Executive Committee. The leader of the Executive Committee is the Chief Executive Officer and Brand President, Greece. The Executive Committee consists of the following members:

- VP Human Resources and Organizational Development &PMO, Greece
- VP IT, Southeastern Europe
- SVP Finance – Chief Financial Officer, Greece
- SVP Operations
- SVP Logistics
- SVP Buying
- SVP Business Opportunities
- VP Marketing & Strategy
- VP Business Development
- VP Legal Affairs

4.1.4 Products and Services

The company offers up to 11,000 different products to the customer including private labeled products through the stores and the online marketplace. The products are divided in 14 categories:

- Fruits and Vegetables
- Dairy and chilled products
- Fresh meat & fish
- Cheese, meats and delicatessen
- Breakfast, snacking & drinks
- Basic packaged food
- Frozen Food
- Bakery
- Wines, spirits, soft drinks and water
- Ready meals
- Toiletries
- Cleaning products, stationary & homeware
- Pet products
- Baby products

The private labeled products include Bio products, fruits, vegetables, fresh meat and cheese, Frozen Foods, home care, kids and pet care products, cosmetics and cleaning products. They also offer private labeled ready healthy and homecooked meals.

The company collaborates with more than 2,000 vendors and supports local products and producers. All producers are selected based on strict sustainability criteria and high-quality standards and certifications to ensure safety and quality to customers. The company tries to offer a wide variety of high quality, fresh products at a low price. All fresh products are cultivated and collected according to GACP.

Aiming to add value to the end customer the company includes extra services:

- ✓ Home Delivery
- ✓ Gift Certificates
- ✓ Loyalty Schemes
- ✓ Partnership with Pockee, a smartphone application for supermarket purchases tracking and cashback coupons
- ✓ Bills' payment
- ✓ Fresh Fish and Yummy orders
- ✓ Money transfers through Western Union
- ✓ Electric cars charging stations (to be launched in 2021)

The company is the first Greek Supermarket to introduce loyalty schemes. The **home delivery service** is applicable for purchases exceeding the amount of 40 euros in store. It is applicable for online orders (>40 euros), e-mail or phone orders and it is free for orders greater than 60 euros and the customer can select a specific delivery time and point. **Gift cards** are provided to customers and redeemed at every store of the company. The company has also in place **loyalty schemes** with customer card, point system, extra discounts, and award system. The **smartphone app Pockee** is used by the company to offer customers with more gift coupons gathered in one place and online redeeming and purchases tracking just by entering their receipt. Another service is **utilities bills payment** for specific providers in store. Finally, the newest service is the **"Fresh Fish and Yummy order"** which allows customers to place orders for specific seafood for example lobster, or rare fish and other and get notified the next days for their order status.

In 2020 the company launched their E-shop as a new distribution channel which includes some features aiming to also add value alongside the offered services. The E-shop contributes with 2% of the earning so far. Through the E-shop a customer can learn new recipes and by selecting the desired recipe they can add in the cart the products to purchase them. They also can get informed for special offers, or products from abroad and their store availability. The E-shop also offers the ability to create shopping list and automatically submit it for purchases and save it for future purchases as well. Finally, the promotional material of the company is available i.e, the company's magazines and overview for all the private labeled products.

4.1.5 Competition and Market Share

In 2020, the Market Volume of the Supermarket sector in Greece came up to 11.34 billion euros with an increase of 9.7% from 2019 (10.43 billion euros). The hypermarket (>2,500 sqm) sales in 2020 are increased by 17.8% from 2019, the supermarket sales increased by 9.7% (1,000-2,499 sqm), Smaller supermarket stores sales increased by 5.2% and superettes sales increased by 7.7%. In Greece, it is observed that in the supermarket sector supermarket chains prevail. The following table shows the number of supermarkets and the percentage of the supermarket chains in Greek ecosystem from 2014 to 2018.

Table 4-1: Number of Supermarkets and Supermarket Chains

Stores	2014	2015	2016	2017	2018
Total # of supermarkets	4,452	4,485	4,117	4,675	4,779
Total # of supermarket chains	2,293	2,307	1,995	2,434	2,492
Percentage of supermarket chains	**51.5%**	**51.4%**	**48.5%**	**52.1%**	**52.1%**

source:(Hellenic Competition Commission "ΕΝΔΙΑΜΕΣΗ ΕΚΘΕΣΗ Κλαδική έρευνα στον κλάδο παραγωγής , διανομής και εμπορίας βασικών καταναλωτικών ειδών και ιδίως ειδών διατροφής , καθώς και ειδών", n.d.)

To create a whole image regarding the Greek Supermarket sector it is important to know and distinguish the total sales of the supermarkets and the sales of the supermarket chains over the years. This information is provided in the presented table.

Table 4-2: Total supermarket sales and supermarket chains sales

Sales in K€	2014	2015	2016	2017	2018
Total sales of supermarkets	11,320,000	11,140,000	11,010,000	11,065,000	11,350,000
Total sales of supermarket chains	9,473,419	9,057,474	8,924,529	9,480,484	8,582,891
Sales percentage of supermarket chains	**83.7%**	**81.3%**	**81.1%**	**85.7%**	**75.6%**

source:(Hellenic Competition Commission “ΕΝΔΙΑΜΕΣΗ ΕΚΘΕΣΗ Κλαδική έρευνα στον κλάδο παραγωγής , διανομής και εμπορίας βασικών καταναλωτικών ειδών και ιδίως ειδών διατροφής , καθώς και ειδών”, n.d.)

Table 4-3: Annual turnover (K€) of the biggest Greek Supermarkets

TOP 10 GREEK SUPERMARKET COMPANIES (excluding Lidl)		
COMPANY	**2017**	**2018**
SKLAVENITIS S.A.	2,524,292	3,011,502
AB VASILOPOULOS S.A.	2,100,319	1,986,336
METRO AEBE	1,172,126	1,190,626
MASOUTIS S.A.	761,589	770,349
PENTE S.A.	482,772	310,348
KRITIKOS GROUP S.A.	229,807	310,348
MARKET-IN S.A.	251,013	284,110
SYN.KA S.A.	175,732	175,625
BAZAAR S.A.	162,628	168,955
GOUNTSIDIS S.A.	48,765	46,903
Sum of the 10 Group/Companies	**7,909,043**	**8,394,723**
Percentage over the grand total	**71.5%**	**74%**

source:(Hellenic Competition Commission "ΕΝΔΙΑΜΕΣΗ ΕΚΘΕΣΗ Κλαδική έρευνα στον κλάδο παραγωγής , διανομής και εμπορίας βασικών καταναλωτικών ειδών και ιδίως ειδών διατροφής , καθώς και ειδών", n.d.)

In Greece, the 10 biggest Supermarket Chain Companies (including Lidl Hellas) have the 85-95% market share. In 2021, the top 4 of them held the 65-75% of the market share.

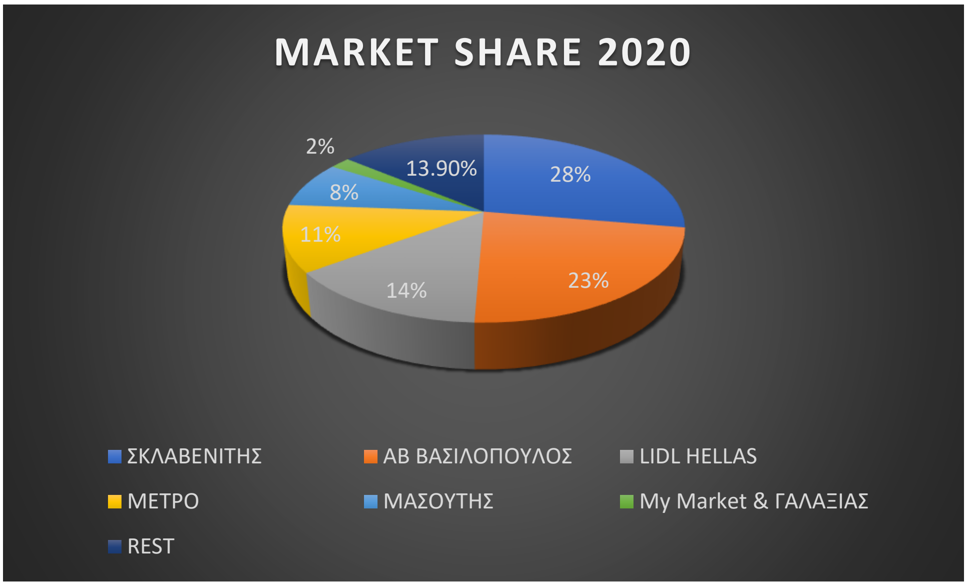


Figure 30, Market Share for 2020

The biggest 3, Sklavenitis, AB Vasilopoulos and Lidl Hellas constitute the 64.6% of the market share, the next three, Masoutis, My Market-Metro and Galaxias constitute the 21.4 and all the rest the remaining value.

Table 4-4: Market Share of Supermarket Chains Companies over the years

MARKET SHARE OF THE TOP 10 GREEK SUPERMARKET COMPANIES			
COMPANY	**2016**	**2017**	**2018**
SKLAVENITIS GROUP	15%-25%	15%-25%	15%-25%
AB VASILOPOULOS	15%-25%	15%-25%	15%-25%
LIDL	10%-15%	10%-15%	10%-15%
METRO	10%-15%	10%-15%	10%-15%
MASOUTIS	5%-10%	5%-10%	5%-10%
PENTE	0%-5%	0%-5%	0%-5%

MARKET-IN	0%-5%	0%-5%	0%-5%
KRITIKOS	0%-5%	0%-5%	0%-5%
SYN.KA	0%-5%	0%-5%	0%-5%
BAZAAR	0%-5%	0%-5%	0%-5%
GOUNTSIDIS	0%-5%	0%-5%	0%-5%

source:(Hellenic Competition Commission "ΕΝΔΙΑΜΕΣΗ ΕΚΘΕΣΗ Κλαδική έρευνα στον κλάδο παραγωγής , διανομής και εμπορίας βασικών καταναλωτικών ειδών και ιδίως ειδών διατροφής , καθώς και ειδών", n.d.)

From 2016 until 2021 Sklavenitis and AB Vasilopoulos antagonizing each other to establish the first place in the market share competition.

Market Players

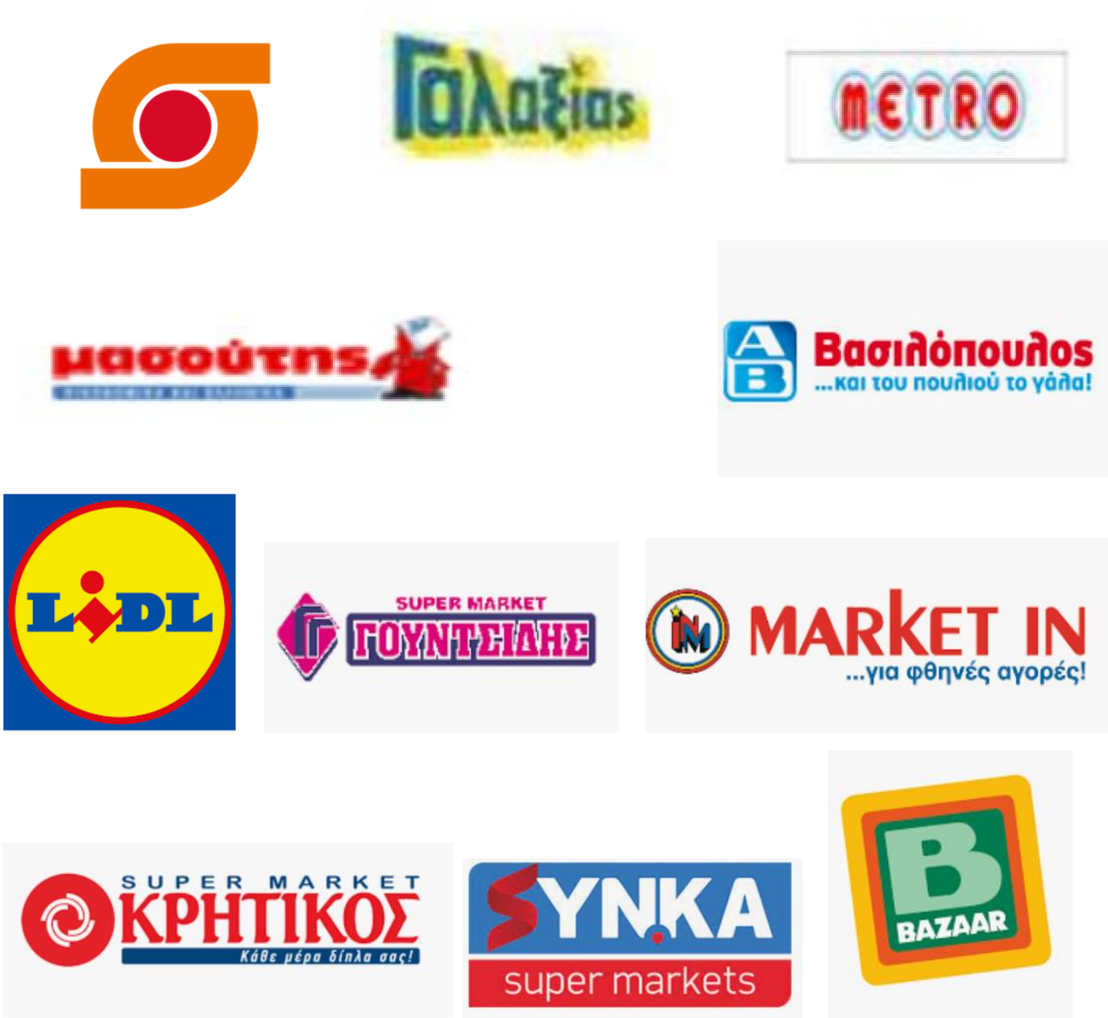


Figure 31, Market Players' Logos

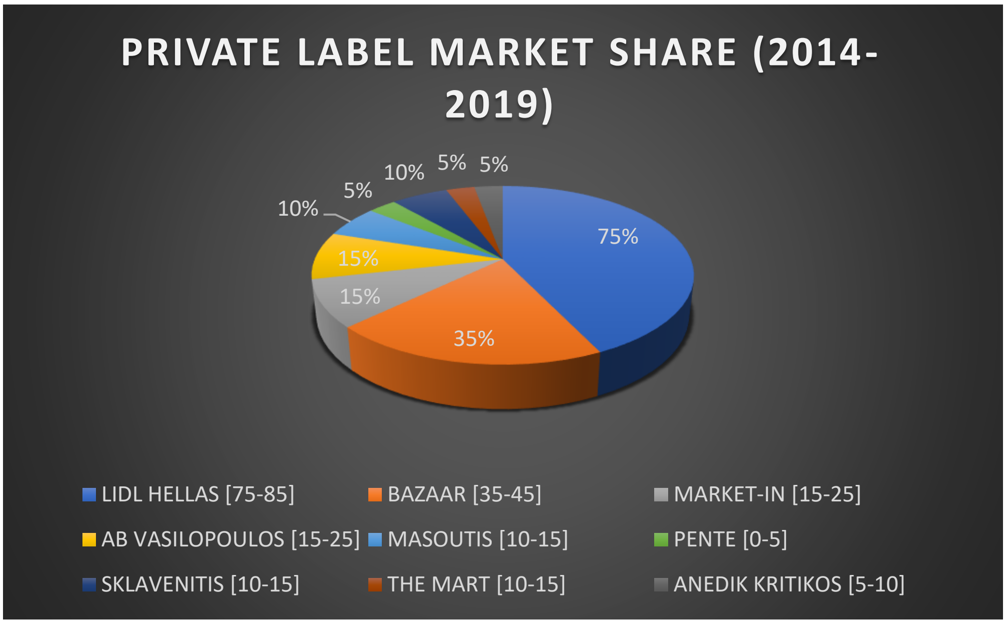


Figure 32, Pie Chart, Private label Market Share 204-2019, source:(Hellenic Competition Commission "ΕΝΔΙΑΜΕΣΗ ΕΚΘΕΣΗ Κλαδική έρευνα στον κλάδο παραγωγής , διανομής και εμπορίας βασικών καταναλωτικών ειδών και ιδίως ειδών διατροφής , καθώς και ειδών", n.d.)

Recent market research with 2,000 consumers showed that 58% believe that the products' quality is the same between well-known brands and private labels. Also, 48% prefer to buy from supermarket chains which have private labeled products.

4.1.6 Company's strategic analysis

4.1.6.1 Company's Supply Chain

Products receival

Products receival is a very important process to ensure the targeted high quality of products. Upon product receival they perform the quality control of products starting by checking the cleanness condition of the trucks, the temperature and humidity conditions of the transportation and finally they examine the products. They check expiration dates, products and packages condition and some specifics according to each product.

Warehousing

The Company has logistics' centralization rate is more than 90%, having three DCs, one in Thessaloniki, one in Attica region and one in Central Greece region. Aiming to support the local producers they keep centralization rate at this level delivering some local products directly to stores. The company decided very early to create their own warehousing and distribution network and it is considered a distinctive example of a non-logistics company with such exemplary supply chain network. Warehousing includes picking. Pickers use clarks to transfer the pallets and then loaders perform the pallet splits and merges according to directions always putting lower the heavier products and the more delicate on top.

Figure 33, Picture of one of the DCs in Attica

Distribution

The Distribution Channel of the supply chain covers the whole Greece and the country is divided in North Greece and South Greece. North Greece is served by the DC in Thessaloniki which can store both temperature-controlled (cold supply chain) supply chain and non-temperature-controlled supply chain. This DC is also used as a cross-docking platform for the other DCs. From the DCs in Attica only one can support the cold supply chain (fresh and frozen products), the second one supports only room temperature products etc. Frozen meat, fish and vegetables for example are stored in -25 Celcius. Although distribution works smoothly, the company wants to use even more high technologies in the distribution. The company has also invested in their own fleet having more than 80 trucks. In their distribution processes the company includes backhauling. Once the owned trucks transport products to various areas they try to arrive back to the warehouse with full load from suppliers. Apart from the owned trucks transportations are executed by Third-Party Logistics Companies. The fleet used is meets very high standard specifications so it can maintain the high quality of products.

Their owned trucks are cutting edge trucks which can support various temperatures and have cold stores.

Stores

Stores are the last mile of the supply chain, the point where the products meet the end user. All stores are HAACP certified for food safety meaning that personnel, machinery, and the place itself are maintaining specific standards. HAACP requires specific procedures such as:

- ✓ Systematic monitoring of refrigeration temperatures and products
- ✓ Regular cleaning and disinfection with specific methods for all used and supporting areas
- ✓ Appropriate measures for personnel' s hygiene
- ✓ Scheduled and unscheduled store inspections

The stores are working with conventional ways. There is available infrastructure and space for the unloading, stock keeping and pallets storing. The personnel helps in the unloading, orders delivering, shelf replenishment and customer service.

4.1.6.2 Used Technology

The company uses several management systems to support the processes such as ERP System, Warehouse Management System, Distribution Management System and Enterprise Performance System (EPM). The newest investment is forecasting systems for orders. Also, the company tries to restructure the logistics in such way to be ready for automation and digitalization. The company also tries to decrease the store energy consumption by 40% by including new HVAC technologies and advanced lighting solutions.

4.1.6.3 SWOT analysis

STRENGTHS	**WEAKNESSES**
• Strong Brand Name	• Subsidiary of a foreign Group
• Wide variety of products	• Considered expensive
• Private labeled products	• Low technological involvement in comparison to the mother company and other companies abroad
• Green Policies	
• SCR initiatives	

• High product quality • Leading company in sector • Strong negotiating capability • Certified vendors and suppliers • Innovative mindset	
OPPORTUNITIES • Consumer preference to high quality, healthy and green solutions • Correlation between customer preference of a supermarket and private labels • No other Greek companies in the sector are using innovative technologies • E-shop/online shopping flourishes • Logistics expansion • Acquisition of smaller brands to increase the geographical presence in Greece	**THREATS** • Competitors start in investing in new technologies, being the first company in Greece to do so • Strong competition • Low rate of investments in Greece • Economic crisis • Uncertainty after the covid19 era • Greek legislations regarding DC development

STRENGTHS

The company over the years has established a well know and strong brand name serving more than 2,2 M customers weekly and hold an important portion of the market share. It is considered one of the leaders in the supermarket sector and has created longstanding relationships with vendors and suppliers based on mutual trust. Due to these facts the company has strong negotiating power achieving good deals and being able to promote the desired quality policies in goods handling and the way suppliers and vendor operate. Also, the company is well known for the wide variety of high-quality products and customers trust and select their private labeled products. The company has in place various SCR initiatives and green polices and customers lately are prone to select chains with such policies. The company has partnered with recycling companies to promote recycling of packages, oil, and batteries. They also sell reusable bags in very low prices in stores. The company owns two fully green certified building being the first and only supermarket in Greece. Moreover, energy consumption is reduced by using only LED lamps in the stores, HVAC systems with electronic monitoring, special refrigerator doors for minimizing losses, and residual heat from refrigeration is reused for heating water. From 2008, the company uses solar panels in the stores' rooftops of 35kW power in total. Logistics' centralization and backhauling apart from reducing distribution cost are aiming to reduce the CO2 emissions, traffic, and noise pollution. In 2021, the company also plans to launch their first electric cars charging spots. Their social responsibility initiatives apart from the environment are focusing on people. The last 10 years the company has volunteering programs for products gathering and distribution to NGOs and families, donations programs and more than 50 different initiatives all over Greece. Finally, the company from early on showed their innovative mindset and also the mother company is world known as an innovator in retail.

WEAKNESSES

On the other hand, the company has several weaknesses. First weakness is being a subsidiary of a foreign group. Although, it was founded by Greek brothers now it is considered as a foreign company and there is the tendency in the Greek market to support Greek Companies and trust them more. Secondly, from market research is shown that the targeted company is considered an expensive one, hence, some consumers may not prefer it. Finally, despite the innovative mindset of their own and the mother company since the acquisition they haven't invested more in new technologies. For example, the E-shop was launched due to the covid19 in 2020.

OPPORTUNITIES

The constant changes in the environment provide plenty opportunities which can be easily seized by a company with these strengths. For once, consumers' preferences are shifting towards fresh, bio, local, high-quality products, and green solutions. Also, a research from the Hellenic Competition Committee showed that consumers trust more supermarket chains with private labeled products. These new trends should the company exploit to add value to the end user. Furthermore, no other Greek supermarket focuses on new technologies and the company has both the know-how from abroad and the resources to invest heavily in it and be a pioneer in Greece reducing cost and providing unique shopping experience to the consumer. According to this scope, investment can be made in logistics and evolution of the online shop. Finally, the company can try to acquire smaller supermarkets to increase the company's presence in Greece. Finally, there is uncertainty for the future of the Greek market due to the covid19, so companies are considering if the time is right for new projects.

THREATS

Of course, it is always important to understand the treats of the company's surrounding environment to make timely the appropriate actions and select the best strategy, so their operations remain intact and are not disrupted. The Greek market is relatively small, and the competition is strong. It is crucial to be one step ahead of the competition. As mentioned no other companies are focusing on new technologies which is a threat in case one of the biggest competitors makes first this move and thus simultaneously being the first and possible gain the biggest market share. Secondly, the legislation regarding the distributions centers development is a bit vague and at the same time economic crisis, low rate of new investments, lack of liquidity in the market, and stability are stopping factors for huge investment. Finally, there is uncertainty for the future of the Greek market due to the covid19 era and so, companies are considering if the time is right for new projects.

4.2. Implementation of DMAEV to create an improved Distribution Processes Model with partial digitalization and new technologies involvement

4.2.2. Define Phase

The objective of the define phase, as stated in the literature review section, is to specify the problem, set the scope and the objectives of the project. This information is all included in the project charter.

The first step in order to construct the project charter is to specify the problem and understand the customer's requirements by conducting a primary market research and using the qualitative tool VOC. The primary market research was conducted in two ways, a series of face-to-face interviews with the Distribution Director, the Shift Coordinator, the Distribution Planner, the Fleet Manager, a Loader and a Driver of the company and a questionnaire to the Logistics Manager. The initial goal was to distribute the questionnaire to all Greek Supermarket's which due to covid-19 was not applicable and it can be a part of a future research. In the series of interviews with the Distribution Director of the company stated that the processes of interest for optimization are the Distribution Processes. After several discussions to concluded that the expectations of such project are the following:

- Increase automation, digitalization, and technological advancements engagement in the processes.
- Decrease the number of exchanged e-mails throughout the processes.
- Improve documentation and data gathering.
- Increase the number of optimization projects in the Distribution Processes.
- Increase Distribution Processes efficiency.

Finally, it was decided that at this state the need is to analyze the "as-is" distribution processes and develop a "to-be" distribution processes model which aims to meet the above expectations and also enable future LSS projects to increase Distribution Processes efficiency.

The second step for the construction of the project charter is to set the objectives of the project. The tool assisting in this task is the CTQ tree.

CTQ TREE

Customer Requirement	Increase Distribution Efficiency			
1st Level	Fewer Transportations	Less Distribution Cost	Less employment involvement	Better Stores Support
2nd Level	• More dynamic planning • Better fleet exploitation	• More back-hauling • Smarter routing • Reduced loading/unloading	• Increased automation • Better scheduling	• On-time delivery • Inquiries fulfillment
Measurement /Metric	✓ # transportations per shift ✓ # trucks used per shift	✓ Backhauling rate ✓ # orders delivered per shift ✓ # transportations per shift ✓ Loading/Unloading time ✓ # inquiries fulfilled per transportation	✓ Automation Rate ✓ # employees needed per shift	✓ Order fulfillment time cycle ✓ On-time delivery rate ✓ # rejected inquiries per shift

Figure 34, CTQ Tree for the project

Project Charter

Project Title: Increase automation, digitalization, and new technologies engagement in Distribution Processes Project.

Problem statement: The current situation in Distribution Processes lacks in systemic ways to record data and perform optimization projects. They also lack in automation and new technologies, and they have excess e-mail communication between employers. Finally, it is realized the overall need to improve Distribution Processes efficiency.

Scope: The scope of this project is to develop a new Distribution Processes model to tackle these issues and to create a fertile environment for future LSS projects.

Objectives: The objective is to improve the metrics associated with the goals of the project. From the CTQ tree we created a pool of metrics which we are trying to improve with the new Distribution Processes Model.

Metrics to increase	**Metrics to decrease**
✓ On-time delivery rate	✓ Loading/Unloading time
✓ Automation rate	✓ Order fulfillment time cycle
✓ Backhauling rate	✓ # Rejected Inquiries shift
✓ # Orders delivered per shift	✓ # Employees needed per shift
✓ # Inquiries fulfilled per transportation	✓ # Transportations per shift
✓ # LSS projects per year	✓ # Trucks per shift

Customers/Stakeholders: The customers of this project are considered the Distribution Director from the side of the Distribution Department and from the CEO from the side of the whole company. The Distribution Director indicates the needs of the project, and the CEO provides the financing and the human resources involved in the project. For each process, customers are also considered the involved parties of the following process when the output of the first is the input for the second. For example, customers for the Loading Process are not only the employees of this process but also the employees of the Distribution Execution Process.

Team Members: Project leader of the project acting as a Green belt is the writer of this thesis. The team members are selected in such way to create a cross-functional team with various backgrounds. Due to the high-tech involvement and crucial technological implementations a very important member of the team is the IT Manager. Finally, the rest of the team is constituted of a Planning Manager, a Distribution Planner, a Loader, a Driver, a Shift Coordinator, the Warehouse Manager, the Distribution Manager and the Fleet Manager.

4.2.3. Measure Phase

During the measure phase we are using tools to measure the metrics deriving from the CTQ tree. This step is the examination of the current state of the processes and the appropriate data collection. Apart from measuring the current state, alongside the Distribution Director we are setting the targeted value for the metrics. The Distribution Director provided us with the current measurement of the metrics. It was observed that most of these metrics, KPIs, the company was not measuring.

Metrics	Current Value	Targeted Value
✓ On-time delivery rate	80%	90%
✓ Automation rate	4%	50%
✓ Backhauling rate	6%	12%
✓ # Orders delivered per shift	100	150
✓ # LSS projects per year	0	3
✓ # Transportations per shift per truck	2-3	4-5

Metrics	Current Value	Targeted Value
✓ Loading/Unloading time	Avg=45’ and minimax (30’-90’)	Avg= 35’ and minmax (25’-85’)
✓ # Loaders needed per shift	50-60	40-50
✓ # of emails	56	20

4.2.4. Analyze Phase

In the analyze the Distribution Processes were handed down and then were translated in Enterprise BPMN collaboration diagram in ARIS architect & designer 10.0 software to capture the current status, map the manual and automated activities and understand the used resources, the needed documentation and the activities. Following to this, through the model we are identifying the non-adding value and the adding value activities, the performance gaps and critical points of the adding value activities, and the possible optimization actions for the next phase.

The following figures are depicting the Process Structure of the AS-IS Distribution Processes and the Enterprise BPMN collaboration diagrams for each one of these processes and sub-processes which were created in the ARIS architect & designer 10.0 software.

Distribution Processes Structure (As-Is)

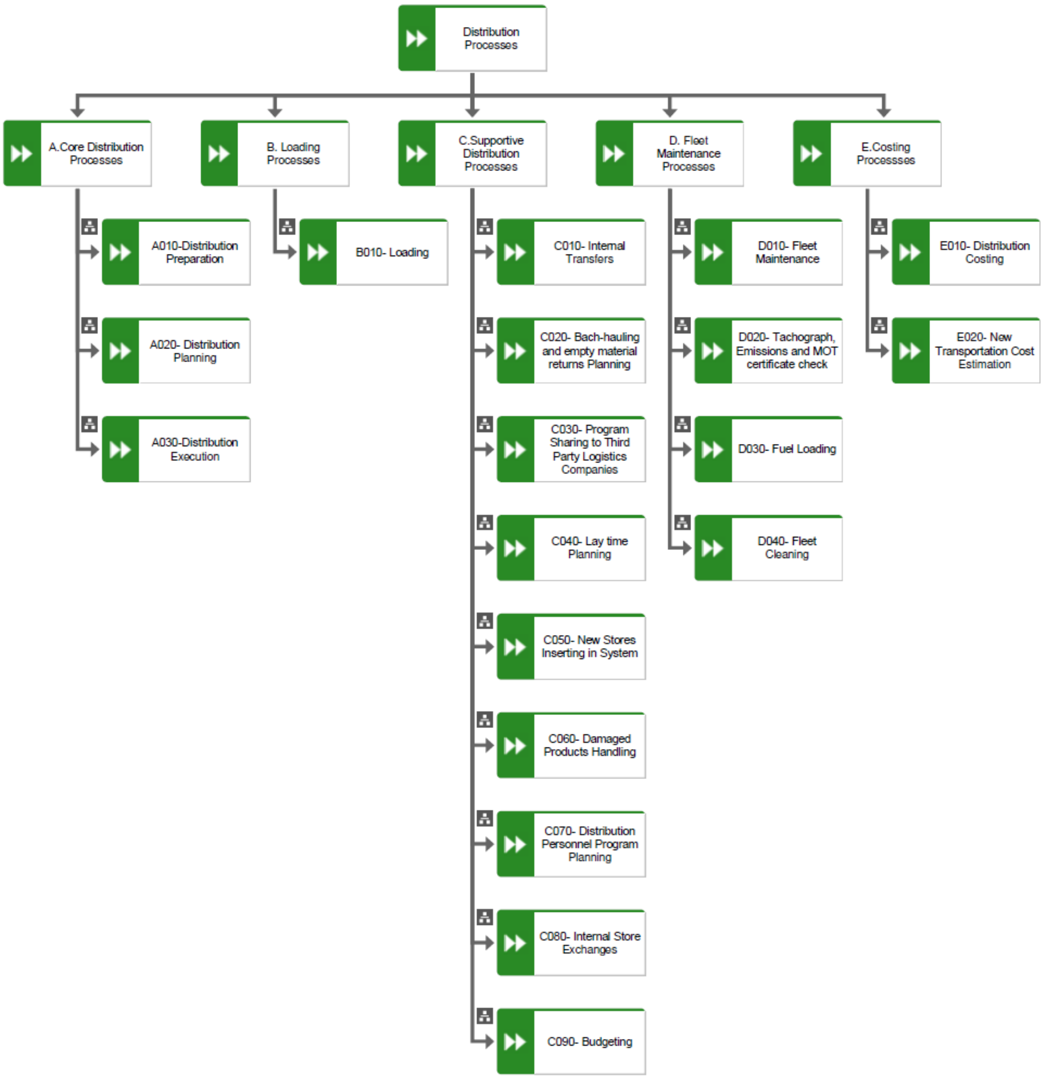
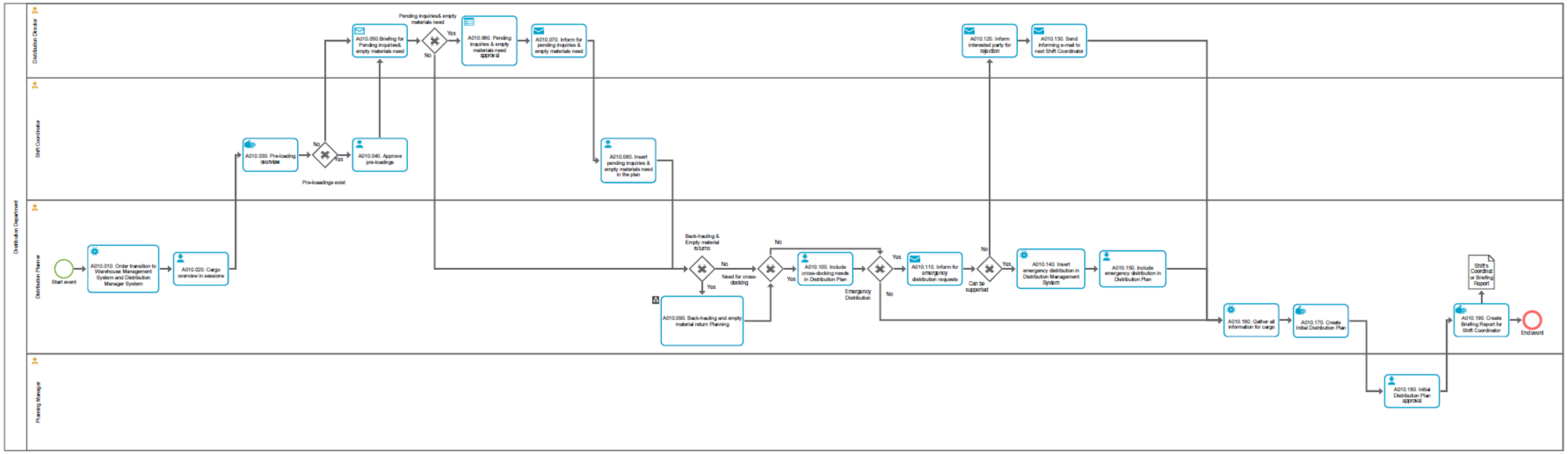
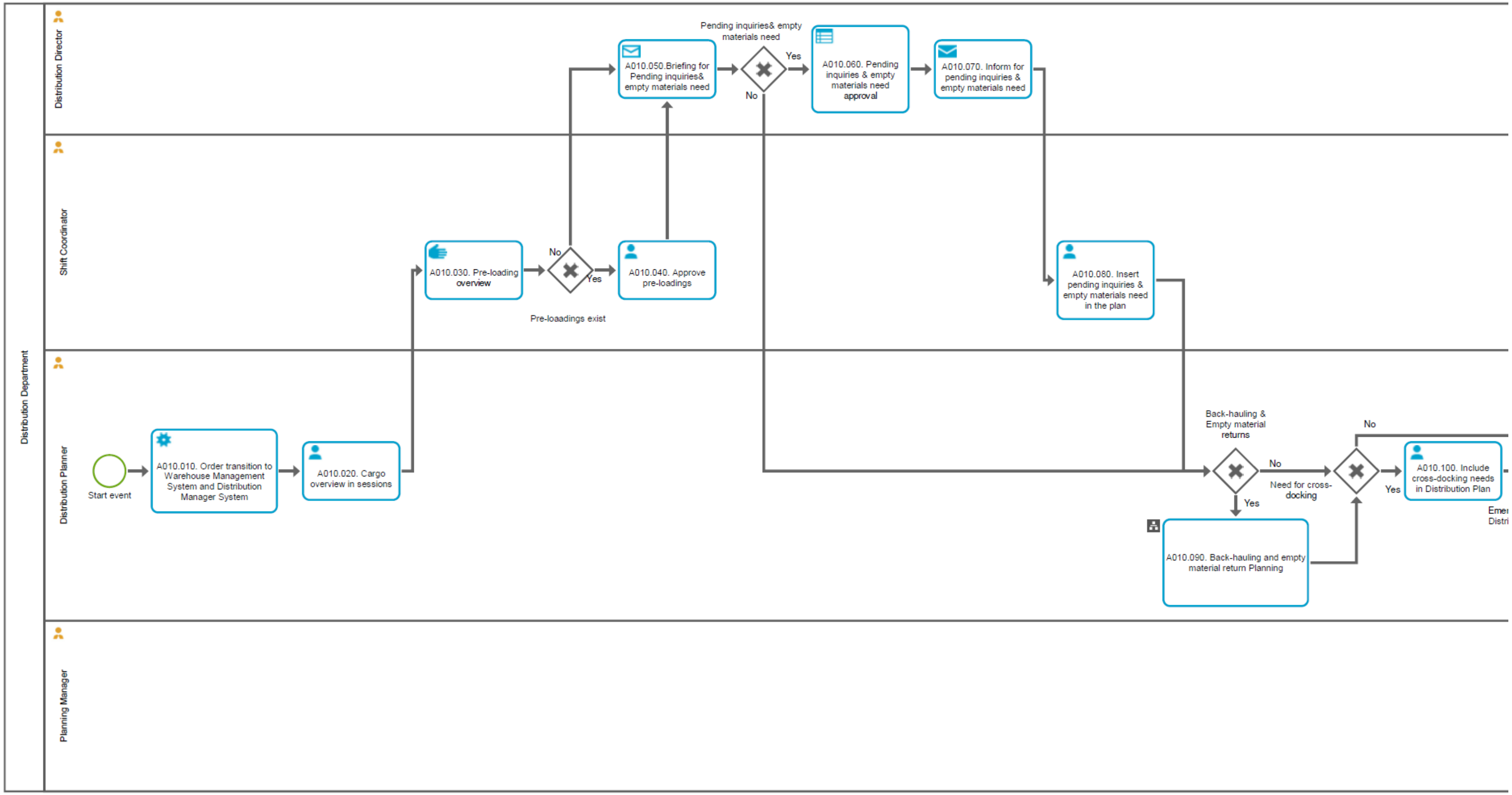
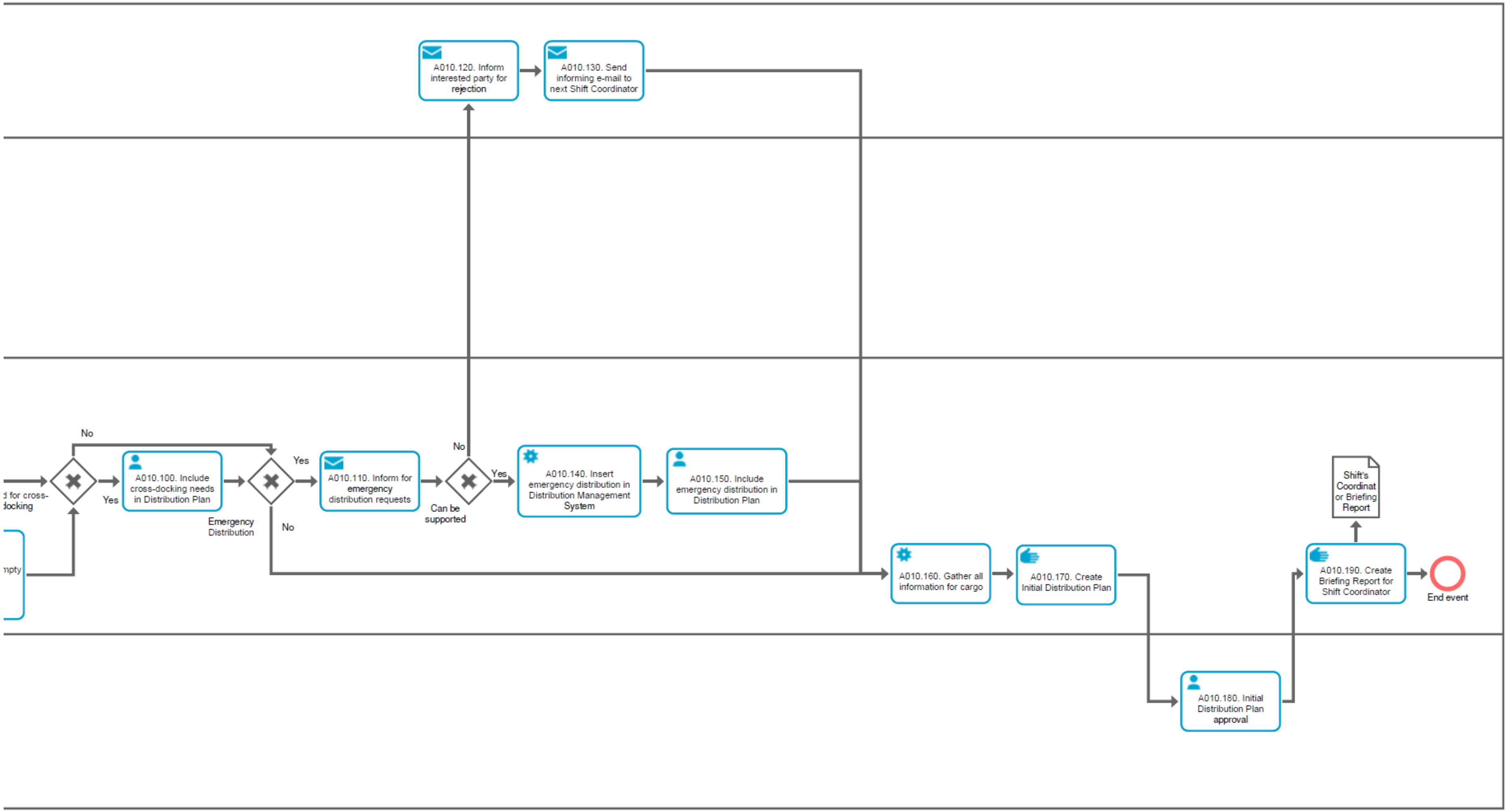


Figure 35, Distribution Processes (as-is) structure

4.2.4.1. A010. Distribution Preparation




Distribution Department
Distribution Director
Shift Coordinator
Distribution Planner
Planning Manager
Start event
A010.010. Order transition to Warehouse Management System and Distribution Manager System
A010.020. Cargo overview in sessions
A010.030. Pre-loading overview
No
Yes
Pre-loaadings exist
A010.040. Approve pre-loadings
A010.050.Briefing for Pending inquiries& empty materials need
Pending inquiries& empty materials need
Yes
No
A010.060. Pending inquiries & empty materials need approval
A010.070. Inform for pending inquiries & empty materials need
A010.080. Insert pending inquiries & empty materials need in the plan
Back-hauling & Empty material returns
No
Yes
A010.090. Back-hauling and empty material return Planning
Need for cross-docking
No
Yes
A010.100. Include cross-docking needs in Distribution Plan


A010.120. Inform interested party for rejection
A010.130. Send informing e-mail to next Shift Coordinator
No
Yes
A010.100. Include cross-docking needs in Distribution Plan
Yes
A010.110. Inform for emergency distribution requests
Emergency Distribution
No
No
Yes
Can be supported
A010.140. Insert emergency distribution in Distribution Management System
A010.150. Include emergency distribution in Distribution Plan
A010.160. Gather all information for cargo
A010.170. Create Initial Distribution Plan
A010.180. Initial Distribution Plan approval
A010.190. Create Briefing Report for Shift Coordinator
Shift's Coordinator Briefing Report
End event

Activities description:

A010.010.: Order transition to Warehouse Management System and Distribution Management System

Activity Description	All stores insert their orders in the ERP system per code. Then the order is transferred in the WMS per loading task and finally it is transferred in the DMS per pallets.
Software / System	WMS, DMS

A010.020.: Cargo Overview in sessions

Activity Description	The Distribution Planner is getting informed in DMS for the orders and divides them in different sessions according to the warehouse session rules. For example, one of the warehouses might have four different sessions for different product categories.
Software / System	DMS

A010.030.: Pre-loading overview

Activity Description	Daily the Shift Coordinator extracts from the WMS the pre-loadings of the previous shift.
Software / System	WMS

A010.040.: Approve pre-loadings

Activity Description	The Shift Coordinator performs physical check of the pre-loadings of the previous shift to ensure the validity of them and then informs via e-mail the Distribution Manager for the approval. In case of inconsistencies, they are investigated.

A010.050: Briefing for pending inquiries and empty materials need

Activity Description	Daily the Shift Coordinator briefs via e-mail the Distribution Manager for pending inquiries from previous shifts and empty materials needs (roll-cages, pallets, etc.)

A-010-060: Pending inquiries and empty materials need approval

Activity Description	The Distribution Manager validated the correctness of the pending inquiries and empty materials need in accordance with previous loadings. In case of discrepancies the Distribution Manager investigates them.

A010.070: Inform for pending inquiries and empty materials need

Activity Description	The Distribution Manager informs via e-mail the Shift Coordinator for all the pending inquiries and empty materials need via e-mail.

A010.080.: Insert pending inquiries and empty materials need in Distribution Plan

Activity Description	The Shift Coordinator inserts the pending inquiries and empty materials received via e-mail in the Distribution Plan.

A010.090.: Backhauling and empty materials returns Planning (sub-process C020)

Activity Description	In case of a backhauling and/or empty materials returns need exists, these needs are getting programmed to be included in the Distribution Plan.

A010.100: Include cross-docking needs in Distribution Plan

Activity Description	In case cross-docking needs occurred, the Shift Coordinator communicates the request in the Department in inserts it in the Distribution Plan. Cross-docking is executed by owned trucks.

A010.110: Inform for emergency distribution requests

Activity Description	During the day emergency distribution request might occur. In that case the Distribution Planner informs the Distribution Director for the requests via-email and then confirms the ability to support them sending a new e-mail to the Distribution Director.

A010.120.: Inform interested party for rejection

Activity Description	The Distribution Director informs the interested parties via e-mail for the rejection of the request.

A010.130.: Send informing e-mail to next Shift Coordinator

Activity Description	The Distribution Director sends an informing e-mail to the next Shift Coordinator for the rejected inquiries.

A010.140.: Insert emergency distribution requests in Distribution Management System

Activity Description	The Distribution Planner inserts the accepted emergency distribution requests in the DMS.
Software / System	DMS

A010.150.: Include emergency distribution requests in Distribution Plan

Activity Description	Following to that the Distribution Planner includes the emergency distribution in the Distribution Plan.

A010.160.: Gather al information for cargo

Activity Description	The Distribution Planner gathers all information for cargo for the whole day from the DMS, WMS and from the e-mails. Specifically, the information gathered are the following:

	• Cargo per store • Pre-loadings • Picking status • Pending inquiries • Emergency distributions • Cross-docking needs • Back-hauling needs • Empty Materials Returns (pallets, Roll-cages etc.)
Software / System	DMS, WMS

A010.170.: Create Initial Distribution Plan

Activity Description	Taking under consideration the gathered cargo information the Distribution Planner creates the Initial Distribution Plan.

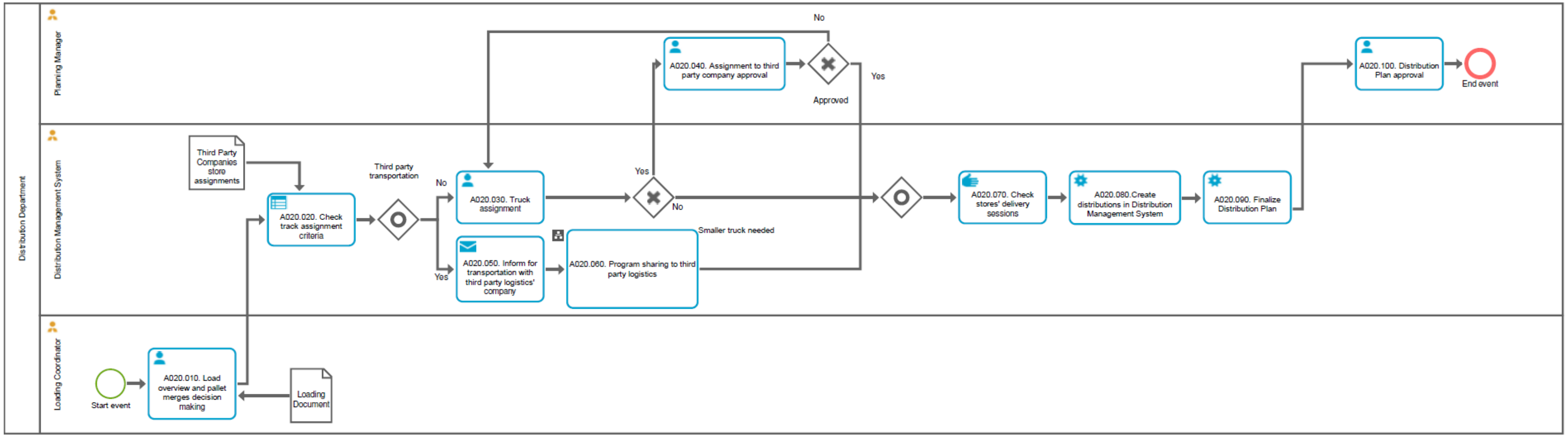
A010.180.: Initial Distribution Plan approval

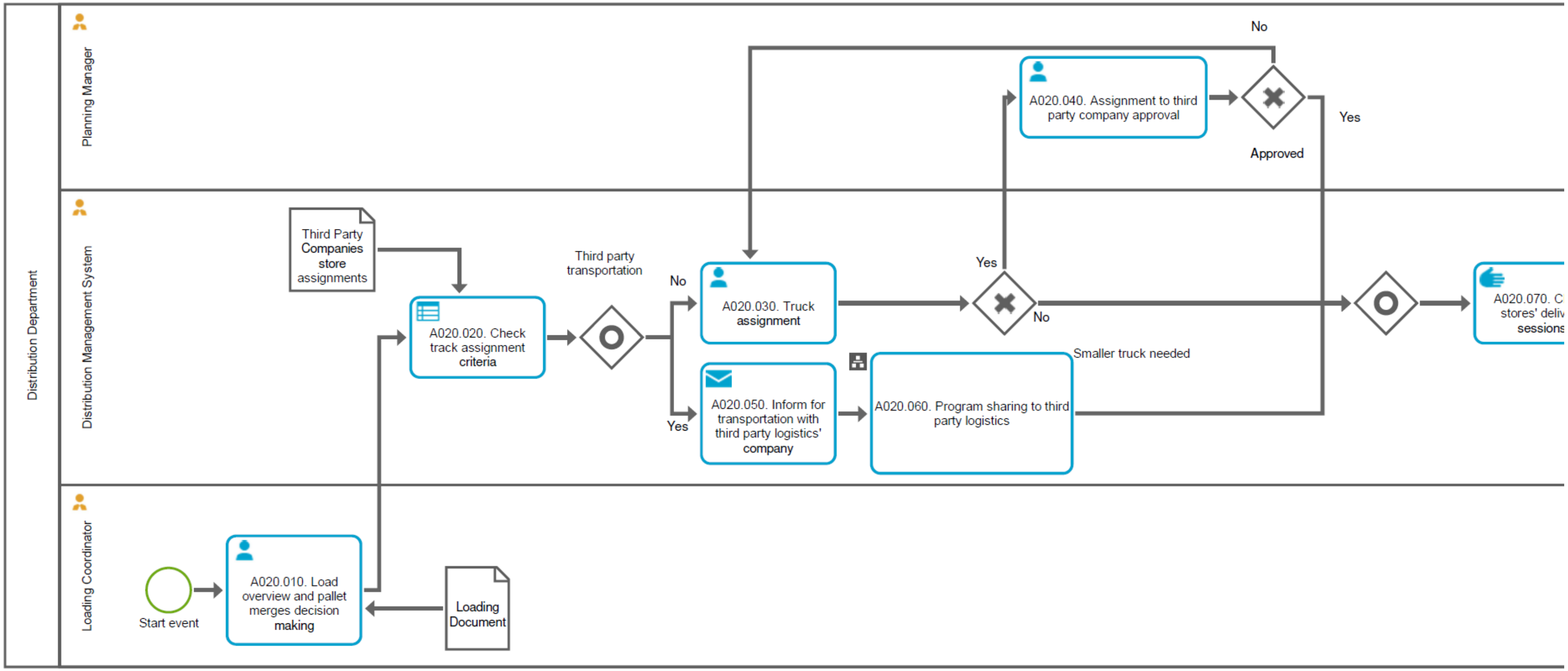
Activity Description	The Planning Manager receives via e-mail the Initial Distribution Plan and checks its correctness and approves it. In case of discrepancies, they are communicated to the Distribution Planner to be resolved.

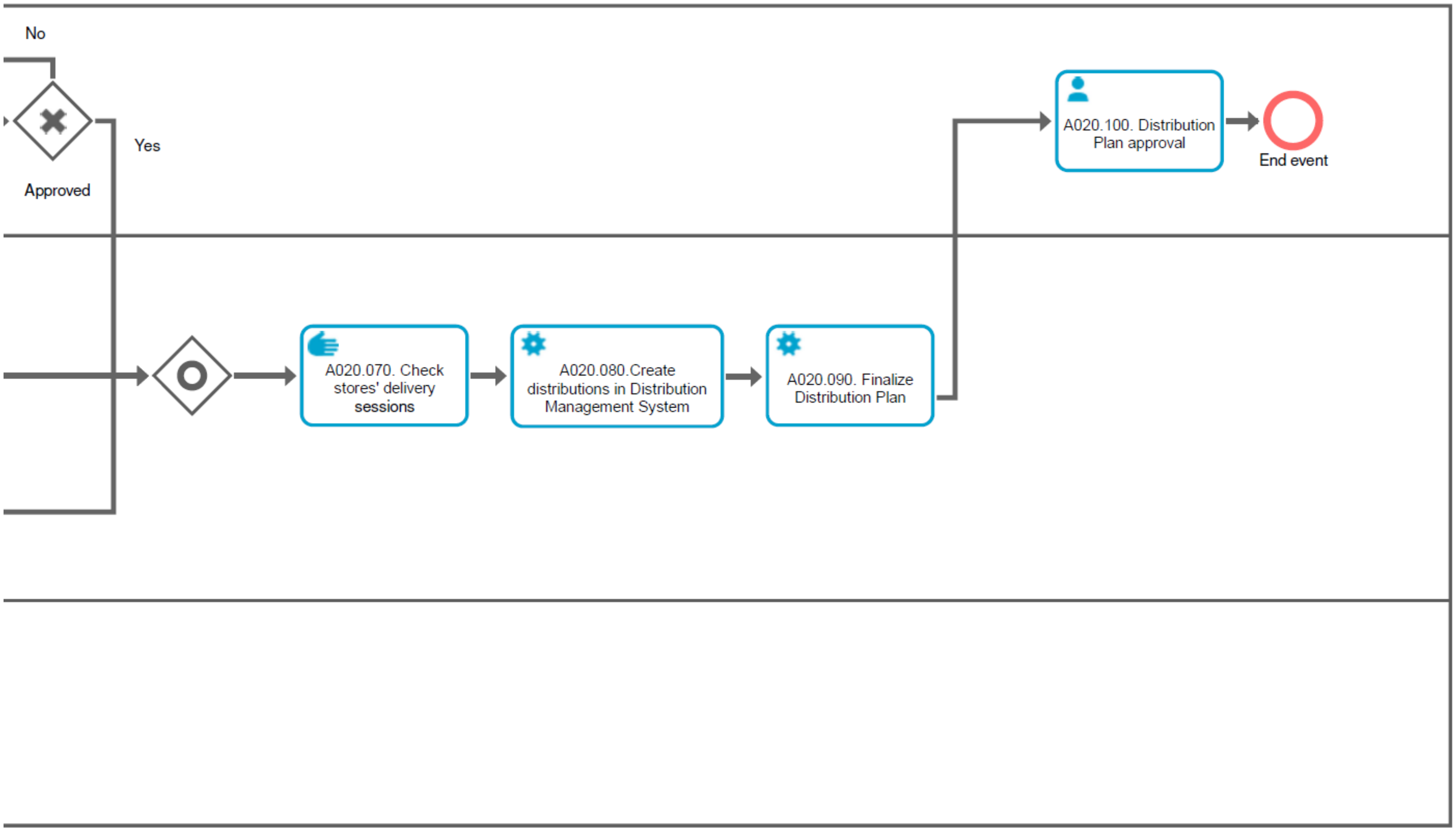
A010.190.: Create Briefing Report for Shift Coordinator

Activity Description	After the approval of the Distribution Plan, the Distribution Planner creates a briefing report for the Shift Coordinator which is send via e-mail.

4.2.4.2. A020.Distribution Planning




Distribution Department
Planning Manager
Distribution Management System
Loading Coordinator
Start event
A020.010. Load overview and pallet merges decision making
Loading Document
Third Party Companies store assignments
A020.020. Check track assignment criteria
Third party transportation
No
Yes
A020.030. Truck assignment
A020.050. Inform for transportation with third party logistics' company
A020.060. Program sharing to third party logistics
Smaller truck needed
Yes
No
A020.040. Assignment to third party company approval
No
Yes
Approved
A020.070. C
stores' deliv
sessions


No
Yes
Approved
A020.070. Check stores' delivery sessions
A020.080.Create distributions in Distribution Management System
A020.090. Finalize Distribution Plan
A020.100. Distribution Plan approval
End event

Activities description:

A020.010: Load overview and pallet merges/splits decision making

Activity Description	When picking is at the final stages, the Loading Coordinator inspects the loading lanes and decides for possible pallet merges/splits.

A020.020.: Check truck assignments criteria

Activity Description	The Distribution Planner checks the truck assignment criteria according to the company's priority rules, stores requirements and legal restrictions.

A020.030.: Truck assignment

Activity Description	The Distribution Planner performs the truck assignment for the owned trucks and checks for need for smaller trucks.

A020.040.: Assignment to third party logistics company approval

Activity Description	The Planning Manager gets informed via e-mail for the need of smaller trucks. If it is approved, it is assigned to a third-party logistics company. If not, the Distribution Planner assigns new trucks.

A020.050.: Inform for transportation with third party logistics company

Activity Description	When a transportation with a third-party logistics company is required, the Distribution Planner informs the company appropriately.

A020.060.: Program sharing to third party logistics companies (C040. Sub-process)

Activity Description	After informing the third-party logistics company about the transportation the sub-process of Program sharing to third party logistics companies to assign the trucks.

A020.070.: Check stores' delivery sessions

Activity Description	The Distribution Planner checks the stores' delivery sessions to decide the transportations.

A020.080.: Create distributions in Distribution Management System

Activity Description	The Distribution Planner checks the drivers program. Then, he distributes the cargo in transportations, taking under consideration various restrictions and parameters such as store delivery session, truck type for store etc. Finally, he creates the distributions in the DMS. An e-mail is automatically sent to the third-party logistics companies to fill the trucks' plates numbers and manually he fills the trucks' plates numbers for the owned trucks.
Software/System	DMS

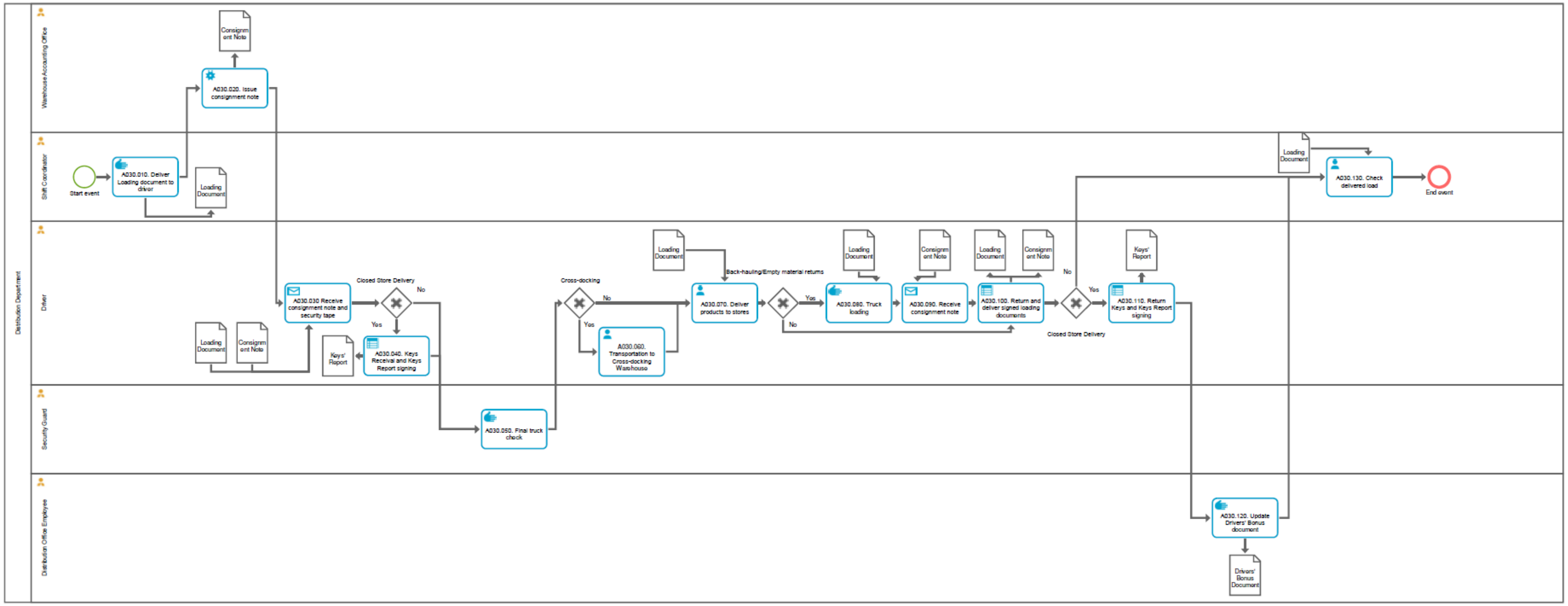
A020.090.: Finalize Distribution Plan

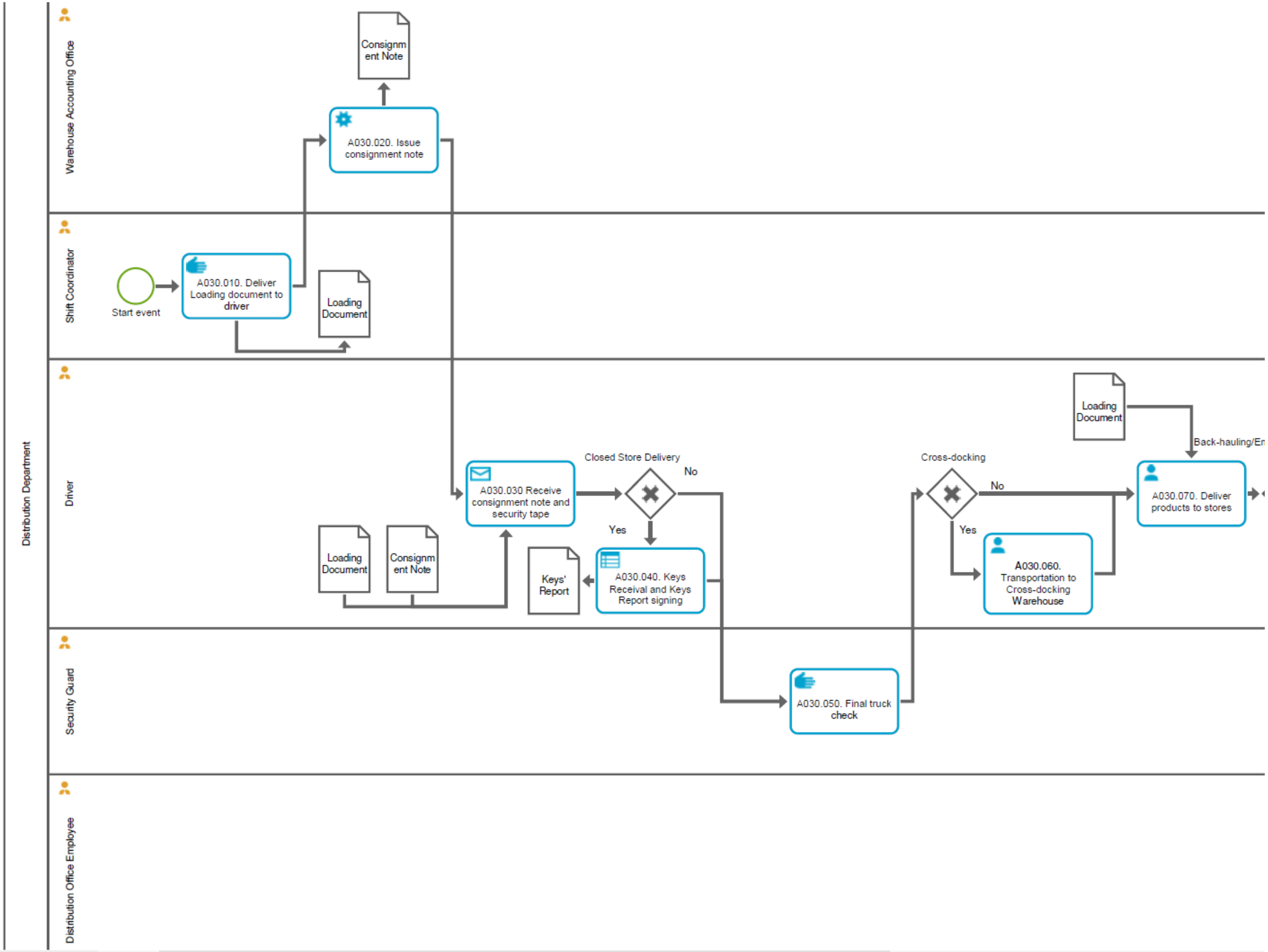
Activity Description	The Distribution Planner uses the Initial Distribution Plan and the one created in the DMS to synchronize them and derive the Finalized Distribution Plan

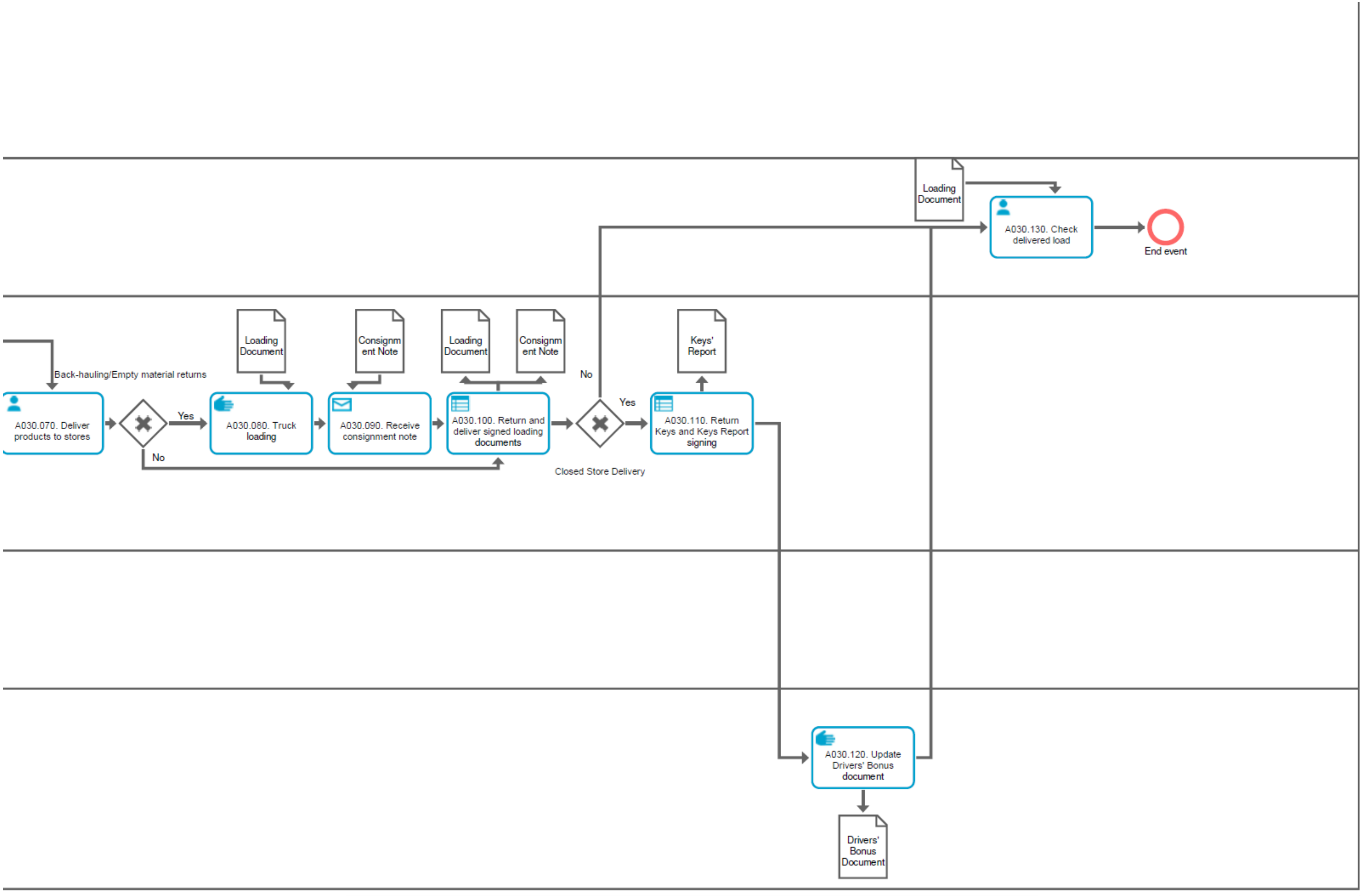
A020.100.: Distribution Plan Approval

Activity Description	The Finalized Distribution Plan is sent to the Planning Manager via e-mail for approval. In case of disagreement, the Planning Manager and the Distribution Planner communicate to resolve it.

4.2.4.3. A030.Distribution Execution




Distribution Department
Warehouse Accounting Office
Shift Coordinator
Driver
Security Guard
Distribution Office Employee
Consignment Note
A030.020. Issue consignment note
Start event
A030.010. Deliver Loading document to driver
Loading Document
A030.030 Receive consignment note and security tape
Closed Store Delivery
No
Yes
Loading Document
Consignment Note
Keys' Report
A030.040. Keys Receival and Keys Report signing
A030.050. Final truck check
Cross-docking
No
Yes
A030.060. Transportation to Cross-docking Warehouse
Loading Document
Back-hauling/Er
A030.070. Deliver products to stores



Loading Document
A030.130. Check delivered load
End event
Loading Document
Consignment Note
Loading Document
Consignment Note
Keys' Report
No
Back-hauling/Empty material returns
A030.070. Deliver products to stores
Yes
A030.080. Truck loading
A030.090. Receive consignment note
A030.100. Return and deliver signed loading documents
Yes
A030.110. Return Keys and Keys Report signing
No
Closed Store Delivery
A030.120. Update Drivers' Bonus document
Drivers' Bonus Document

Activities Description:

A030.010.: Deliver Loading Document to Driver

Activity Description	When Loading is done, the Shift Coordinator gives the Loading Document to the Driver.

A030.020.: Issue consignment note

Activity Description	If the transportation is not referred to a pre-loading, the ERP is notified automatically by the WMS for the on-going distribution and the warehouse accounting office issues and prints the consignment note. The consignment note is constructed according to the orders from the ERP.
Software/System	ERP

A030.030.: Receive consignment note and security tape

Activity Description	The Driver receives from the warehouse accounting office the consignment notes and the security tape.

A030.040.: Keys receival and Keys Report signing

Activity Description	The Driver gets informed if the distribution is for a closed store delivery by the Loading Documents and gets the store keys and signs the Keys Report.

A030.050.: Final Truck Check

Activity Description	The security guard at the exit station checks if the security tape is correctly used and if the number is correctly written on the Consignment notes. Before departure, some trucks are randomly checked for their weight to identify if it is in accordance with the load scan in the WMS.

A030.060.: Transportation to cross-docking warehouse

Activity Description	The Driver transports the truck to the cross-docking warehouse if it is included in the Loading Documents.

A030.070.: Product delivery to stores

Activity Description	The Driver delivers the products according to the Distribution Plan. Both Driver and Store Manager sign the Loading Document and then the Driver signs the consignment note and delivers it to the store. Then the truck is shield again with the unique security tape of the store.

A030.080.: Truck Loading

Activity Description	According to the Distribution Plan if the distribution involves Backhauling or/and empty materials return, the driver executes the backhauling from the supplier or/and the loading of the material and returns to the warehouse.

A030.090.: Receive consignment note

Activity Description	Before departure, the consignment notes for those loading are received and new security tapes.

A030.100.: Return and Deliver signed loading documents

Activity Description	The driver returns to the warehouse, unloads the truck if needed and delivers the signed Loading Documents to the Shift Coordinator.

A030.110.: Return Keys and Keys Report signing

Activity Description	If the delivery was for a closed store, the Driver returns the Keys and signs the Keys Report.

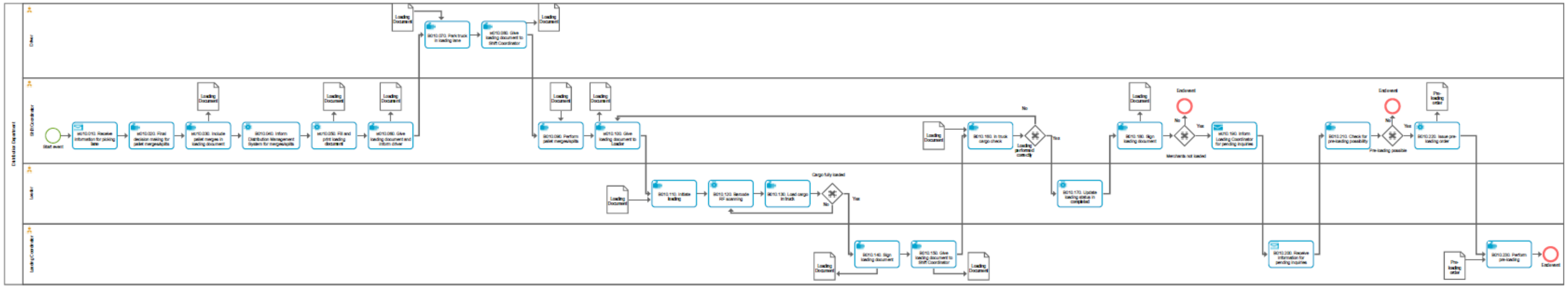
A030.120.: Update Drivers' Bonus Document

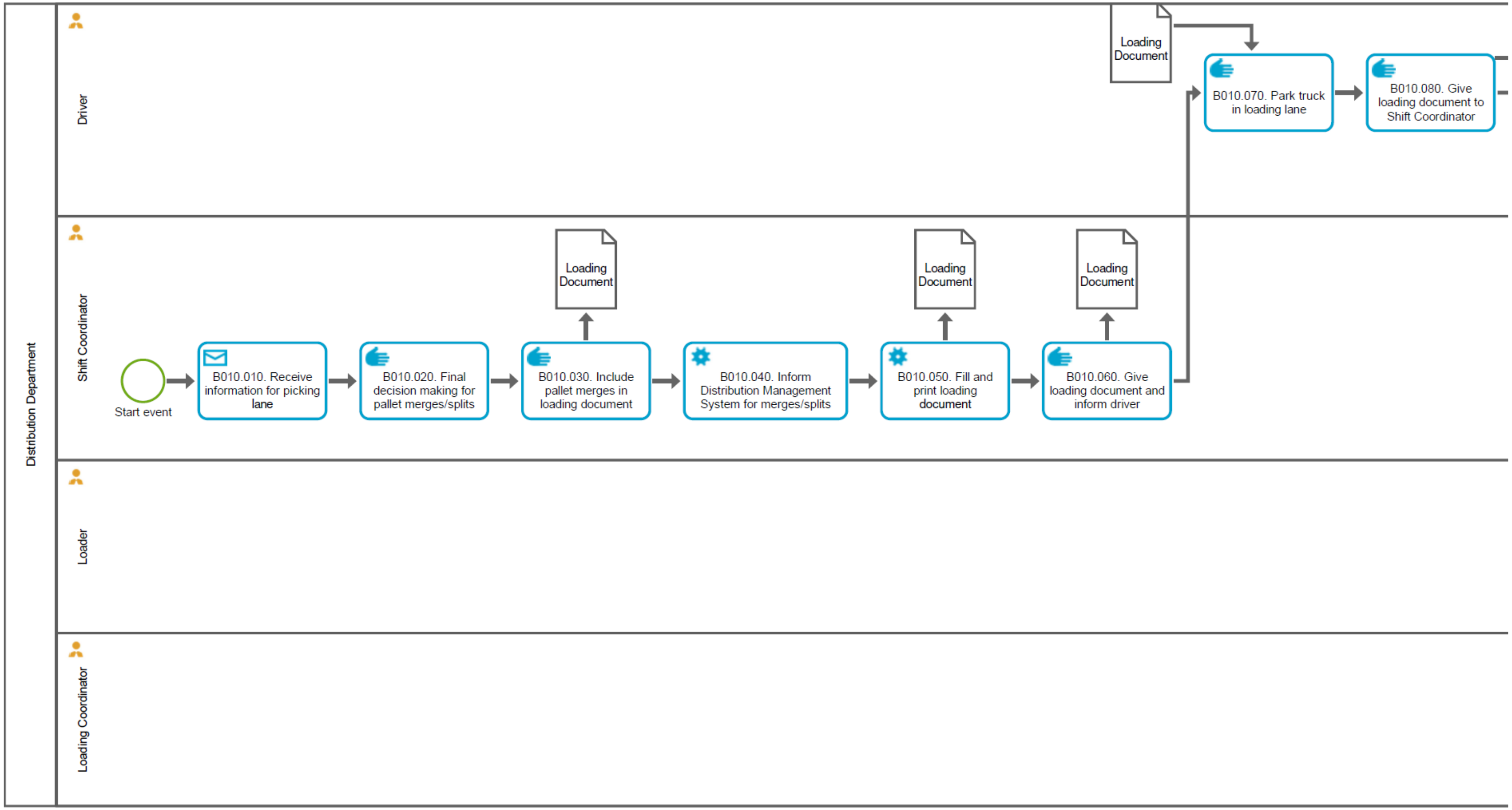
Activity Description	Drivers receive bonus when their transportations include closed store deliveries. An employee from the Distribution Office updates the Driver's Bonus Document.

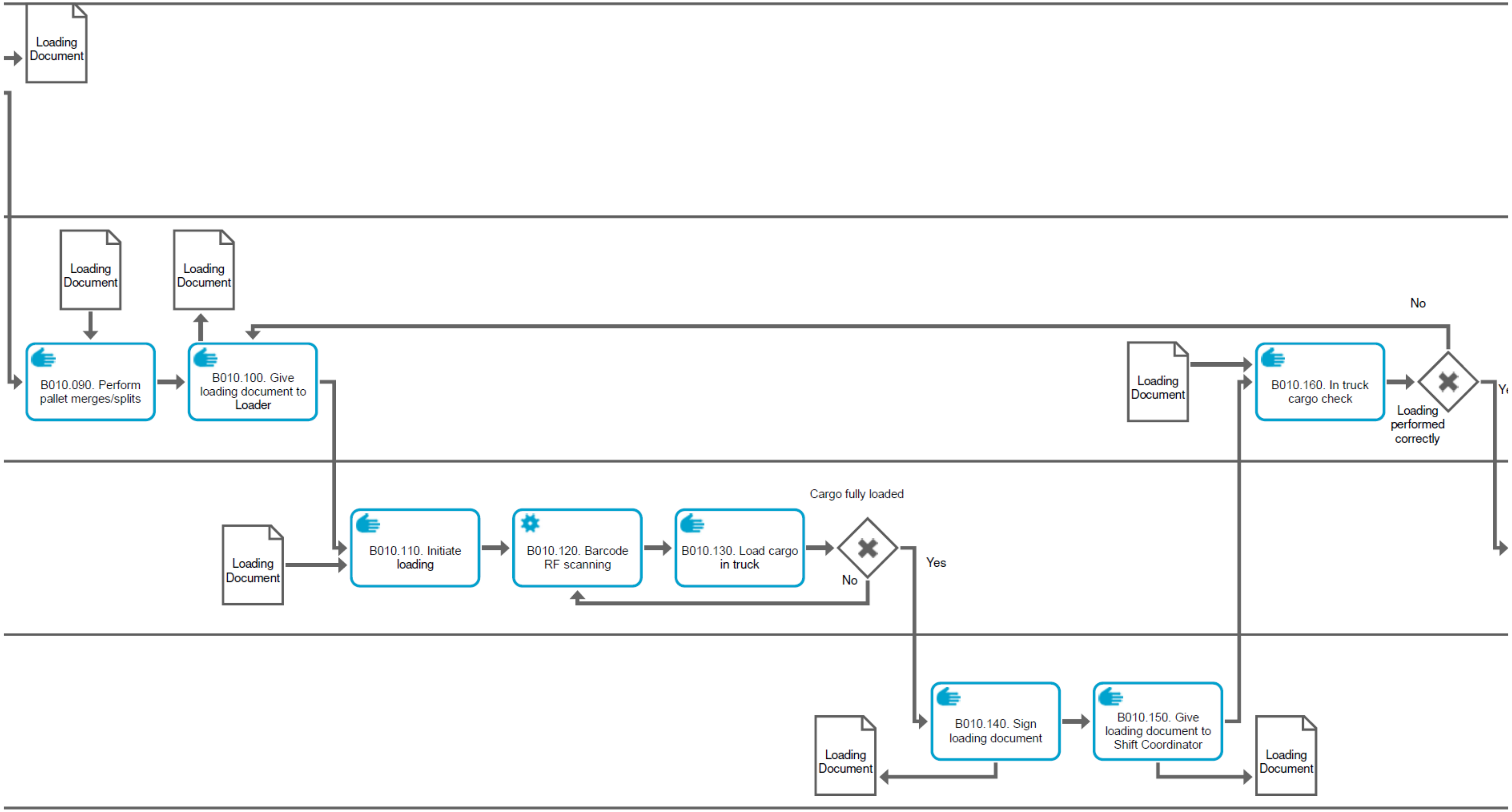
A030.130.: Check delivered load

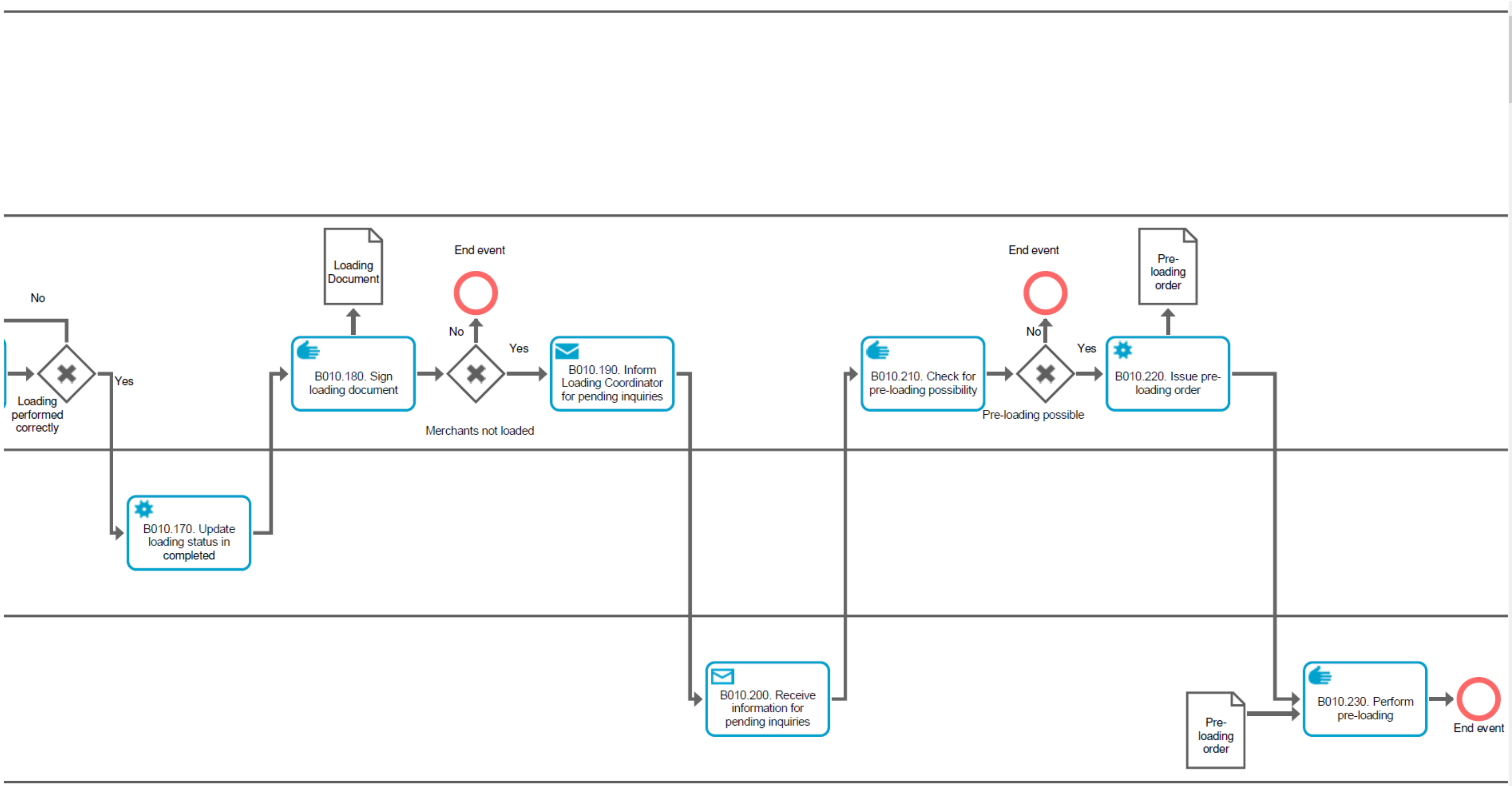
Activity Description	The Shift Coordinator receives the signed Loading Documents and ensures that all is correct according to security tape numbers, signings, etc.

4.2.4.4. B010. Loading




Distribution Department
Driver
Shift Coordinator
Loader
Loading Coordinator
Start event
B010.010. Receive information for picking lane
B010.020. Final decision making for pallet merges/splits
B010.030. Include pallet merges in loading document
Loading Document
B010.040. Inform Distribution Management System for merges/splits
B010.050. Fill and print loading document
Loading Document
B010.060. Give loading document and inform driver
Loading Document
Loading Document
B010.070. Park truck in loading lane
B010.080. Give loading document to Shift Coordinator


Loading Document
Loading Document
Loading Document
B010.090. Perform pallet merges/splits
B010.100. Give loading document to Loader
No
Loading Document
B010.160. In truck cargo check
Loading performed correctly
Ye
Cargo fully loaded
Loading Document
B010.110. Initiate loading
B010.120. Barcode RF scanning
B010.130. Load cargo in truck
Yes
No
B010.140. Sign loading document
B010.150. Give loading document to Shift Coordinator
Loading Document
Loading Document


No
Yes
Loading performed correctly
B010.170. Update loading status in completed
Loading Document
B010.180. Sign loading document
End event
No
Yes
Merchants not loaded
B010.190. Inform Loading Coordinator for pending inquiries
B010.200. Receive information for pending inquiries
B010.210. Check for pre-loading possibility
End event
No
Yes
Pre-loading possible
Pre-loading order
B010.220. Issue pre-loading order
Pre-loading order
B010.230. Perform pre-loading
End event

Activities Description:

B010.010.: Receive information for picking/loading lane

Activity Description	The Shift coordinator gets informed from the warehouse or/and the WMS/DMS the picking/ loading lane after picking is completed.
Software/System	WMS, DMS

B010.020.: Final decision making for pallet merges/splits

Activity Description	The Shist Coordinator makes the final decision making for the pallet merges/splits.

B010.030.: Include pallet merges/splits in Loading Document

Activity Description	The Shift Coordinator after finalizing the pallet merges and splits includes them in the Loading Document.

B010.040.: Inform pallet merges/splits in Distribution Management System

Activity Description	The Shift Coordinator inserts the final decision for pallet merges/splits in the DMS.
Software/System	DMS

B010.050.: Fill and Print Loading Document

Activity Description	The Shift Coordinator fills the Loading Document supported by the DMS and prints it. The information included in the Loading Document are the following: • Distribution destination • Transportation order number (ID) • Truck's plate number • Warehouse of departure

	• Printing date • Owned truck or third-party logistics company truck • Cross-docking needs • Cargo type • Time of departure • Number of pallets, materials, and machinery • Closed or Opened store delivery • Pallet merges/splits (manually filled)
Software/System	DMS

B010.060.: Give Loading Document and inform Driver

Activity Description	The Shift Coordinator gives the Loading Document to the Driver and informs him for the picking/loading lane.

B010.070.: Park truck in loading lane

Activity Description	The Driver transfers the truck at the picking/loading lane.

B010.080.: Give Loading Document to Shift Coordinator

Activity Description	The Driver gives the Loading Document to the Shift Coordinator.

B010.090.: Perform pallet merges/splits

Activity Description	The Shift Coordinator performs the pallet merges/splits according to the Loading Document.

B010.100.: Give Loading Document to Loader

Activity Description	The Shift Coordinator gives the Loading Document to the Loader.

B010.110.: Initiate Loading

Activity Description	The Loaders start the loading according to the Loading Coordinator ‘s directions.

B010.120.: Barcode RF Scanning

Activity Description	Before loading the cargo, the loaders scan the barcodes with RF in a specific order.
Software/System	WMS

B010.130.: Load cargo in truck

Activity Description	After the barcode scanning, they start loading the cargo in the truck according to a specific priority rule.

B010.140.: Sign Loading Document

Activity Description	When the truck is fully loaded the Loading Coordinator signs the Loading Document.

B010.150.: Give Loading Document to Shift Coordinator

Activity Description	The Loading Coordinator gives the Loading Document to the Shift Coordinator.

B010.160.: In truck cargo check

Activity Description	After receiving the signed Loading Document, the Shift Coordinator performs in truck cargo check to ensure that the loading was performed according to the Loading Document.

B010.170.: Update loading status in completed

Activity Description	The Loader updates the loading status in WMS in completed through the RF scanning. Then automatically, the orders are transferred in the ERP for the consignment note issuance. In case of pre-loading scanning the Shift Coordinator informs the accounting office not to proceed with the consignment note issuance.
Software/System	WMS, ERP

B010.180.: Sign Loading Document

Activity Description	The Shift Coordinator signs the Loading Document for the first time indicating the correctness of the loading process.

B010.190.: Inform Loading Coordinator for pending inquiries

Activity Description	The Shift Coordinator informs via e-mail the Loading Coordinator for pending inquiries which should be included in the next distribution.

B010.200.: Receive information for pending inquiries

Activity Description	The Loading Coordinator gets informed via e-mail by the Shift Coordinator for pending inquiries which should be included in the next distribution.

B010.210.: Check for pre-loading possibility

Activity Description	The Shift Coordinator checks for available trucks in the warehouse and the possibility for pre-loading.

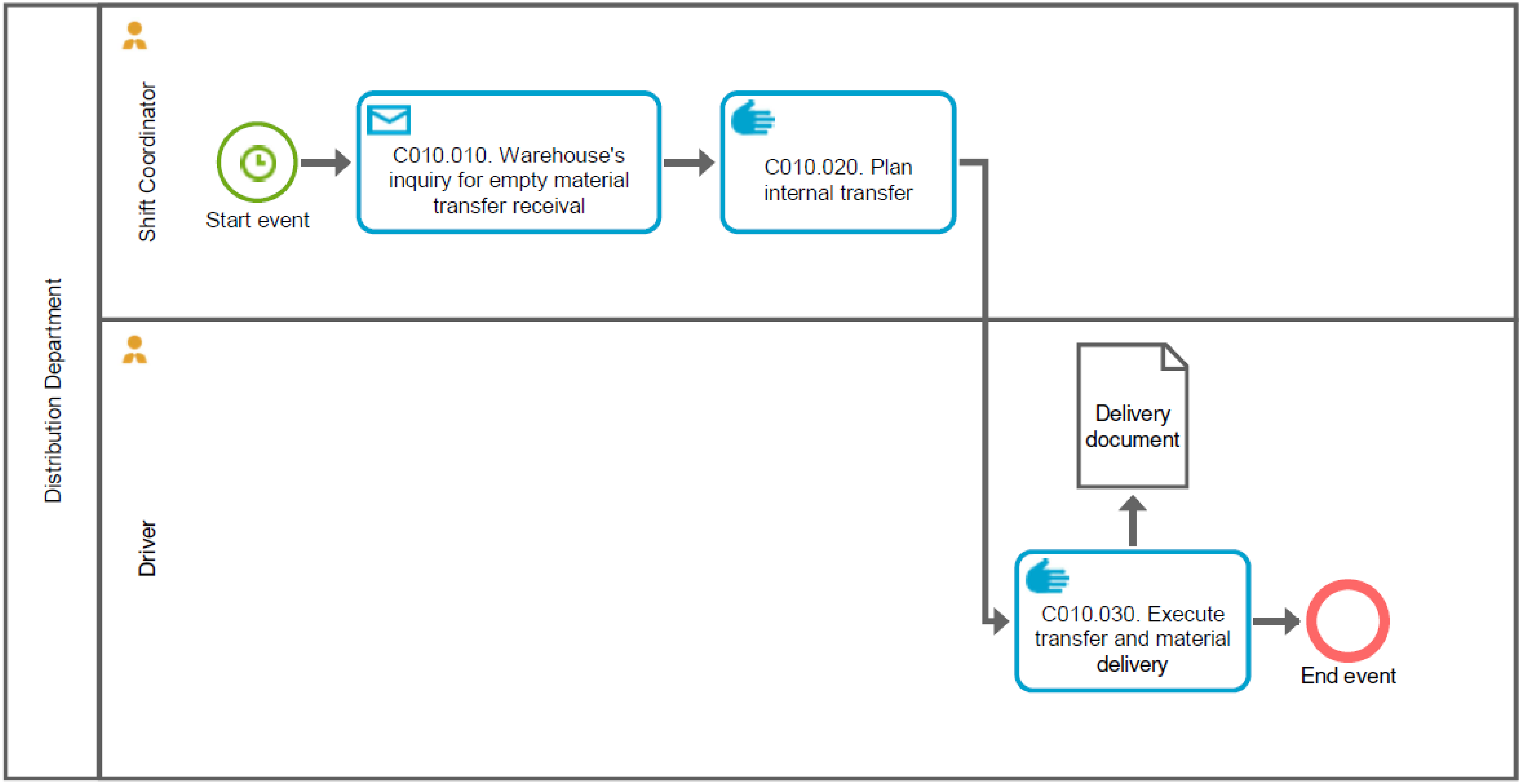
B010.220.: Issue pre-loading order

Activity Description	If needed the Shift Coordinator decides to issue order for pre-loading

B010.230.: Perform pre-loading

Activity Description	After the pre-loading order issuance, the Loader Coordinator supervises and ensures the pre-loading in the trucks.

4.2.4.5. C010. Internal Transfers



Activities Description:

C010.010.: Warehouse’s inquiry receival for empty material transfer

Activity Description	Regularly during the day, the Shift Coordinator receives inquiries for empty material transfers and machinery in the warehouse or to other warehouses via e-mail.

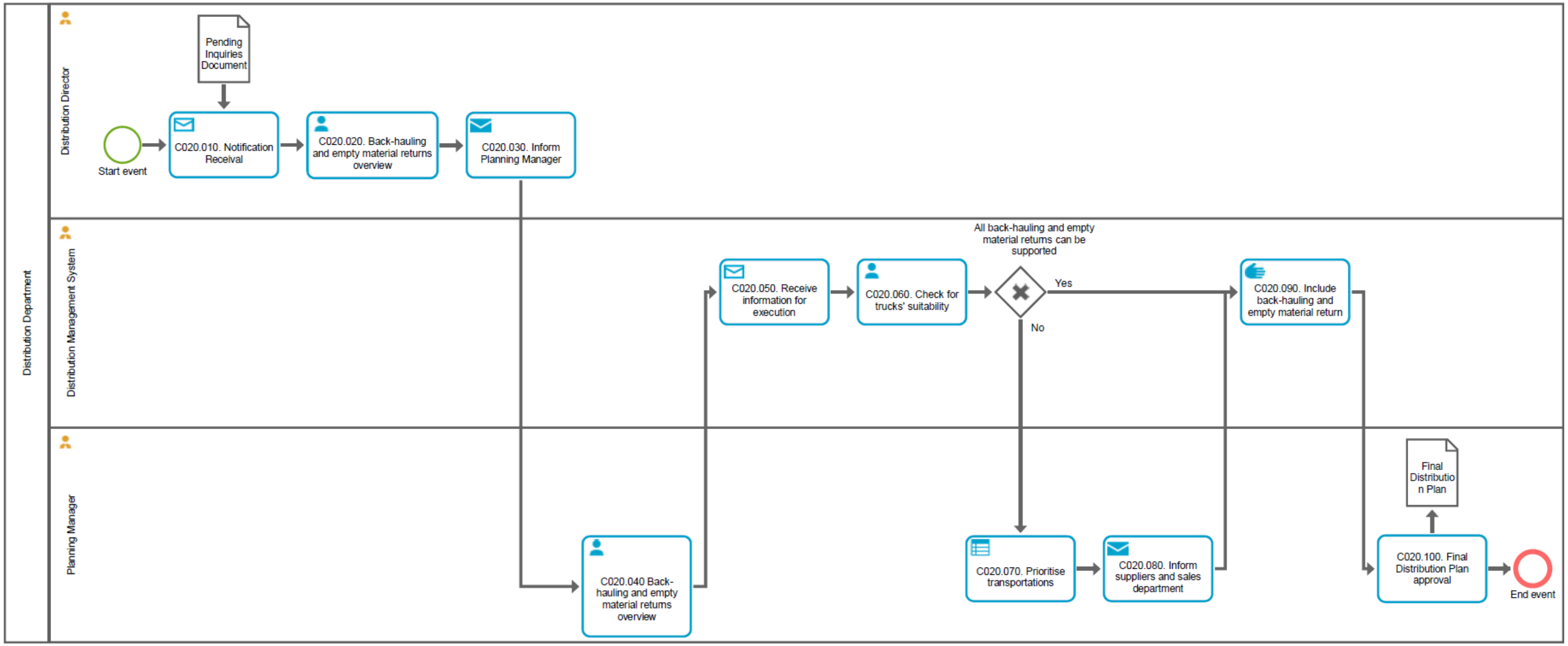
C010.020.: Plan Internal Transfers

Activity Description	The Shift Coordinator according to company’s rules regarding the trucks and the loading plans the transfers.

C010.030.: Execute Transfer and Material Delivery

Activity Description	The Driver receives the cargo and executes the transfer to the appointed place by the Shift Coordinator. When the transfer is completed the Driver receives delivery verification di=documentation which gives to the Shift Coordinator.

4.2.4.6. C020. Backhauling and empty material returns Planning (A010.090 Sub-process)



Activities Description:

C020.010.: Notification Receival

Activity Description	The Distribution Manager received during the day from specific suppliers or the sales department notification for the backhauling needs and empty material returns needs via e-mail.

C020.020.: Backhauling and empty material returns overview

Activity Description	The Distribution Manager gathers all these requests and creates an overview.

C020.030.: Inform Planning Manager

Activity Description	The Planning Manager receives the overview.

C020.040.: Backhauling and empty material returns overview

Activity Description	The Planning Manager reviews the overview and if he is in an agreement, he informs the Distribution Planner via e-mail for the needs which will be included in the Distribution Plan.

C0200.050.: Receive information for execution

Activity Description	The Distribution Planner receives via e-mail for the needs which will be included in the Distribution Plan alongside possible directions.

C020.060.: Check for trucks suitability

Activity Description	After checking the requirements for these inquiries, the Distribution Planner selects the appropriate trucks according to specific company's truck selection rules. In case there is not the ability to fully support the inquiries the Distribution Planner informs the Planning Manager.

C020.070.: Prioritize Transportations

Activity Description	The Planning Manager prioritizes the inquiries according to company's rules and informs the Distribution Planner.

C020.080.: Inform Suppliers and Sales Department

Activity Description	In case there is not the ability to fully support the inquiries the Planning Manager informs Suppliers and the Sales Department via e-mail.

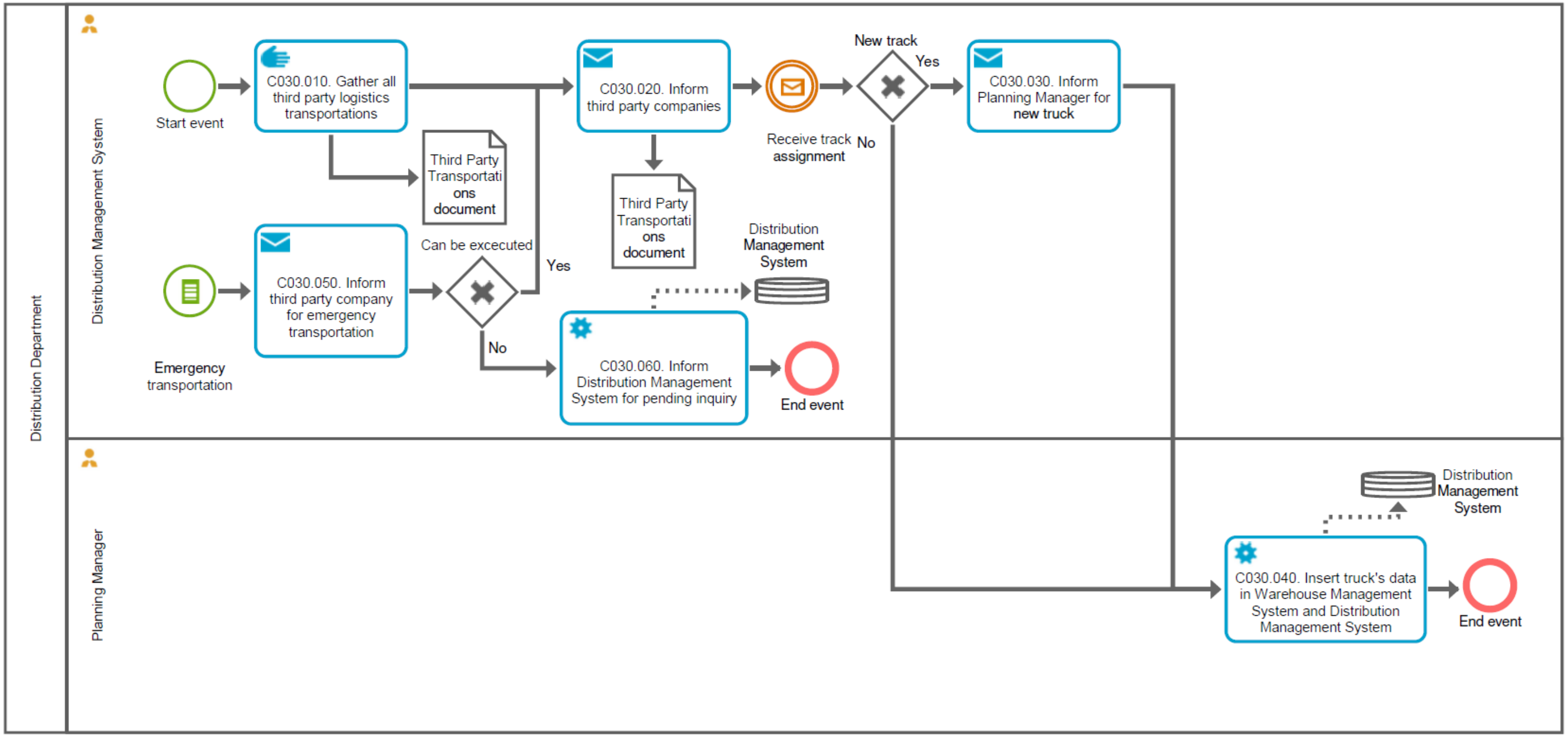
C020.090.: Include backhauling and empty material returns in Distribution Plan

Activity Description	The Distribution Planner includes the backhauling and empty material returns needs in Distribution Plan according to directions from the Planning Manager, the prioritization, the trucks availability and the company's rules.

C020.100.: Final Distribution Plan approval

Activity Description	The Planning Manager receives via e-mail the Distribution Plan, makes amendments as needful and approves it. Finally, the Planning Manager send via e-mail the approval to the Distribution Planner.

4.2.4.7. C030. Program Sharing to Third Party Logistics Companies (A020.060. Sub-process)



Activities Description:

C030.010.: Gather all third-party logistics companies transportations

Activity Description	The Distribution Planner chooses the distributions which will be executed by third-party logistics companies. Save them in DMS and creates an excel with all these transportations.
Software/System	DMS

C030.020.: Inform third-party logistics companies

Activity Description	According to the districts an e-mail with the excel for the transportation is sent through DMS by the Distribution Planner to the selected third-party company. Then the Distribution Director waits for the e-mail response with the truck assignments.

C030.030.: Inform Planning Manager for new truck

Activity Description	The Distribution Planner checks the truck's plate number. In case the truck assigned by the third-party company is new, he informs the Planning Manager for the needed truck's data.

C030.040.: Inform third-party logistics companies

Activity Description	In case an emergency distribution is needed to be executed by a third-party logistics company, the Distribution Planner informs via e-mail the company for the need. The company should answer via e-mail in the next two hours to inform if they can execute the transportation. If the transportation cannot be performed, the Distribution Planner informs the interested party for the rejection.

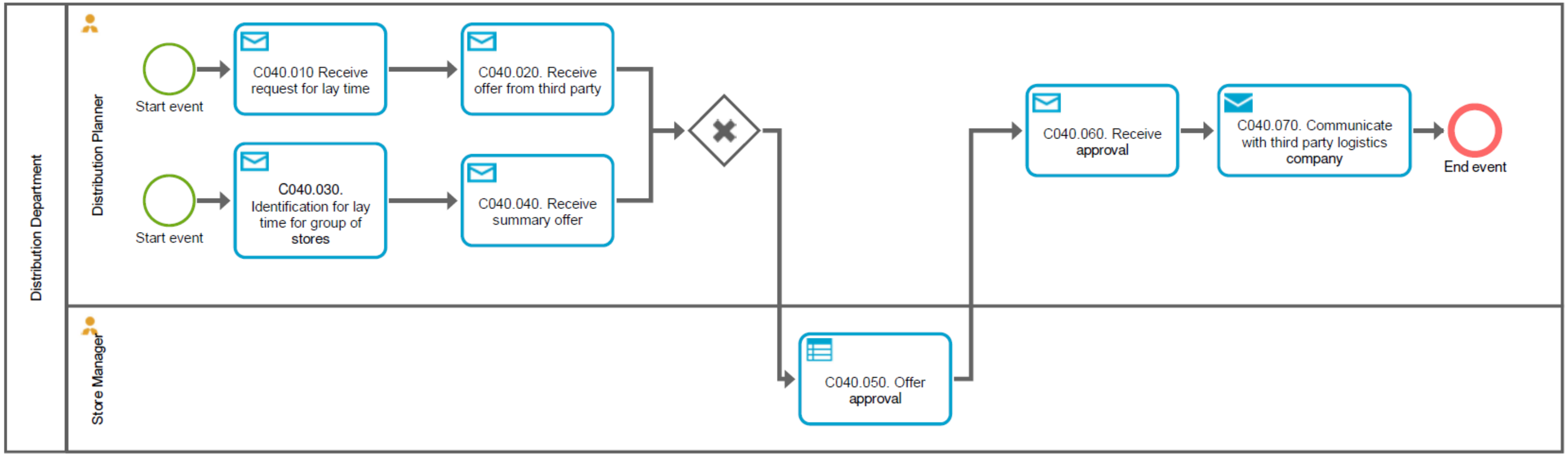
C030.050.: Inform Distribution Management System for pending inquiry

Activity Description	In case the inquiry cannot be supported, the Distribution Planner informs DMS for the pending inquiry.
Software/System	DMS

C030.060.: Insert truck’s data in Warehouse Management System and Distribution Management System

Activity Description	The Planning Manager inserts the needed truck’s data in the DMS and WMS.
Software/System	DMS, WMS

4.2.4.8. C040. Laytime Planning



Activities Descriptions:

C040.010.: Receive request for laytime

Activity Description	The Distribution Planner receives request via e-mail for laytime (loaded truck parking) need of a store which includes some specifics regarding the laytime such as type and number of products, laytime duration etc.

C040.020: Receive offer from third-party logistics company

Activity Description	The Distribution Planner communicates the laytime specifics to the districts assigned third-party logistics companies and receives offers.

C040.030.: Identification for laytime for group of stores

Activity Description	The Distribution Planner alongside the District Manage identify the need for laytime for several stores.

C040.040.: Receive summary offer

Activity Description	The Distribution Planner communicates the laytime specifics to the available third-party logistics companies and receives summary offer for the whole district.

C040.050.: Offer check and approval

Activity Description	The Store Manager or the District Manager evaluates the offer and approves the most beneficial and send an e-mail to the Distribution Planner for the approval.

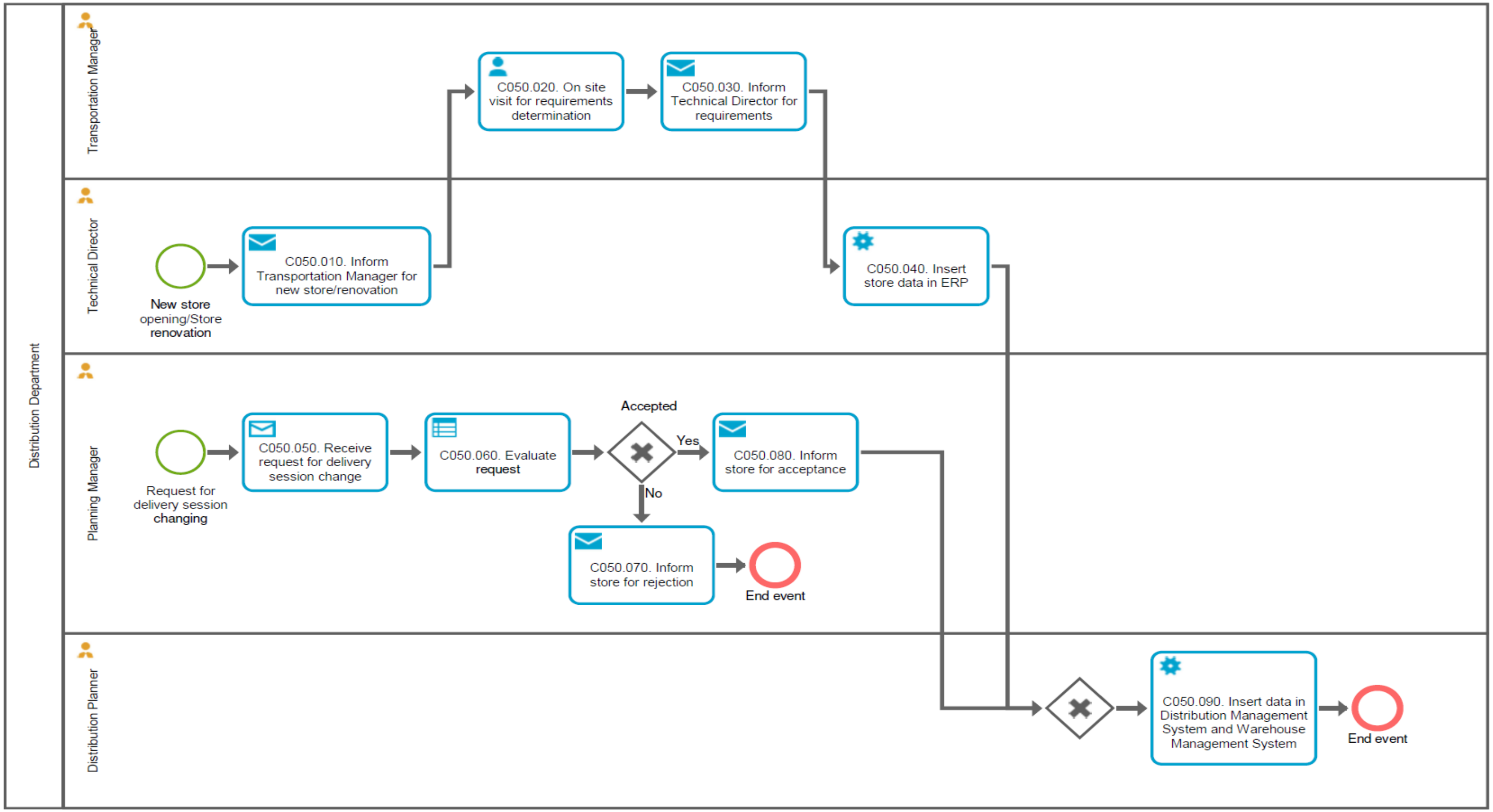
C040.060.: Receive approval

Activity Description	The Distribution Planner receives the e-mail for the offer approval.

C040.070.: Communicate with third-party logistics company

Activity Description	The Distribution Planner communicates with third-party logistics company to inform them for the approval and plan the laytime.

4.2.4.9. C050. New Stores Inserting in System



Activities Description:

C050.010.: Inform Transportation Manager for new store/renovation

Activity Description	The Technical Director informs the Transportation Manager for a store opening/renovation via e-mail.

C050.020.: On site visit for requirements determination

Activity Description	The Transportation Manager visits the location to determine the transportation requirements such as truck size etc.

C050.030.: Inform Technical Director for store requirements

Activity Description	The Transportation Manager informs the Technical Director for the store requirements.

C050.040.: Insert store data in ERP

Activity Description	The Technical Director inserts the requirements in the ERP System. Σε περίπτωση που υπάρχει ανάγκη αλλαγής του παραθύρου παράδοσης ενός καταστήματος, ο Planning Manager λαμβάνει το σχετικό αίτημα που υπέβαλε ο Περιφερειακός Διευθυντής του καταστήματος.
Software/System	ERP

C050.050.: Receive request for delivery session change

Activity Description	The Planning Manager receives request for delivery session change from a store.

C050.060.: Evaluate request

Activity Description	The Planning Manager evaluates the request.

C050.070.: Inform store for rejection

Activity Description	In case of rejection, the Planning Manager informs the store for the rejection and the reasons of rejection via e-mail.

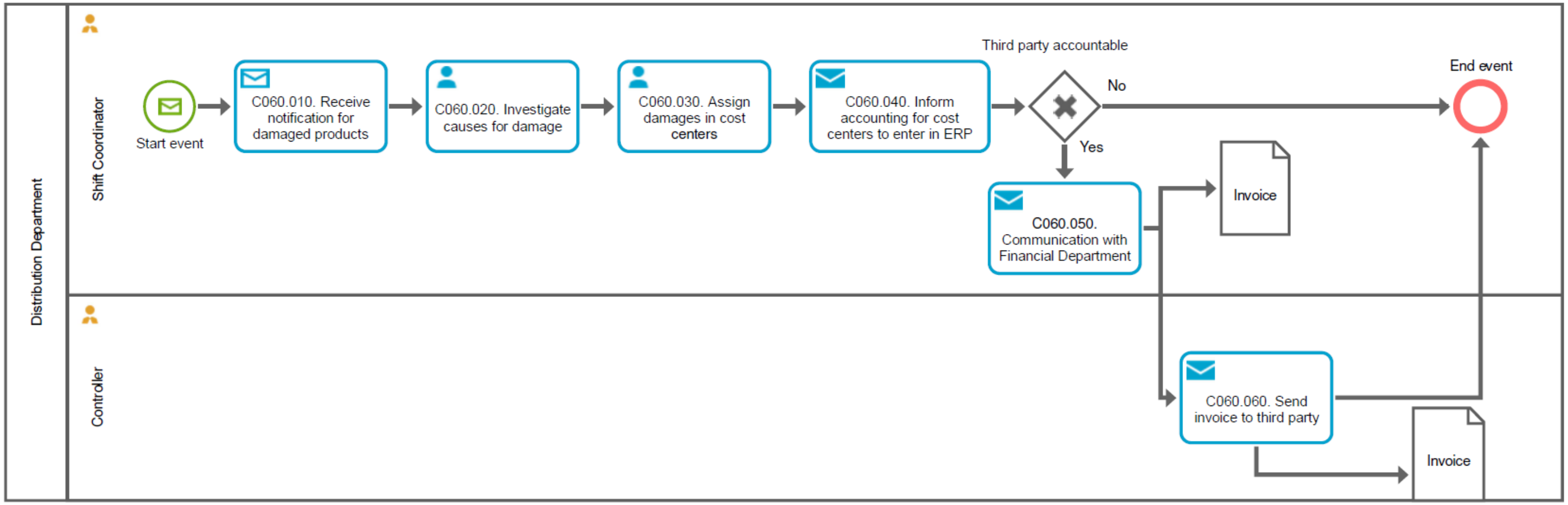
C050.080.: Inform store for acceptance

Activity Description	In case of acceptance, the Planning Manager informs the store for the acceptance of the request via e-mail.

C050.090.: Insert data in Distribution Management System and Warehouse Management System

Activity Description	The Distribution Planner inserts the new data for the store in the Distribution Management System and in the Warehouse Management System.
Software/System	DMS, WMS

4.2.4.10. C060. Damaged Products Handling



Activities Description:

C060.010.: Receive notification for damaged products

Activity Description	In case of damaged products identification during delivery is realized Shift Coordinator receives a notification e-mail from the store.

C060.020.: Investigate causes of damage

Activity Description	The Sift coordinator uses all means available to investigate the causes of the damage.

C060.030.: Assign damages in cost centers

Activity Description	According to the results of the investigation, the Shisft Coordinator allocates the cost of the damage in a specific cost center (Driver, Warehouse, Store etc.)

C060.040.: Inform accounting for cost centers to enter in the ERP

Activity Description	The Shift Coordinator informs the accounting via e-mail for the assigned cost center to enter it in the ERP.

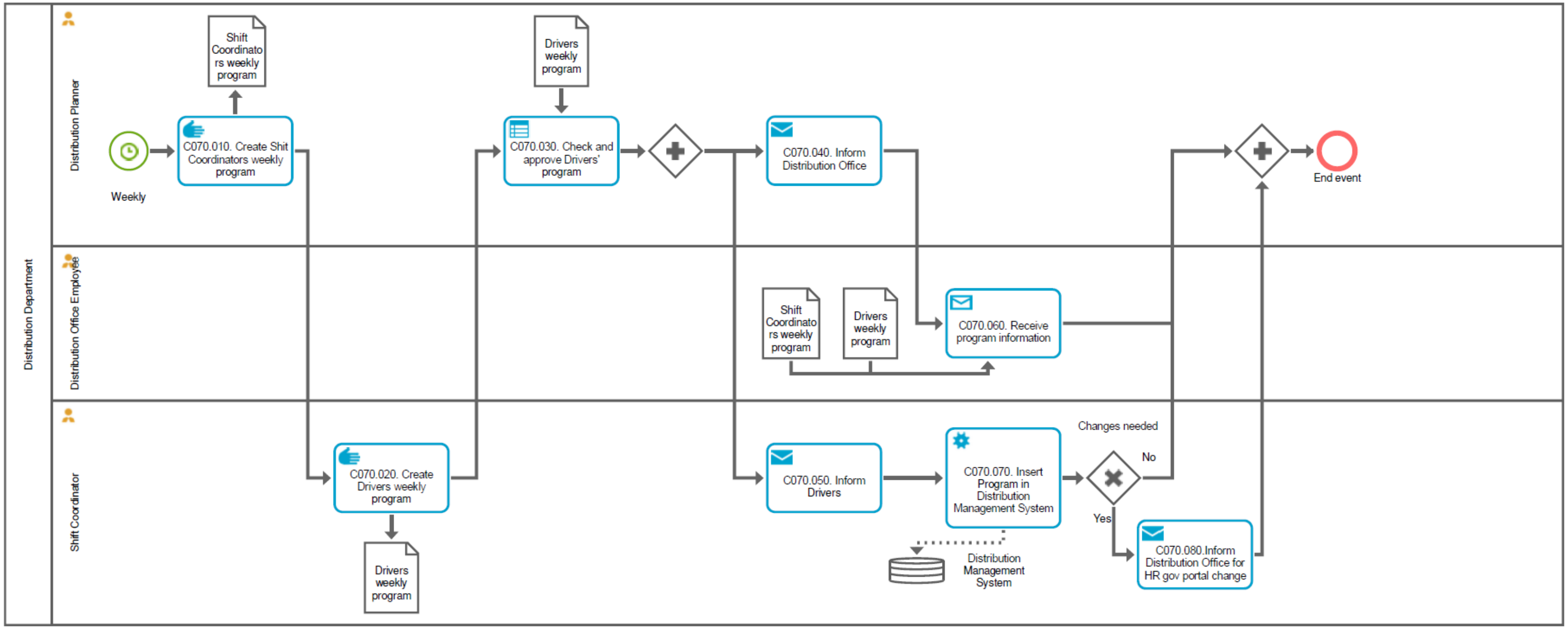
C060.050.: Communication with the Financial Department

Activity Description	In case the damage was caused by the third-party logistics company, the Shift Coordinator communicates with the Financial Department for the execution of the appropriate process.

C060.060.: Send invoice to the third-party logistics company

Activity Description:	Finally, the Controller send the invoice for the damage to the third-party logistics company.

4.2.4.11. C070. Distribution Personnel Program Planning



Activities Description:

C070.010.: Create Shift Coordinators weekly program

Activity Description	The Distribution Planner creates the weekly program for the Shift Coordinators.

C070.020.: Create Drivers weekly program

Activity Description	The Shift Coordinator taking under consideration the legal restrictions creates the weekly program for the drivers and sends it via e-mail to the Distribution Planner.

C070.030.: Check and approve Drivers program

Activity Description	The Distribution Planner checks the program. In case of disagreement, they resolve it with the Shift Coordinator and approves the Drivers program.

C070.040.: Inform Distribution Office

Activity Description	The Distribution Planner sends via e-mail the programs to the Distribution Office for upload in the HR governmental portal.

C070.050.: Inform Drivers

Activity Description	The Shift Coordinator after the approval from the Distribution Planner informs the Drivers for their program.

C070.060.: Receive program information

Activity Description	The Distribution Office receives the programs and uploads the data in the HR governmental portal.
Software/System	HR governmental Portal (ΕΡΓΑΝΗ)

C070.070.: Insert program in Distribution Management System

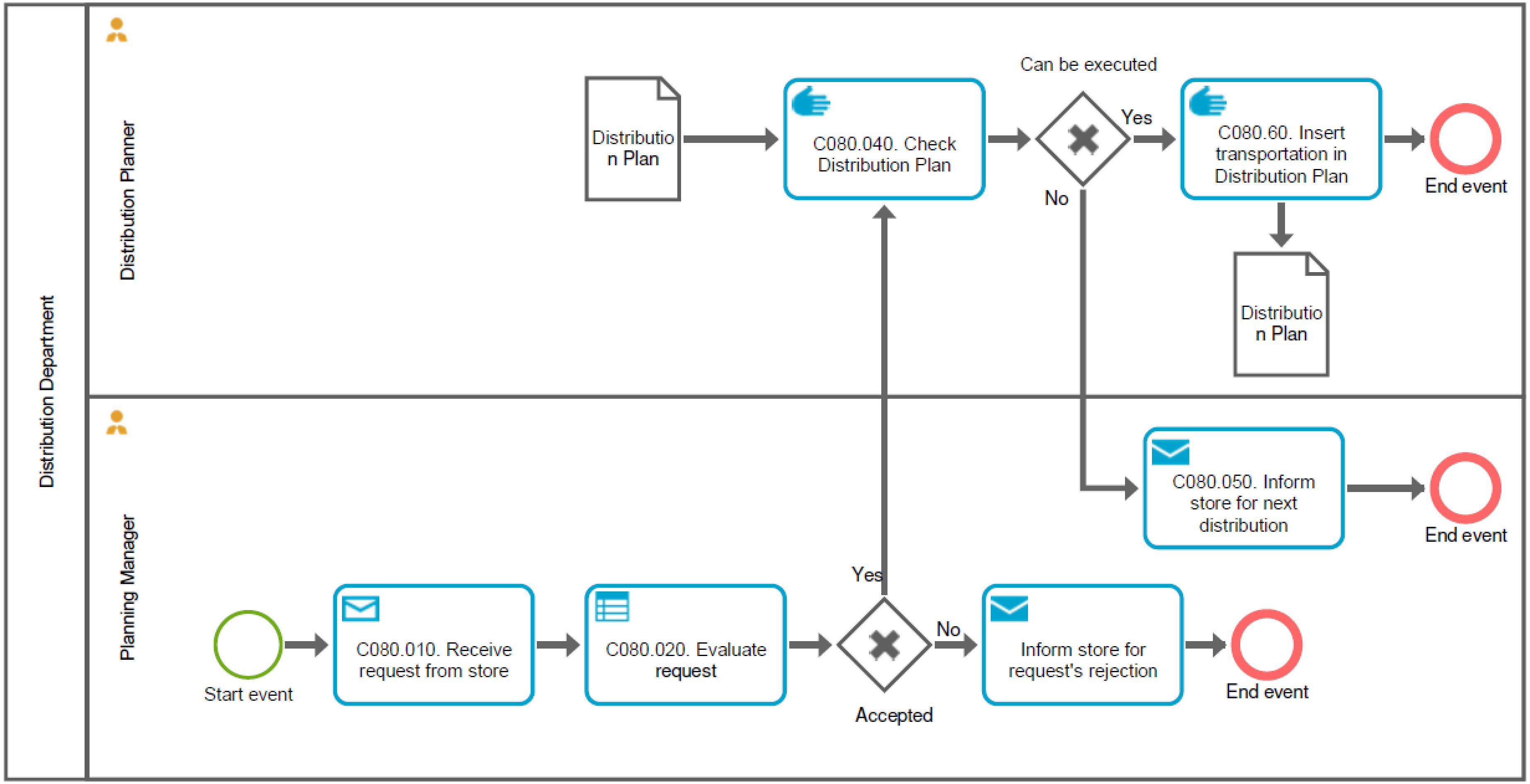
Activity Description	The Shift Coordinator uploads the programs in the Distribution Management System.
Software/System	DMS

C070.080.: Inform Distribution Office for HR governmental portal change

Activity	In case a change in the Drivers' program is required, the Shift

Description	Coordinator sends a new excel with the Drivers' new program via e-mail to the Distribution Office to make the appropriate changes in the HR governmental portal.

4.2.4.12. C080. Internal Store Exchanges



Activities Description:

C080.010.: Receive request from store

Activity Description	The Planning Manager receives an e-mail from the store requesting internal product transfer between stores.

C080.020.: Evaluate request

Activity Description	The Planning Manager calculates the cost and according to a company's rule for acceptance or rejection, makes the decision.

C080.030.: Inform store for request's rejection

Activity Description	The Planning Manager informs the store via e-mail for the request's rejection.

C080.040.: Check Distribution Plan

Activity Description	The Distribution Planner checks the Distribution Plan to explore if there is the possibility to support it.

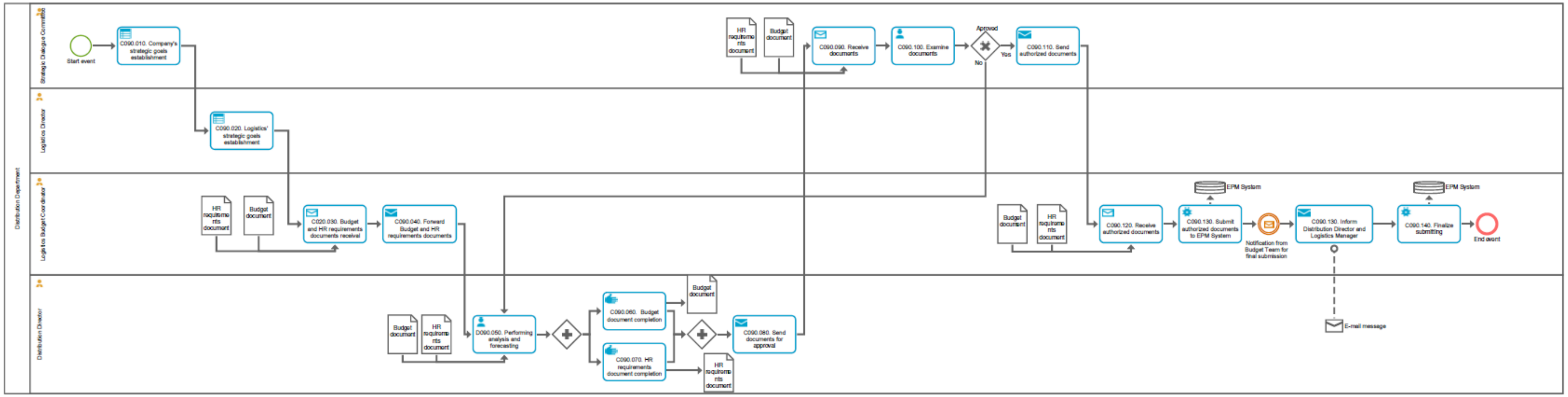
C080.050.: Inform store for next Distribution

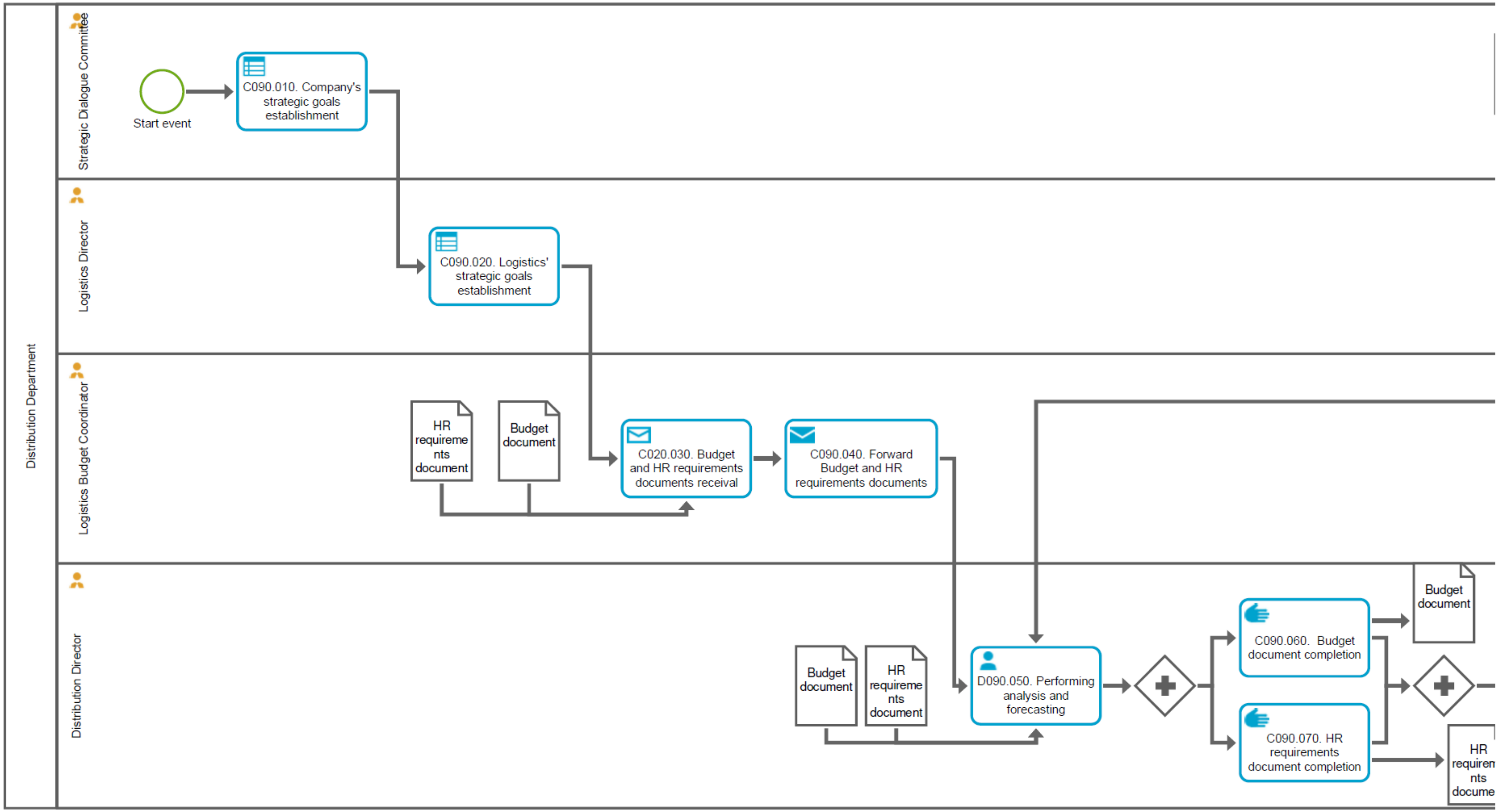
Activity Description	The Planning Manager informs the store that the request cannot be supported with the current Distribution Plan and it will be scheduled for the next transportation.

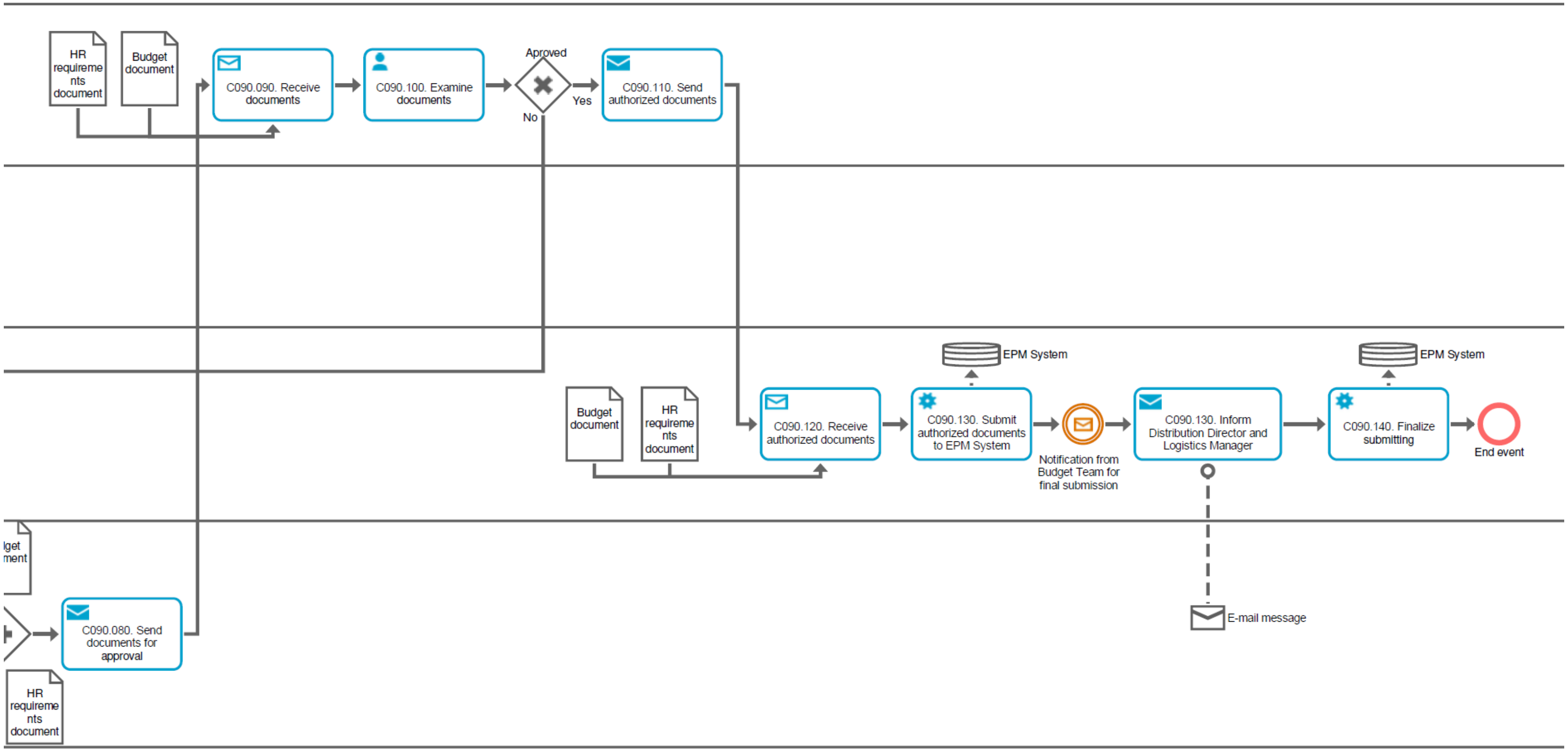
C080.060.: Include transportation in Distribution Plan

Activity Description	In case the request can be supported by the current Distribution Plan, the Distribution Planner includes it in it.

4.2.4.13. C090. Budgeting




Distribution Department
Strategic Dialogue Committee
Start event
C090.010. Company's strategic goals establishment
Logistics Director
C090.020. Logistics' strategic goals establishment
Logistics Budget Coordinator
HR requirements document
Budget document
C020.030. Budget and HR requirements documents receival
C090.040. Forward Budget and HR requirements documents
Distribution Director
Budget document
HR requirements document
D090.050. Performing analysis and forecasting
C090.060. Budget document completion
C090.070. HR requirements document completion
Budget document


HR requirements document
Budget document
C090.090. Receive documents
C090.100. Examine documents
Aproved
Yes
No
C090.110. Send authorized documents
EPM System
Budget document
HR requirements document
C090.120. Receive authorized documents
C090.130. Submit authorized documents to EPM System
Notification from Budget Team for final submission
C090.130. Inform Distribution Director and Logistics Manager
EPM System
C090.140. Finalize submitting
End event
E-mail message
C090.080. Send documents for approval
HR requirements document

Activities Description:

C090.010.: Company's strategic goals establishment

Activity Description	The Strategic Dialogue Committee sets in the Strategic Workshops the Strategic Goals and the corresponding KPIs.

C090.020.: Logistics' strategic goals establishment

Activity Description	The Logistics Manager alongside the Warehousing Director and Distribution Director using the Strategic Goals and KPIs set the Logistics' Strategic Goals and KPIs.

C090.030.: Budget and HR requirements documents receival

Activity Description	The Logistics Budget Coordinator receives via e-mail in excel forms the Budget and HR requirements documents.

C090.040.: Forward Budget and HR requirements documents receival

Activity Description	The Logistics Budget Coordinator sends via e-mail in excel forms the Budget and HR requirements documents to the Distribution Director to fill them.

C090.050.: Performing analysis and forecasting

Activity Description	The Distribution Director performs analysis of the historic data available, macro and micro analysis, new trends and estimates the future needs of the Distribution Department.

C090.060.: Budget Document completion

Activity Description	The Distribution Director based on CAPEX and OPEX estimations fills the Budget Document. For the document's completion input is provided also from the Transportation Manager, Planning Manager and Technical Fleet Manager.

C090.070.: HR requirements document completion

Activity Description	The Distribution Director based on historic sales, administrative human resources need, new stores, expected and previous transportations fills the HR requirements document. For the document's completion input is provided also from the Transportation Manager, Planning Manager and Technical Fleet Manager.

C090.080.: Send documents for approval

Activity Description	The Distribution Director sends the filled documents to the Strategic Dialogue Committee for approval.

C090.090.: Receive documents

Activity Description	The Strategic Dialogue Committee receives the documents.

C090.100.: Examine documents

Activity Description	The Strategic Dialogue Committee examines the documents. In case of disagreement the communicate with the Distribution Director and he makes the appropriate changes.

C090.110.: Send authorized documents

Activity Description	The Strategic Dialogue Committee send the approval via e-mail and the authorized documents to the Logistics Budget Coordinator.

C090.120.: Receive authorized documents

Activity Description	The Logistics Budget Coordinator receives the authorized documents via e-mail.

C090.130.: Submit authorized document in the ERM System

Activity Description	The Logistics Budget Coordinator submits the authorized documents in the used EPM before the final date and informs the Budget Team for the submission. The Budget Team performs the required checks regarding completeness and validity of the estimation from the Distribution Department. In case changes are needed the Budget team informs the Logistics Budget Coordinator via e-mail and the Logistics Budget Coordinator informs the Distribution Director to include the required changes.
Software/System	EPM

C090.140.: Inform Distribution Director and Logistics Manager

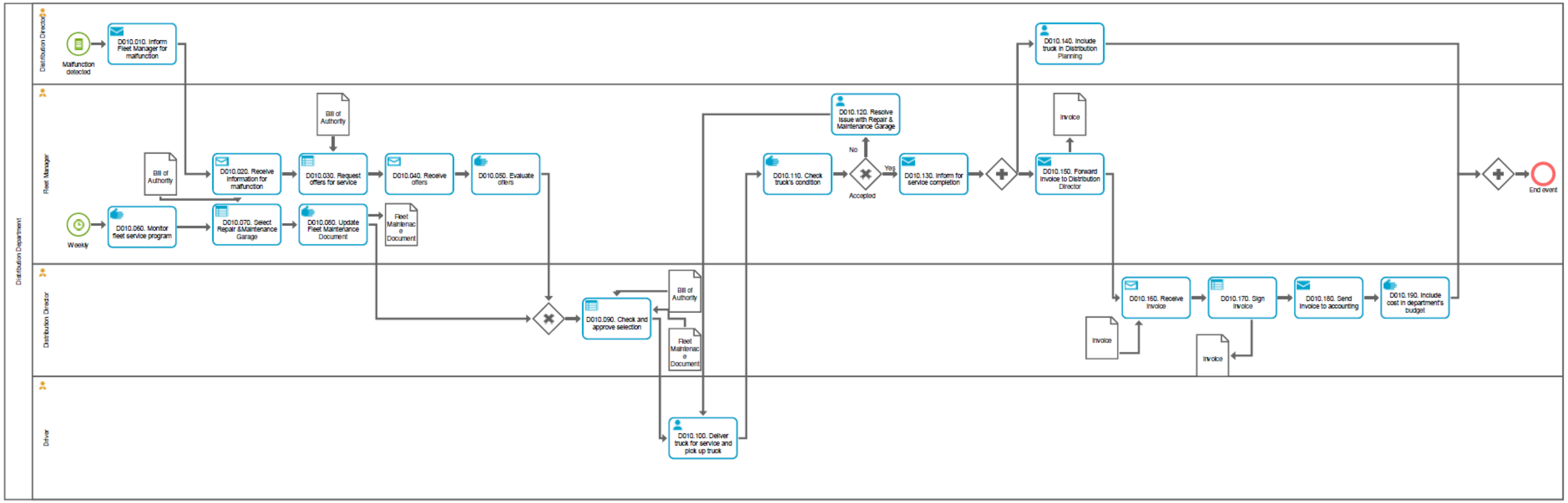
Activity Description	In case changes are needed the Budget team informs the Logistics Budget Coordinator via e-mail and the Logistics Budget Coordinator

	informs the Distribution Director to include the required changes. Otherwise, the Logistics Budget Coordinator informs the Distribution Director for the acceptance of the documents.

C090.150.: Finalize Submission

Activity Description	Logistics Budget Coordinator finalizes the submission of the documents.

4.2.4.14. D010. Fleet Maintenance



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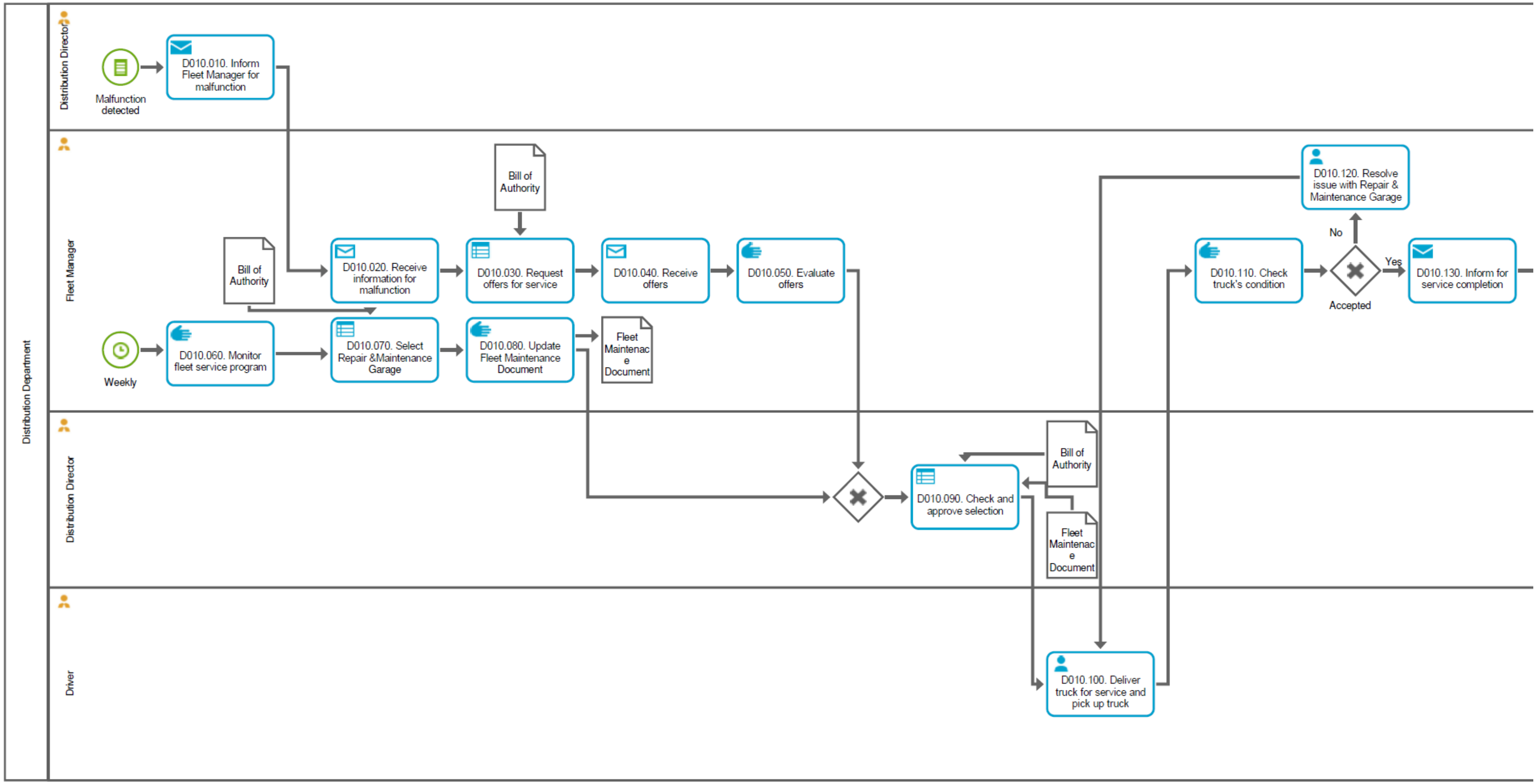
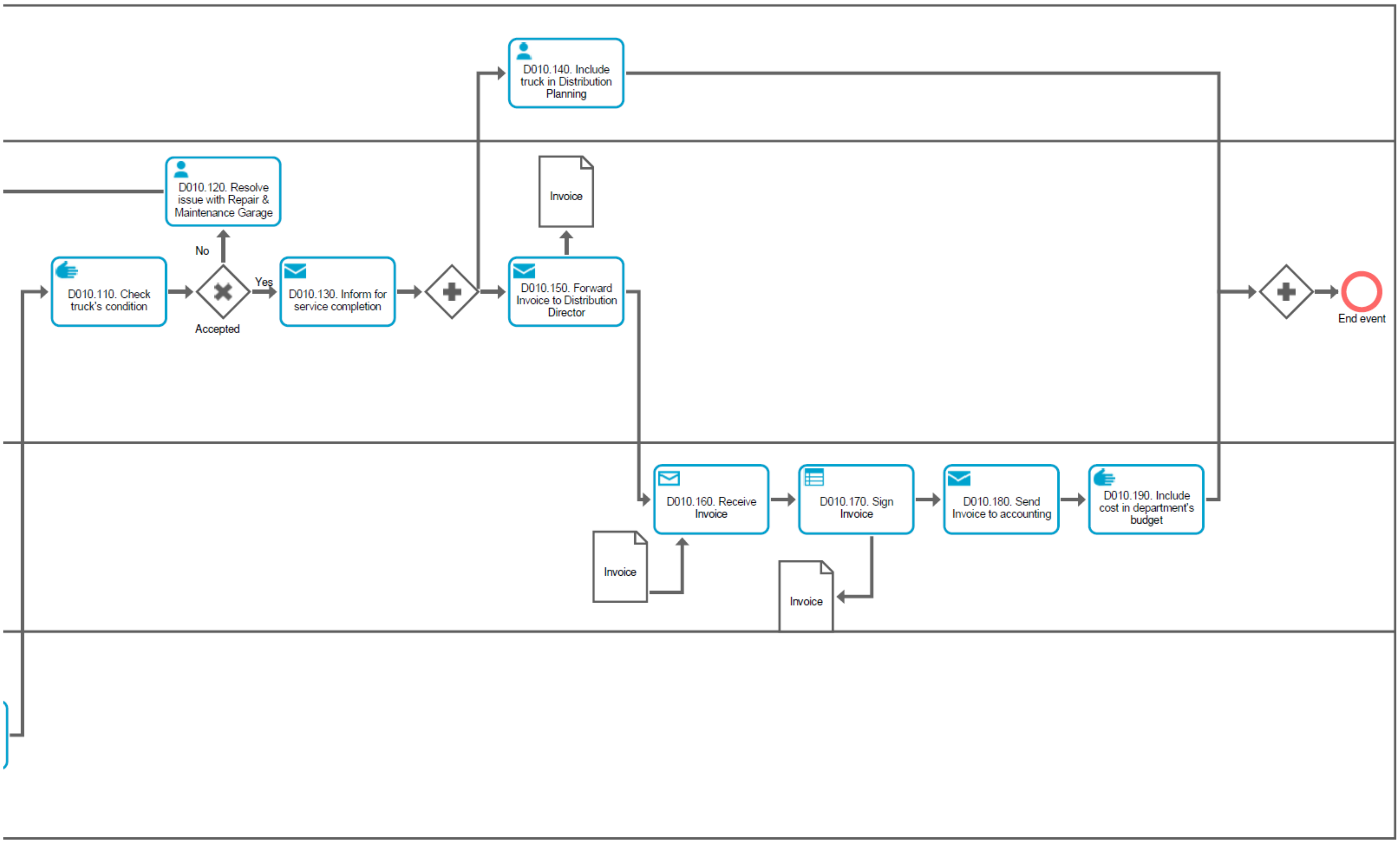

Distribution Department
Distribution Director
Malfunction detected
D010.010. Inform Fleet Manager for malfunction
Fleet Manager
Bill of Authority
D010.020. Receive information for malfunction
Bill of Authority
D010.030. Request offers for service
D010.040. Receive offers
D010.050. Evaluate offers
Weekly
D010.060. Monitor fleet service program
D010.070. Select Repair &Maintenance Garage
D010.080. Update Fleet Maintenance Document
Fleet Maintenac e Document
D010.110. Check truck's condition
No
Yes
Accepted
D010.120. Resolve issue with Repair & Maintenance Garage
D010.130. Inform for service completion
Distribution Director
Bill of Authority
D010.090. Check and approve selection
Fleet Maintenac e Document
Driver
D010.100. Deliver truck for service and pick up truck


D010.140. Include truck in Distribution Planning
D010.120. Resolve issue with Repair & Maintenance Garage
Invoice
No
D010.110. Check truck's condition
Yes
Accepted
D010.130. Inform for service completion
D010.150. Forward Invoice to Distribution Director
End event
D010.160. Receive Invoice
D010.170. Sign Invoice
D010.180. Send Invoice to accounting
D010.190. Include cost in department's budget
Invoice
Invoice

Activities Description:

D010.010.: Inform Fleet Manager for malfunction

Activity Description	When a malfunction in owed trucks is identified the Distribution Manager informs the Fleet Manager via e-mail for the malfunction.

D010.020.: Receive information for malfunction

Activity Description	The Fleet Manager receives the e-mail for the malfunction.

D010.030.: Request offers for service

Activity Description	The Fleet Manager requests for offers from the suitable Repair & Maintenance Garages for each truck. The emergency services are in higher priority than the scheduled. All actions are performed according to the Bill of Authority (Specific company’s rules).

D010.040.: Receive offers for service

Activity Description	The Fleet Manger receives the offers.

D010.050.: Evaluate offers

Activity Description	The Fleet Manger evaluates the received offers according to the company’s rules.

D010.060.: Monitor Fleet Service Program

Activity Description	In a weekly base, the Fleet Manger monitors the Service Program taking under consideration driven kilometers and truck’s technical specifications.

D010.070.: Select Repair & Maintenance Garage

Activity Description	The Fleet Manager selects according to company’s rules a Repair & Maintenance Garage for the service.

D010.080.: Update Fleet Maintenance Document

Activity Description	The Fleet Manager updates the Fleet Maintenance Document with all the scheduled services.

D010.090.: Check and approve selection

Activity Description	The Distribution Director reviews the offers and checks the selected Garage and gives his approval in the ERP system.
Software/System	ERP

D010.100.: Deliver truck for service and pick up truck from service

Activity Description	The Driver delivers the truck for the service and when the service is completed the Driver picks up the truck.

D010.110.: Check trucks condition

Activity Description	The Fleet Manager check the truck’s condition.

D010.120: Resolve issue with Repair & Maintenance Garage

Activity Description	In case of improper service, the Fleet Manager communicates with the Garage to resolve the issue and the driver delivers again the truck for service continuing the loop.

D010.130.: Inform for service completion

Activity Description	The Fleet Manager informs the Distribution Director via e-mail for the service completion.

D010.140.: Include truck in Distribution Planning

Activity Description	The Distribution Planner gets informed by the Distribution Director to include the truck in the Distribution Planning

D010.150.: Forward invoice to Distribution Director

Activity Description	The Fleet Manager receives the invoice for the service and forwards the invoice to the Distribution Director via e-mail.

D010.160.: Receive invoice

Activity Description	The Distribution Director receives the invoice.

D010.170.: Sign invoice

Activity Description	The Distribution Director signs the invoice.

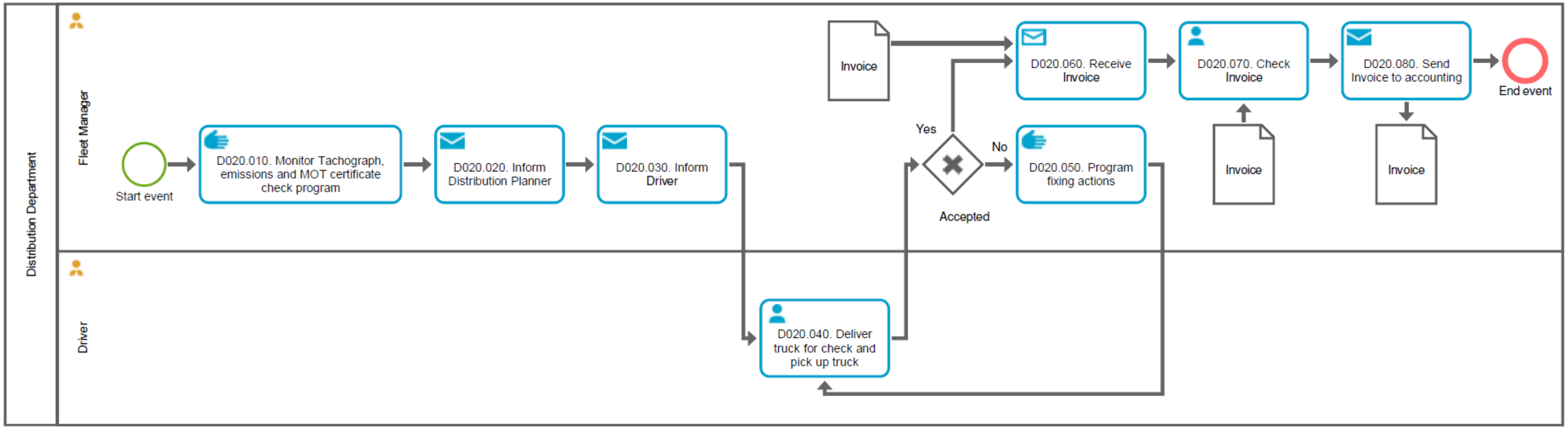
D010.180.: Send invoice to accounting

Activity Description	The Distribution Director sends the signed invoice to the accounting.

D010.150.: Include cost in Department's budget

Activity Description	The Distribution Director includes the cost in the Department's budget.

4.2.4.15. D020. Tachograph, emissions, and MOT certificate check



Activities Description:

D020.010.: Monitor Tachograph, emissions, and MOT certificate check program

Activity Description	At the beginning of each month the Fleet Manager monitors the Tachograph, emissions, and MOT certificate check program.

D020.020.: Inform Distribution Planner

Activity Description	The Fleet Manager informs the Distribution Planner for the programmed appointments three weeks prior to them.

D020.030.: Inform Driver

Activity Description	The Fleet Manager informs the Driver for the selected date for the appointment.

D.020.040.: Deliver truck for check and pick up truck

Activity Description	The Driver delivers the truck and when the check is completed the Driver picks up the truck.

D020.050.: Program fixing actions

Activity Description	In case the check recommend some fixing actions, the Fleet Manager schedules them.

D020.060.: Receive invoice

Activity Description	The Fleet Manager receives the invoice.

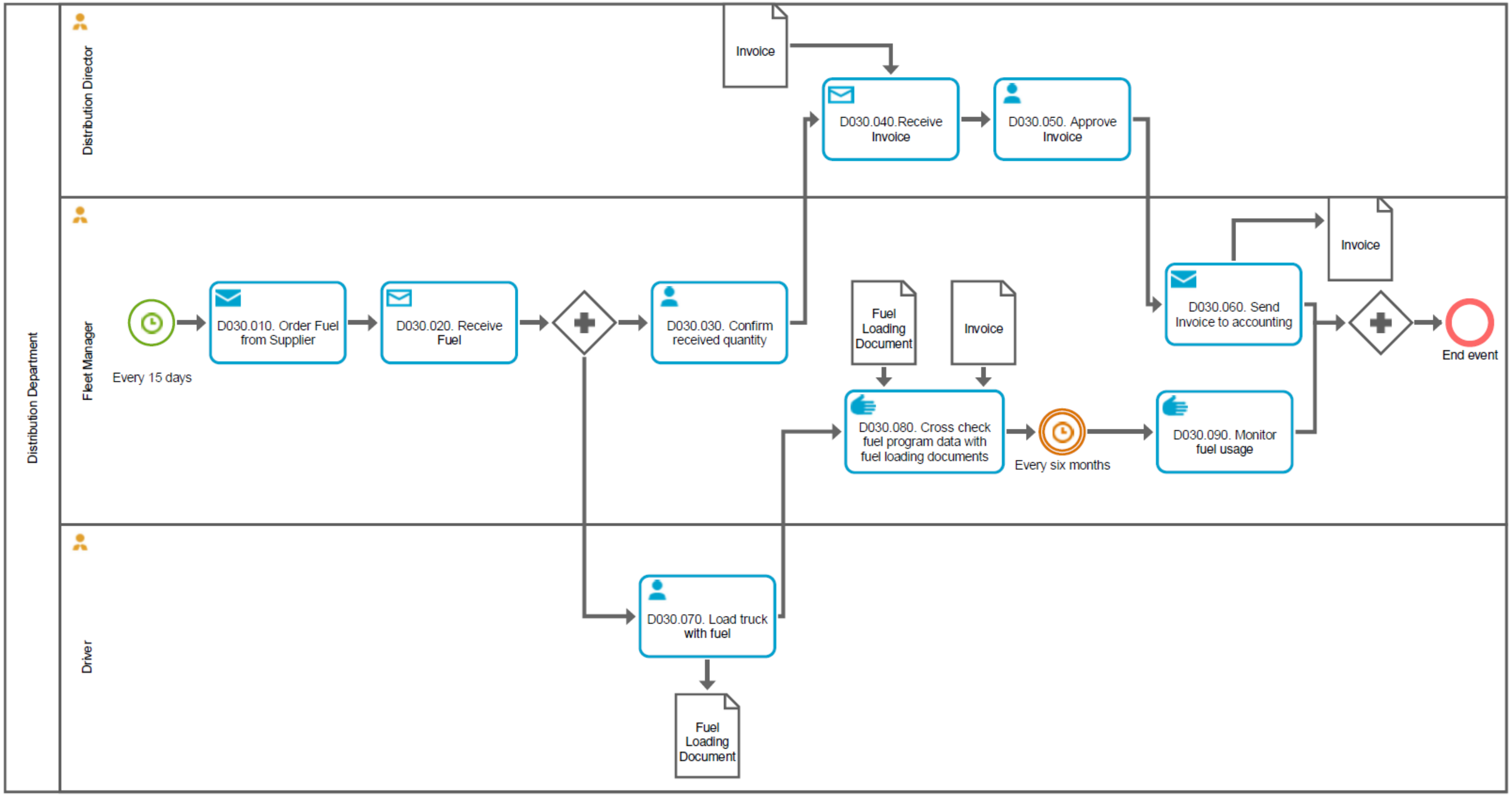
D020.070.: Check invoice

Activity Description	The Fleet Manger check the invoice and if he is in agreement he confirms the payment.

D020.080.: Send invoice to accounting

Activity Description	The Fleet Manager then sends the invoice to the accounting to execute the payment and include it in the ERP.

4.2.4.16. D030. Fuel Loading



Activities Description:

D030.010.: Order fuel from supplier

Activity Description	Every 15 days according to forecasts for fuel usage, the Fleet Manger orders fuel from specific supplier at the fixed price of the supplier's contract.

D030.020.: Receive fuel

Activity Description	The Fleet Manager receives the fuel at the company's depositor. .

D030.030.: Confirm received quantity

Activity Description	The Fleet Manager confirms the received quantity. In case the quantity is not the ordered the follow the company's protocol.
Software/System	Fuel program

D030.040.: Receive invoice

Activity Description	The Distribution Director receives the invoice.

D030.050.: Approve invoice

Activity Description	The Distribution Director checks and approves the invoice.

D030.060.: Send invoice to accounting

Activity Description	The Fleet Manager send the invoice to the accounting via e-mail.

D030.070.: Load truck with fuel

Activity Description	The Driver transfers the truck to the company's depositor and loads the truck. When the truck is loaded, the Driver fill the Fuel Receival Document.

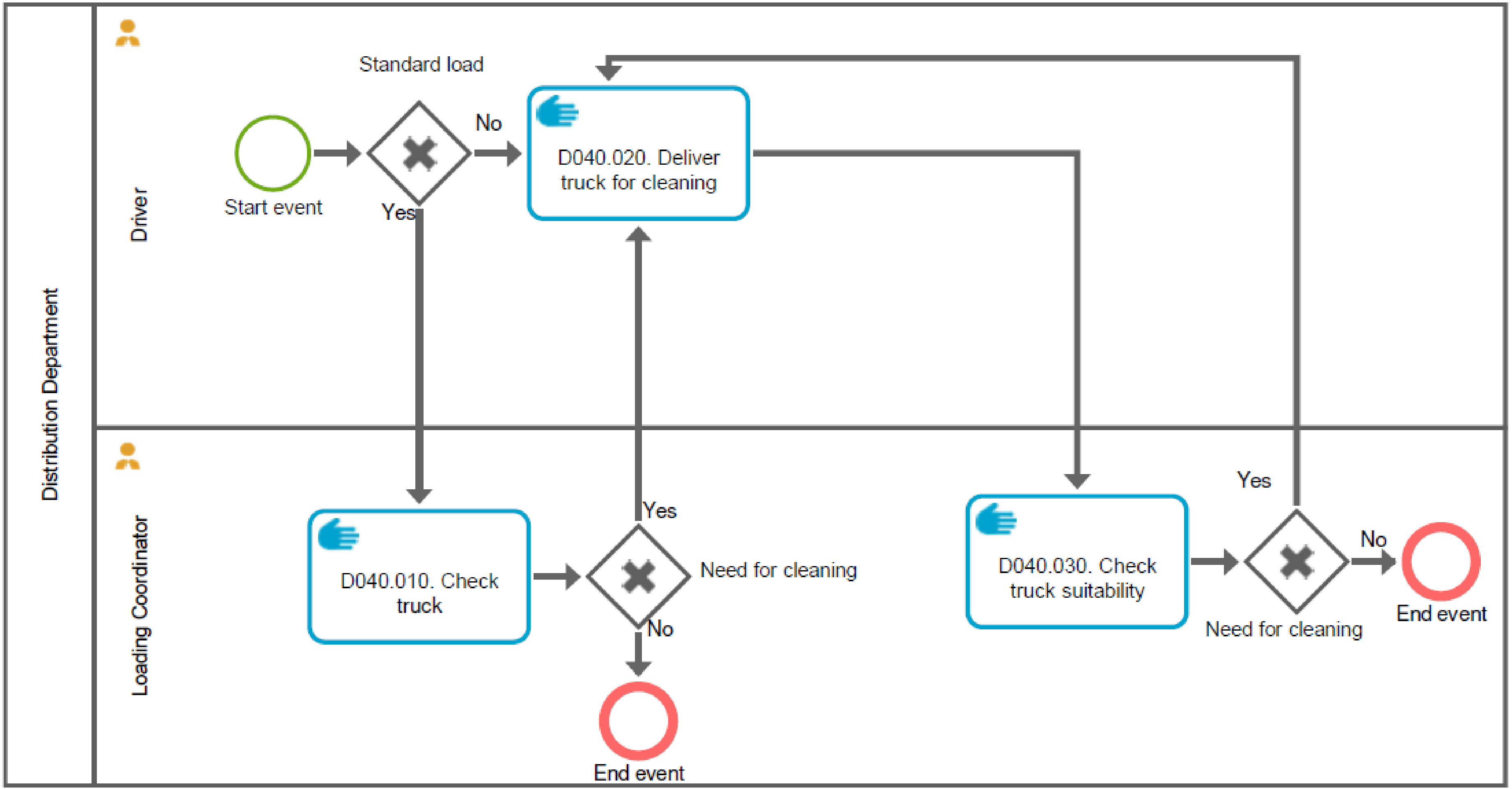
D030.080.: Cross-check fuel program data with fuel loading documents

Activity Description	The Fleet Manager inserts the in the fuel program the data from the Documents and checks if they are on agreement with the depositor data.
Software/System	Fuel Data

D030.090.: Monitor fuel usage

Activity Description	The Fleet Manager checks the recording and the depository every six months and creates a report to monitor the usage and find possible discrepancies (stolen fuel, fuel losses).

4.2.4.17. D040. Fleet Cleaning



Activities Description:

D040.010.: Check truck

Activity Description	In case the truck was loaded with standard cargo, it is checked if the truck needs cleaning. In case the cargo was not standard it goes straight for cleaning.

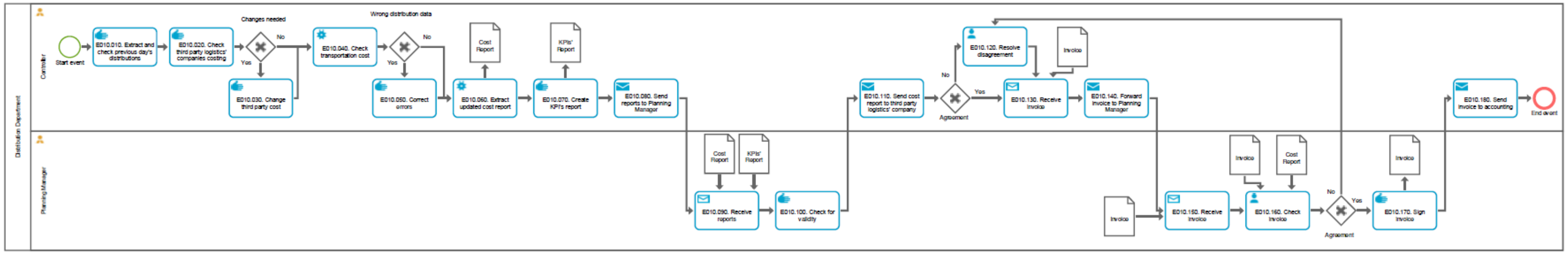
D040.020.: Deliver truck for cleaning

Activity Description	The truck is delivered for cleaning.

D040.030.: Check for truck's suitability

Activity Description	The loading Coordinator inspects the truck to determine if its condition is suitable for usage. If it is not suitable, it goes back for cleaning. If is suitable the process ends.

4.2.4.18. E010. Distribution Costing



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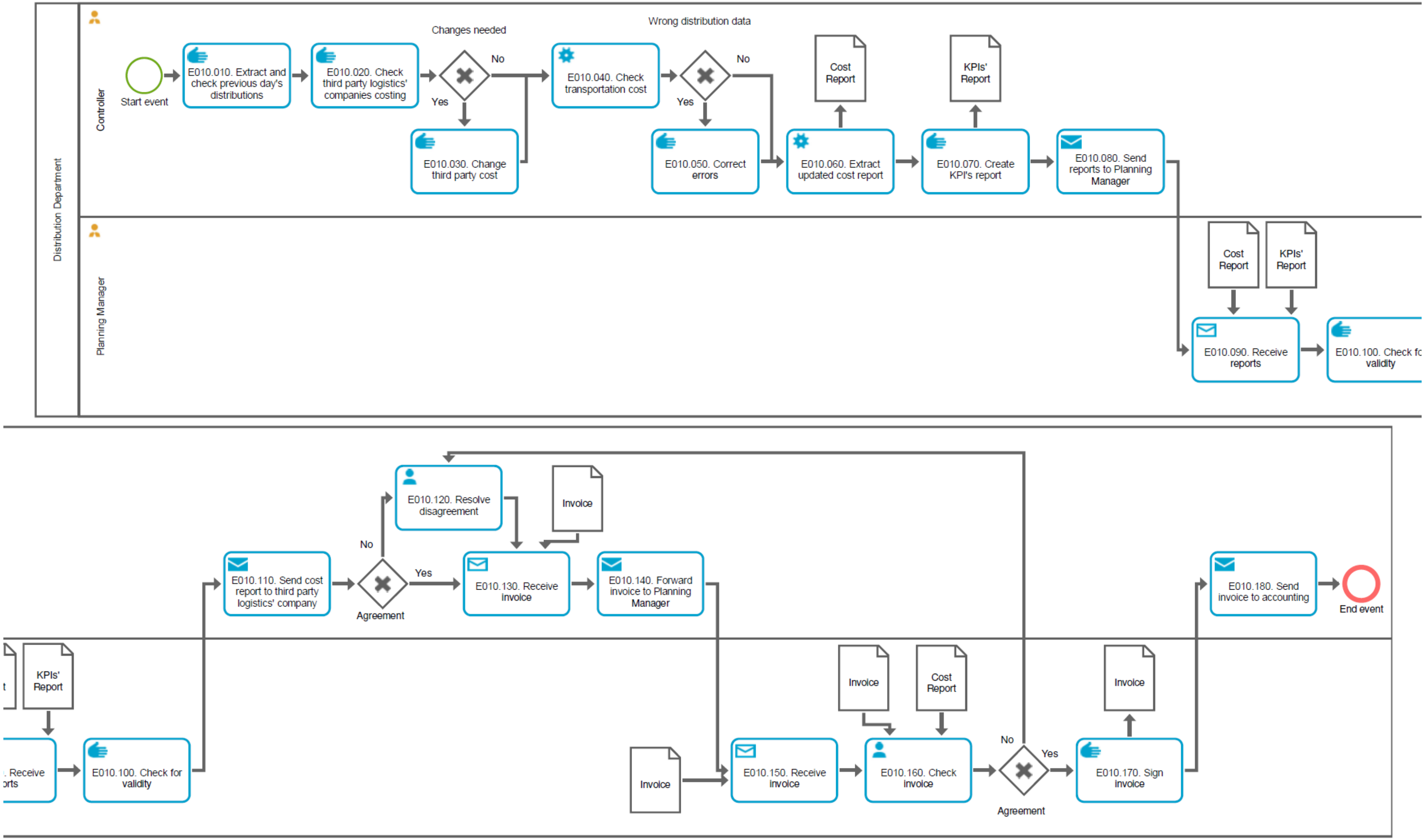


Distribution Department
Controller
Planning Manager
Start event
E010.010. Extract and check previous day's distributions
E010.020. Check third party logistics' companies costing
Changes needed
No
Yes
E010.030. Change third party cost
E010.040. Check transportation cost
Wrong distribution data
E010.050. Correct errors
Cost Report
KPIs' Report
E010.060. Extract updated cost report
E010.070. Create KPI's report
E010.080. Send reports to Planning Manager
E010.090. Receive reports
E010.100. Check for validity
E010.110. Send cost report to third party logistics' company
Agreement
E010.120. Resolve disagreement
Invoice
E010.130. Receive invoice
E010.140. Forward invoice to Planning Manager
E010.150. Receive invoice
E010.160. Check invoice
E010.170. Sign invoice
E010.180. Send invoice to accounting
End event

Activities Description

E010.010.: Extract and check previous day's distributions

Activity Description	The Controller checks the previous day's distribution entries in the DMS and extracts the report. The Controller checks further the cost report and makes manual corrections in the DMS system. The report contains information regarding transportation costs per transportation, per district and per logistics company.
Software/System	DMS

E010.020.: Check third-party logistics companies costing

Activity Description	The Controller checks the third-party companies costing at the contract to ensure the correctness of the transportation cost per logistics company.
Software/System	DMS

E010.030.: Change third-party logistics companies costs

Activity Description	In case a discrepancy is identified, the Controller changes it manually.

E010.040.: Check transportation costs

Activity Description	The Controller checks the transportation costs for wrong entries in the DMS.
Software/System	DMS

E010.050.: Correct errors

Activity Description	The Controller manually corrects the errors.
Software/System	DMS

E010.060.: Extract updated cost report

Activity Description	The Controller extracts the updated cost report in an excel document with all the manual changes been visible.

E010.070.: Create KPIs report

Activity Description	The Controller creates with the cost report's data a KPIs report by calculating manually the KPIs.

E010.080.: Send reports to Planning Manager

Activity Description	The Controller send via e-mail both cost report and KPIs report to the Planning Manager for further check.

E010.090.: Receive reports

Activity Description	The Planning Manager receives both reports.

E010.100.: Check for validity

Activity Description	The Planning Manager checks the validity and the correctness of the reports. In case of disagreement, the Planning Manager communicates with the Controller to resolve it and make the appropriate amendments.

E010.110.: Send cost report to third-party logistics company

Activity Description	The Controller sends to each third-party company the cost report for the specific company.

E010.120.: Resolve disagreement

Activity Description	The Controller resolves any disagreements with the logistics companies. In case of changes, the Controller changes them manually and inputs them in the DMS.
Software/System	DMS

E010.130.: Receive invoice

Activity Description	The Controller receives the invoice from the logistics company.

E010.140.: Forward invoice to Planning Manager

Activity Description	The Controller forwards the invoice from the logistics company to the Planning Manager.

E010.150.: Receive invoice

Activity Description	The Planning Manager receives the invoice.

E010.160.: Check invoice

Activity Description	The Planning Manager checks that the amount payable at the invoice is the same with the one at the cost report. In case there is a disagreement the Controller communicates again with the logistics company and the activities are repeated until the Planning Manager accepts the invoice.

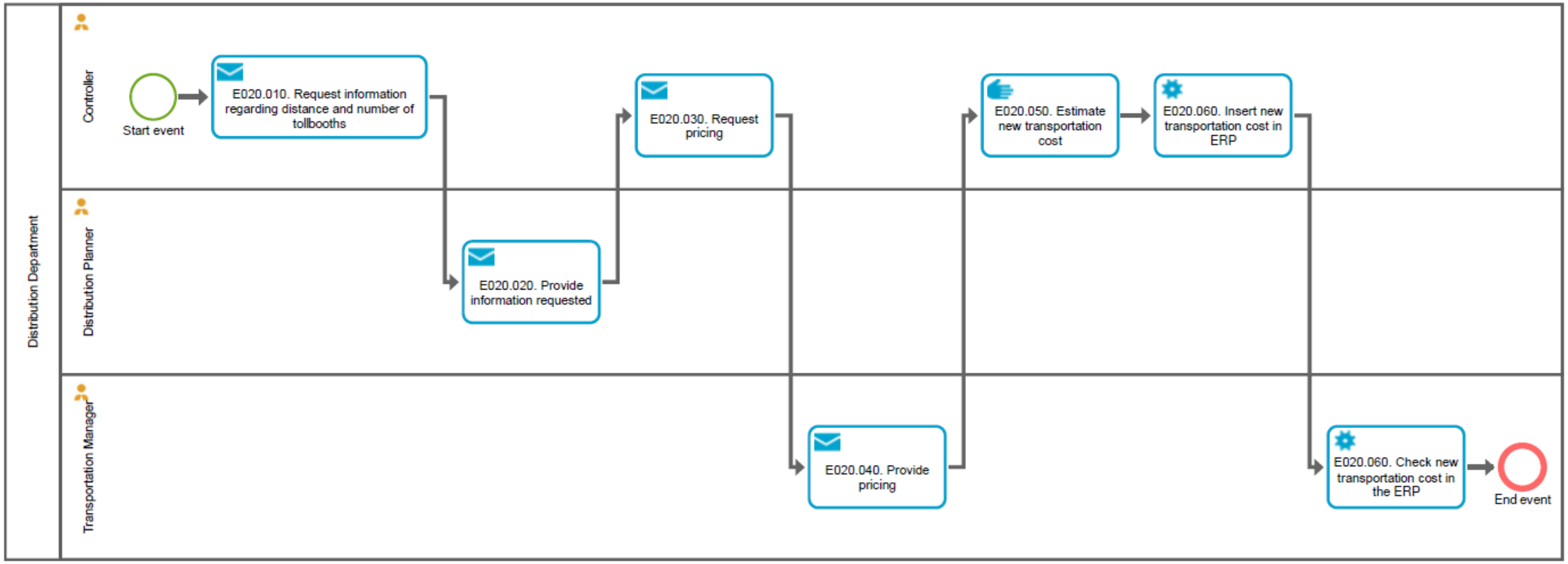
E010.170.: Sign invoice

Activity Description	The Planning Manager signs the invoice.

E010.180.: Send invoice to accounting

Activity Description	The Controller sends the signed invoice to the accounting to proceed with the payment.

4.2.4.19. E020. New transportation cost estimation



Activities Description

E020.010.: Request information regarding distance and tollbooths

Activity Description	The Controller requests information regarding distant and number of tollbooths from the Distribution Planner via e-mail.

E020.020.: Provide information requested

Activity Description	The Distribution Planner provides the requested information via e-mail response.

E020.030.: Request pricing

Activity Description	The Controller requests pricing information (€/km) for the transportation from the Planning Manager via e-mail.

E020.040.: Provide pricing

Activity Description	The Planning Manager provides the information requested via e-mail response.

E020.050.: Estimate new transportation cost

Activity Description	The Controller estimates according to the received information the transportation cost.

E020.060.: Insert transportation cost in DMS

Activity Description	The Controller inserts the new transportation cost in the DMS.
Software/System	DMS

E020.070.: Check new transportation cost in DMS

Activity Description	The Planning Manager extracts a report from DMS daily which includes all transportation changes made during the day.

Software/System	DMS

4.2.5. Enable Phase

In the enable phase is presented the proposed new Distribution Processes Model (TO-BE) incorporating state of art technologies used in the supply chain aiming to meet the customer's expectations described in the define phase. The new model is constructed in ARIS architect & designer 10.0 software using Enterprise BPMN collaboration diagrams to describe the improved and new processes.

State of art technologies used for the new model

In the literature review section, most of the state-of-the-art technologies are described as their application in the market. The proposed Distribution Processes Model tries to benefit from some of them to succeed higher automation and digitalization. The suggested technological advancements included in the model are described below.

The model requires installment of Cloud ERP System, Cloud WMS and Cloud DMS which are interconnected and communicative with each other and store data in the Cloud Platform. All software systems have the ability to collaborate with the other systems weather is a Management System, Mobile application or Statistical Process Control software. Inquiries and data are automatically transferred from the ERP and WMS to the DMS and translated into the system notions. For example, the orders from the DMS are transferred to the WMS for picking as SKUs and then transferred to the DMS as pallets.

The DMS provides multiple capabilities such as:

- Fleet Management System
- Routing and routing optimization
- Loading monitoring and optimization
- Dynamic Distribution Planning/ Same day delivery/ Time-slot booking
- Distribution Costing and Estimation
- Transportation Costing
- Digital Documents creation
- Sending e-mails and notifications
- Communication with the smartphone application
- Reducing empty miles

All these systems are using cloud databases for data storage and cloud computing to run all the different algorithms. The data reside from the different software systems are finally, reside in a common Cloud Platform to make data-mining easier. Blockchain technology is also used to record the transactions i.e., payments, products delivery, fuel etc. and to manage the digital documents, e-loading documents and e-consignment notes and the Smart Contracts and Procurements.

The DMS handles all the orders, the cross-docking needs, internal transfers, store exchanges, emergency distributions, backhauling and unexpected incidents, storing all these data for future use in predictive algorithms. Cargo data information, business rules, priority rules and restrictions (standard and ad-hoc) can be inserted in the system to be used for the decision making.

A vital part of the DMS is the Fleet Management System which uses information from different databases to perform various activities.

- Storing trucks' data in the appropriate database
- Trucks' assignment to each distribution
- Monitoring and sending notification for the fleets' scheduled services, need for maintenance etc.
- Tracking the location, the condition, and the fuel usage of the trucks
- Informs for trucks' availability

Trucks, stores, warehouses/DCs, suppliers, partners, third-party logistic companies and drivers are different entities in the databases with their own attributes, profiles and information. For example, each truck's ID is the plate number and information such as storage capacity is an attribute and information such as last service, total cost per year, transportation conditions are stored data and used appropriately for different processes such as Distribution Costing or Damaged Products Handling.

Other technological advancements used in the model are sensors, RFID, QR codes EPC, WSN and GPS for real time data collection to store them in the Cloud Platform and use them in the different algorithms for the data-backed decision making and the intelligent forecasting. For example, all trucks have sensors and when they are loaded with fuel automatically, the amount of fuel loaded, and the time/date are saved in the database for the specific truck.

As mentioned before blockchain technology enables the usage of e-loading documents, e-consignment notes, Smart Contracts and Smart Procurements. Instead of using the conventional loading documents, e-loading documents can be used which are verified at different nodes when a stage is completed such as loading completed or unloading to store A competed. Similar is the usage of the e-consignment note, which does not require signing upon delivery but digital confirmation. Smart Contracts and Procurements are used to close deals and execute payments aiming to support smart logistics and promote automation in processes. In the Distribution Processes Smart Contracts are used with the fuel suppliers, selection of third-party logistic companies and Repair & Maintenance Garages for the fleets' services and maintenance. The Smart Contracts are created automatically using data from the DMS and they are shared with the service providers and after selecting the best price. The Smart Contracts automatically calculate, arrange payments, and carry out their terms and conditions. For example, for the perishable products there is a set temperature in truck and in case this standard is not met the payment is not executed, or in laytime if the agreed duration is exceeded an extra cost is paid automatically.

A real time SPC software for monitoring and analysis aids in resolving quality problems before they even occur. Visual cues and control charts give the operators the needed information for proactive processes control. The real time Statistical Control Process software has access to all databases from the different systems and can exploit even undefined or different format data and send alerts in case entered data are out of specifications or control. It also offers monitoring of KPIs and quality metrics, data mining, and reports and charts creation allowing the team members to concentrate on reviewing and analyzing the results.

Finally, it is suggested the incorporation of a Mobile/Smartphone application for communication, documents sharing, RFID scanning and collection and data entrance in the systems. The Smartphone application also helps in activities execution by giving directions. Apart from the Distribution Processes can also be used in Warehousing Processes such as picking. These applications are very helpful especially in loading processes automating the confirmation of each status if combined with the e-loading documents. They also improve communication between stakeholders, reducing e-mails exchanges and making alerts and notifications easily used.

It is important to keep the complexity of the IT infrastructure to the minimum to make data mining and data finding easier. The IT infrastructure apart from the Cloud Platform, Blockchain Technology and Cloud Computing is also the IoT and the 5G Network which are essential for the data-acquisition and the real time processing.

After describing the used technologies in the model, the Process Structure of the TO-BE Distribution Processes and the Enterprise BPMN collaboration diagrams for each one of these processes and sub-processes are presented in the following sections with explanation of how the process is changed. All of them are created in the ARIS architect & designer 10.0 software.

Overall changes in the Distribution Processes:

- ✓ Distribution Preparation, Planning, Execution and Emergency Distributions become dynamic, and triggered from multiple events during the day
- ✓ Distribution Plans, trucks' and drivers' assignment are automatically created
- ✓ Activities are systematically and automatically monitored and events and durations documented
- ✓ Information and directions are shared via smartphone app
- ✓ Automated communication with 3PL companies, suppliers, and partners
- ✓ Automated payment execution and recording in ERP System
- ✓ All documents have digital form, verification stages and are updated and stored in the System
- ✓ Most inquiries are received internally
- ✓ New inquiries can be handled by ongoing distributions
- ✓ Requests can be evaluated internally in the system according to the business rules, priority rules and restrictions inserted in this
- ✓ Contracts and reports are automatically generated using saved data
- ✓ New processes are established (Monthly Process Monitoring and Damaged Products) and follow the LSS principles and can generate LSS projects

Distribution Processes (to-be) structure

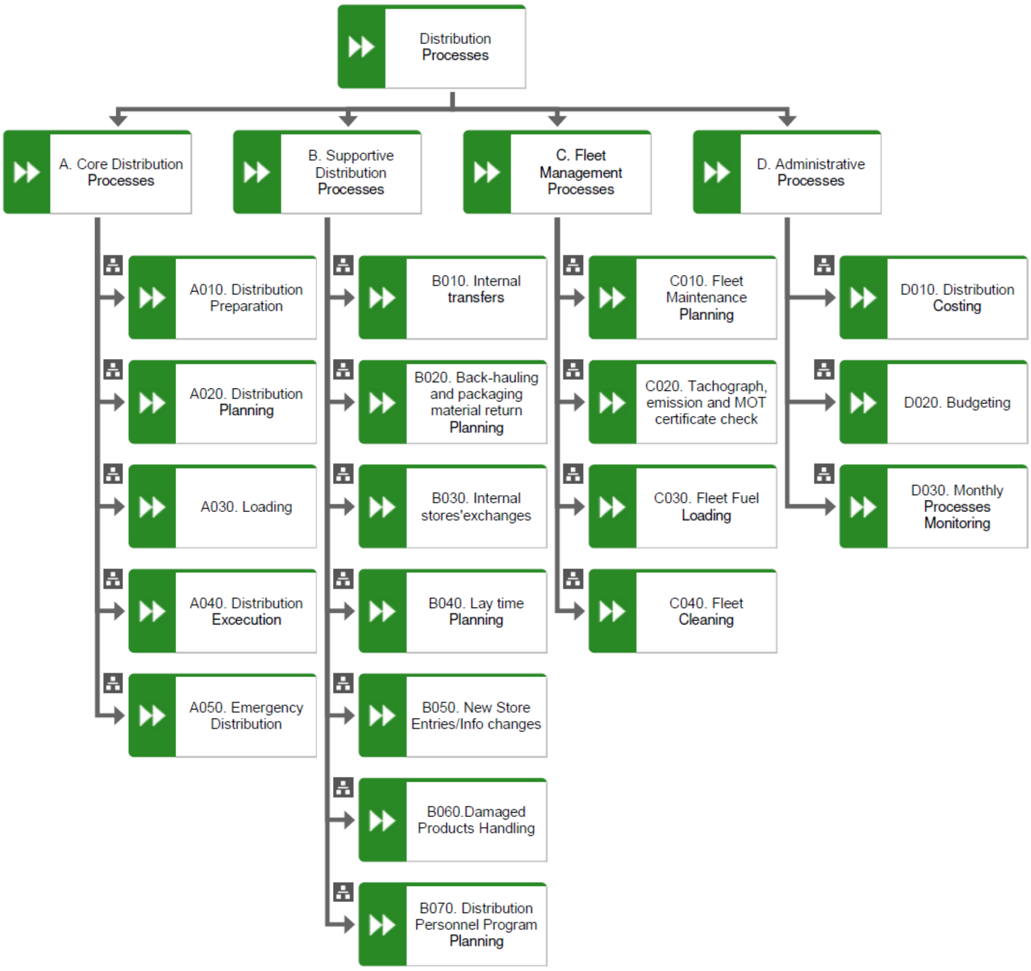
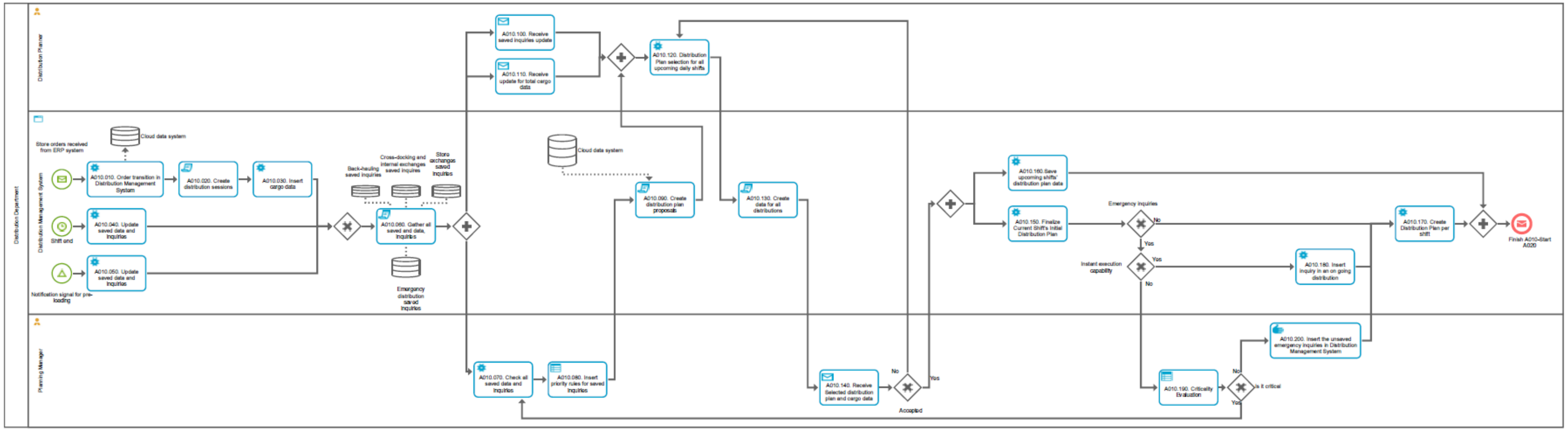
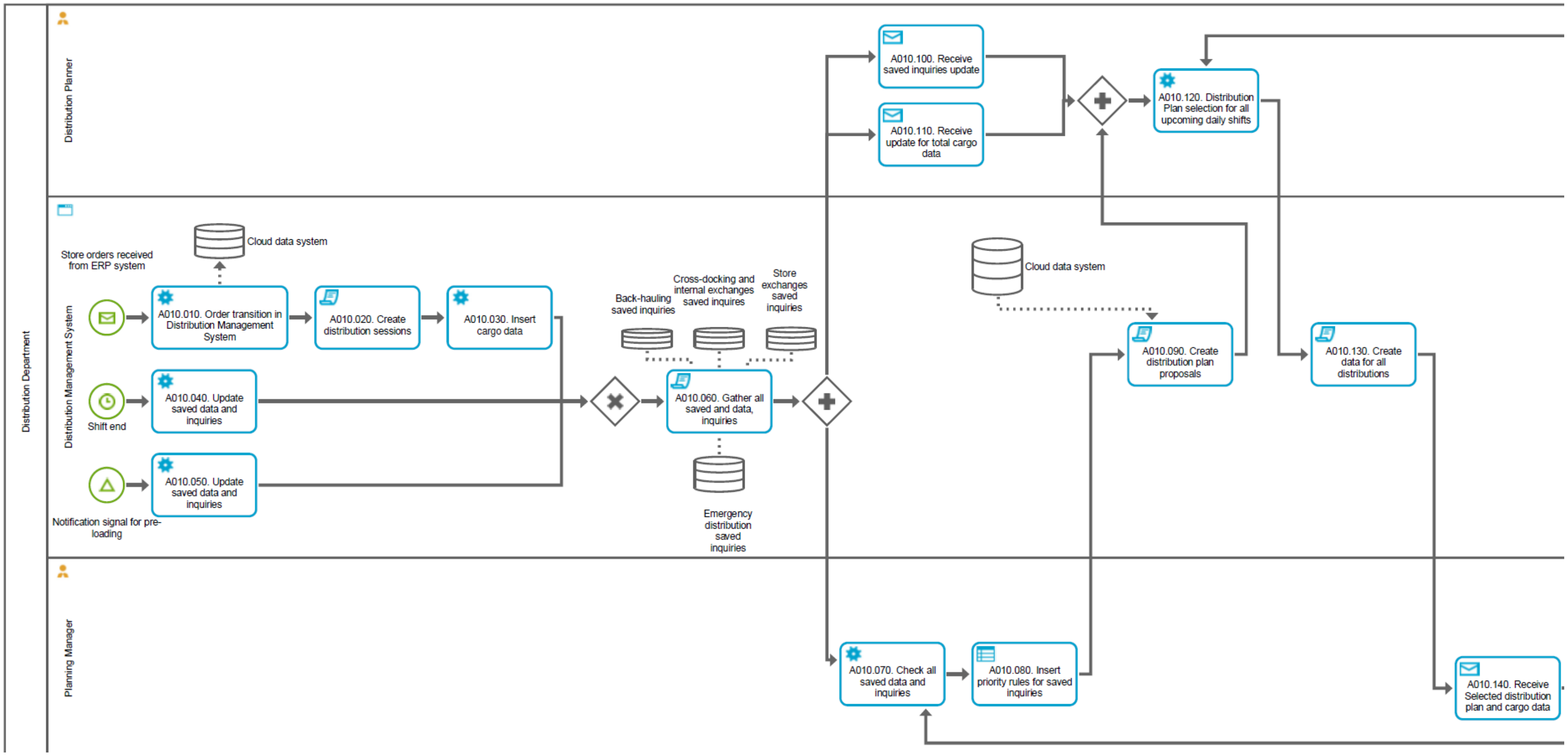
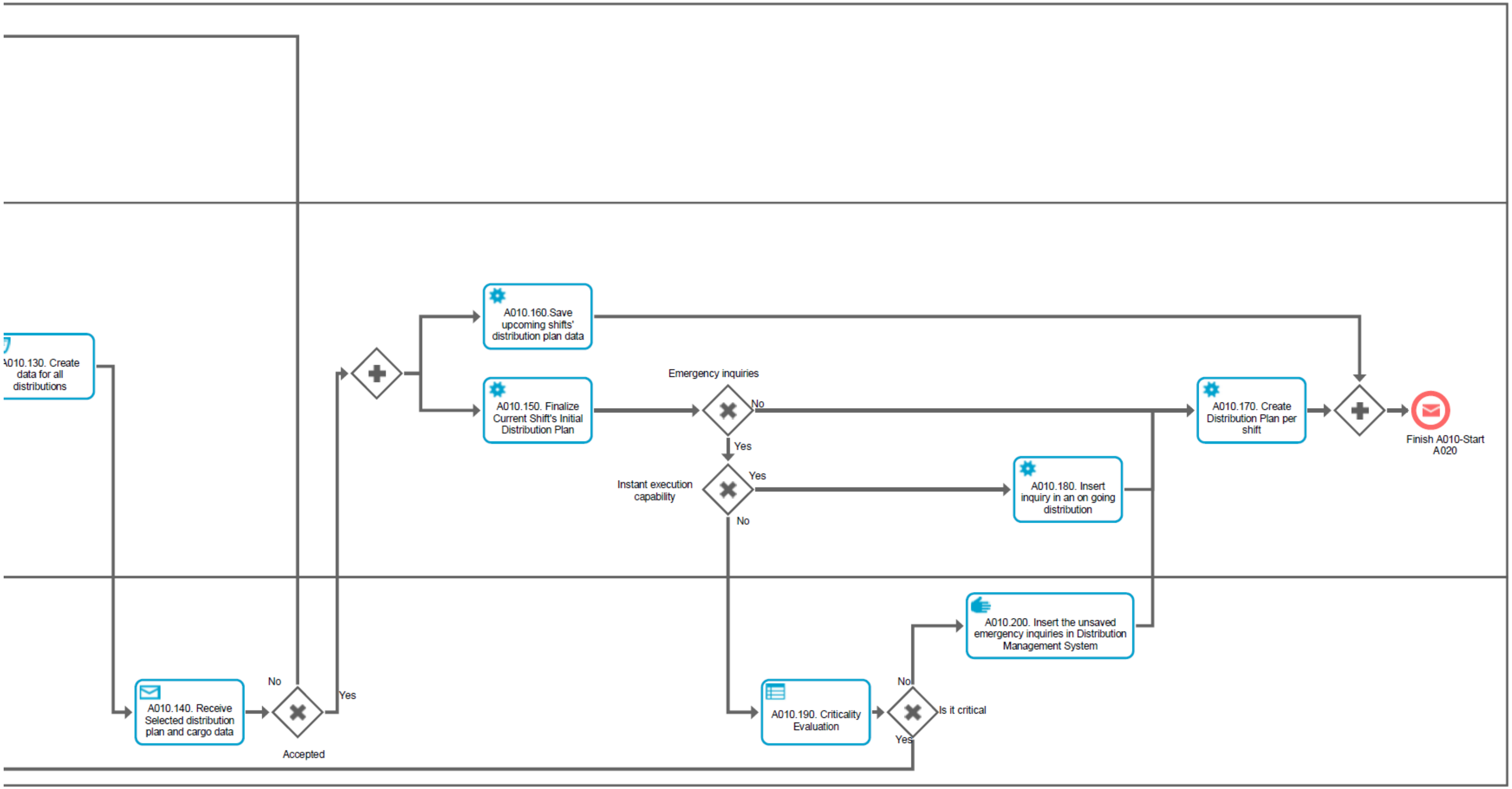


Figure 36, Distribution Processes (to-be) structure

4.2.5.1. A010. Distribution Preparation




Distribution Department
Distribution Planner
Distribution Management System
Planning Manager
A010.100. Receive saved inquiries update
A010.110. Receive update for total cargo data
A010.120. Distribution Plan selection for all upcoming daily shifts
Cloud data system
Store orders received from ERP system
A010.010. Order transition in Distribution Management System
A010.020. Create distribution sessions
A010.030. Insert cargo data
Back-hauling saved inquiries
Cross-docking and internal exchanges saved inquires
Store exchanges saved inquiries
A010.040. Update saved data and inquiries
Shift end
A010.050. Update saved data and inquiries
Notification signal for pre-loading
A010.060. Gather all saved and data, inquiries
Emergency distribution saved inquiries
Cloud data system
A010.090. Create distribution plan proposals
A010.130. Create data for all distributions
A010.070. Check all saved data and inquiries
A010.080. Insert priority rules for saved inquiries
A010.140. Receive Selected distribution plan and cargo data


A010.130. Create data for all distributions
A010.140. Receive Selected distribution plan and cargo data
No
Yes
Accepted
A010.160.Save upcoming shifts' distribution plan data
A010.150. Finalize Current Shift's Initial Distribution Plan
Emergency inquiries
No
Yes
Instant execution capability
Yes
No
A010.180. Insert inquiry in an on going distribution
A010.170. Create Distribution Plan per shift
Finish A010-Start A020
A010.200. Insert the unsaved emergency inquiries in Distribution Management System
A010.190. Criticality Evaluation
No
Is it critical
Yes

Main Changes

- ✓ Distribution Preparation is a dynamic process instead of static
- ✓ Takes place multiple times during the day using the new inquires and data
- ✓ It is triggered by multiple events
- ✓ Distribution Plan is automatically proposed by the Distribution Management System using algorithms and includes from the begging the truck and drivers assignment
- ✓ The participants duties are mainly decision making, correcting the system, and inserting new data
- ✓ Activities are systematically monitored and statistics automatically saved

Table 4-5: Process Comparison A010

	As-Is Model	To-Be Model
Process Participants	• Distribution Director • Planning Manager • Distribution Planner • Shift Coordinator	• Planning Manager • Distribution Planner • Distribution Management System
#e-mails exchanged	10	0
#Automated activities	3/19	12/20

Process Description

The Distribution Preparation starts by three different start events, when an order is placed, when a shift ends and when pre-loading is triggered. The DMS gathers all saved data regarding orders, backhauling, crossdocking, internal store exchanges, internal transfers, empty materials return requests and sends them to the Distribution Planner and the Planning Manager.

The Planning Manager sets the priority rules if existing and the DMS automatically creates alternative Distribution Plan proposals using the cargo data and fleet data for all the Shifts during the day.

The Distribution Planner selects a Plan and automatically the DMS saves all the information regarding the selected plan.

Then DMS send the Plan to the Planning Manager for final acceptance. If the Plan is not accepted the Distribution Planner selects a new one until acceptance from the Planning Manager. Once the Distribution Plan is accepted the DMS creates the current Distribution and saves the upcoming Distributions.

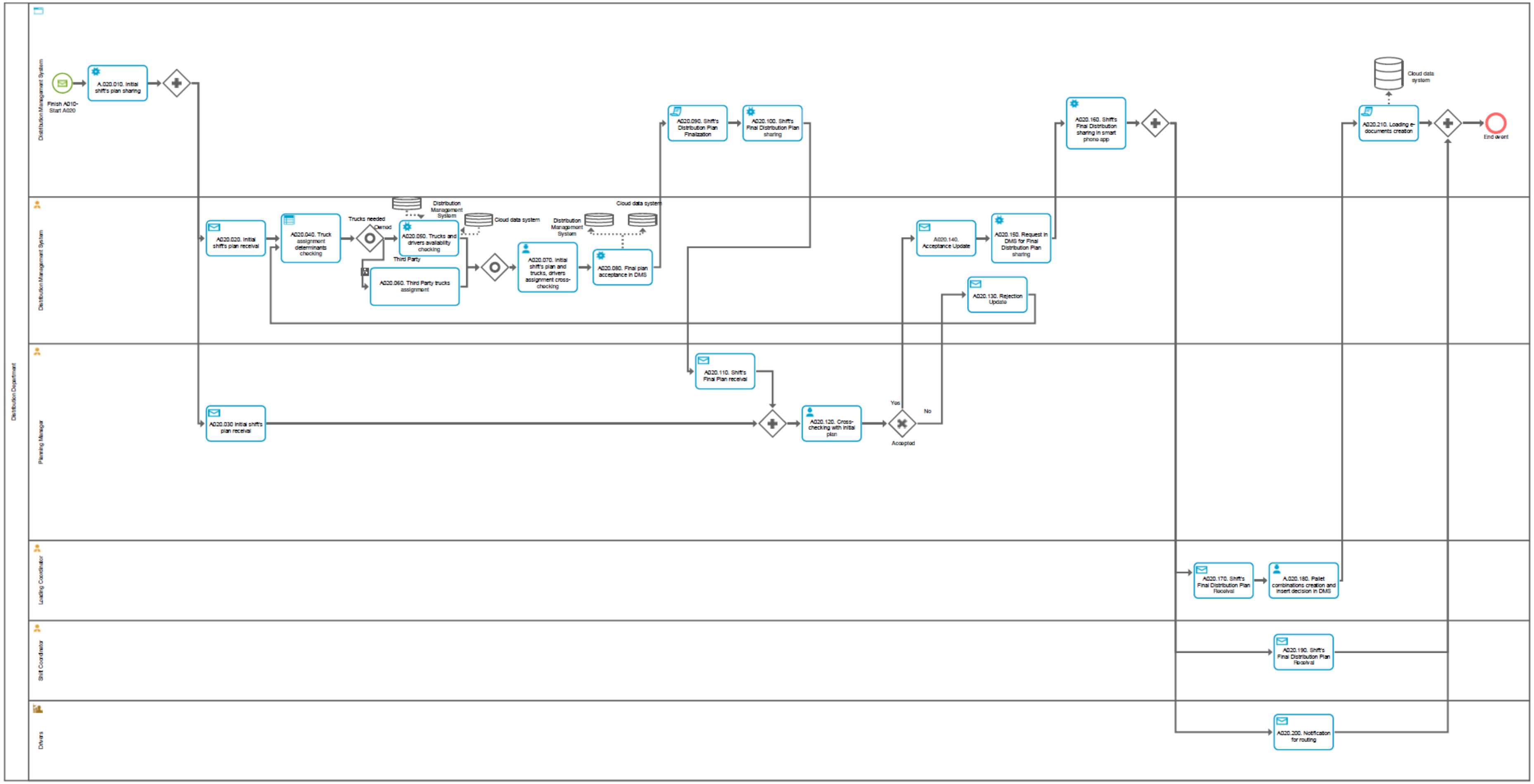
If emergency requests occur while Distribution Preparation is ongoing the DMS using the Fleet Management System investigates if the request can be executed by an on-going distribution. For example, if a truck is delivering products to store A and store B requests a store exchange, the systems checks if this request can be executed by this truck.

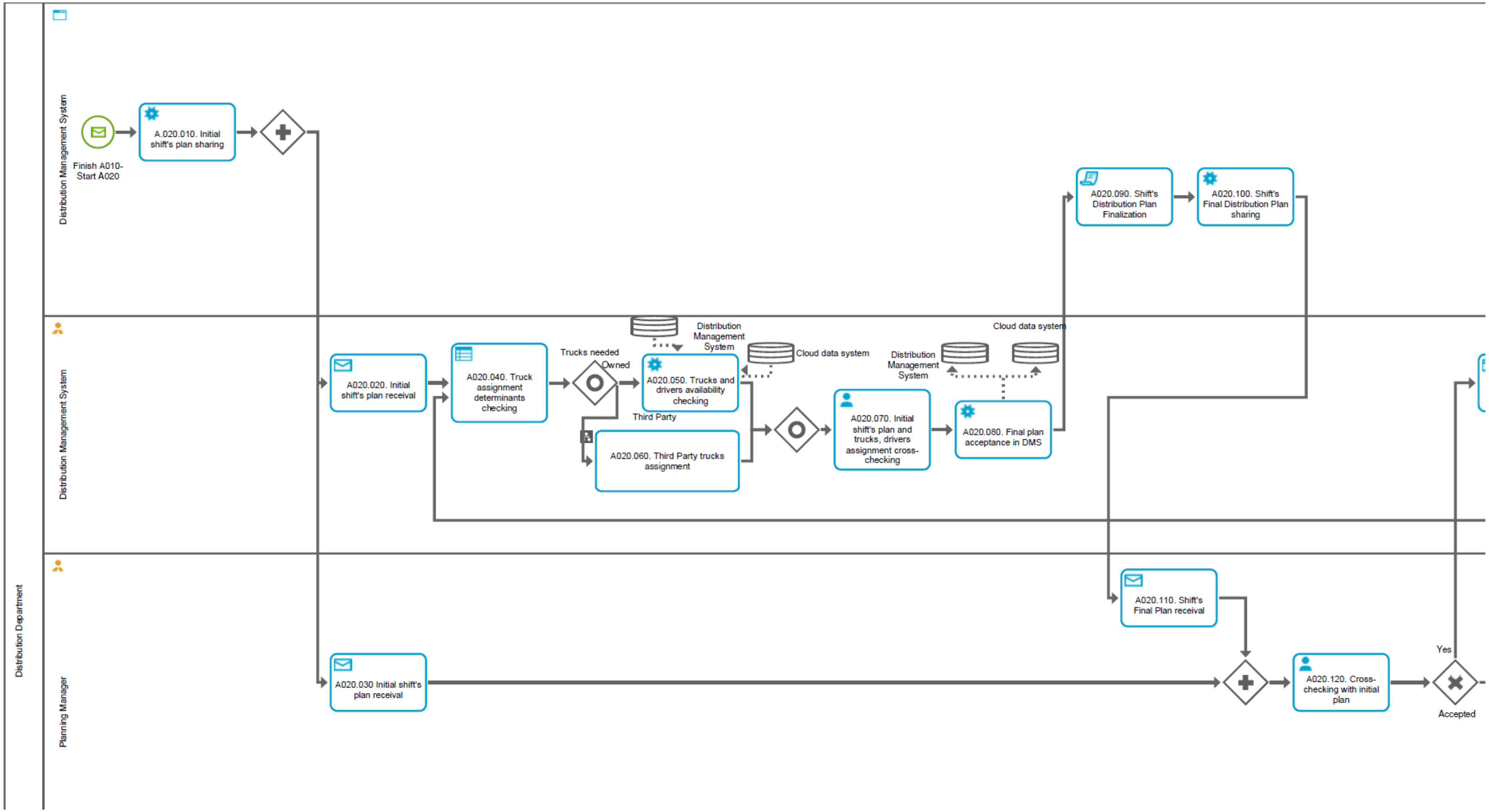
If that is possible the request is included in this transportation and the following activities are shown in Distribution Execution. If there is not such capability, the Planning Manager receives the request and evaluates its criticality. If it is critical, he sets new priority rules, and a new Distribution Plan is selected, or it is saved for the next Distribution Preparation.

The Distribution Planner and the Planning Manager are using their computers for the Distribution Plan and once the Distribution Plan is selected, they receive information for the new requests via the mobile application. Still, in order to make any changes the use of the computer is required.

The Distribution Management System apart from the regular orders' and requests' data also stores data for the emergency requests received such as how many, when, what type of requests, from whom and if they were considered critical and saves them in the cloud database for future use like the creation of forecasting algorithms using ML techniques, KPIs creation or statistical analysis. Specifically, the emergency requests are labeled differently in order to create patterns for regular and emergency requests.

4.2.5.2. A020.Distribution Planning





Distribution Department
Distribution Management System
Finish A010-Start A020
A.020.010. Initial shift's plan sharing
A020.090. Shift's Distribution Plan Finalization
A020.100. Shift's Final Distribution Plan sharing
Distribution Management System
A020.020. Initial shift's plan receival
A020.040. Truck assignment determinants checking
Trucks needed
Owned
Third Party
Distribution Management System
A020.050. Trucks and drivers availability checking
Cloud data system
A020.060. Third Party trucks assignment
Distribution Management System
A020.070. Initial shift's plan and trucks, drivers assignment cross-checking
Cloud data system
A020.080. Final plan acceptance in DMS
Planning Manager
A020.110. Shift's Final Plan receival
A020.030 Initial shift's plan receival
A020.120. Cross-checking with initial plan
Yes
Accepted

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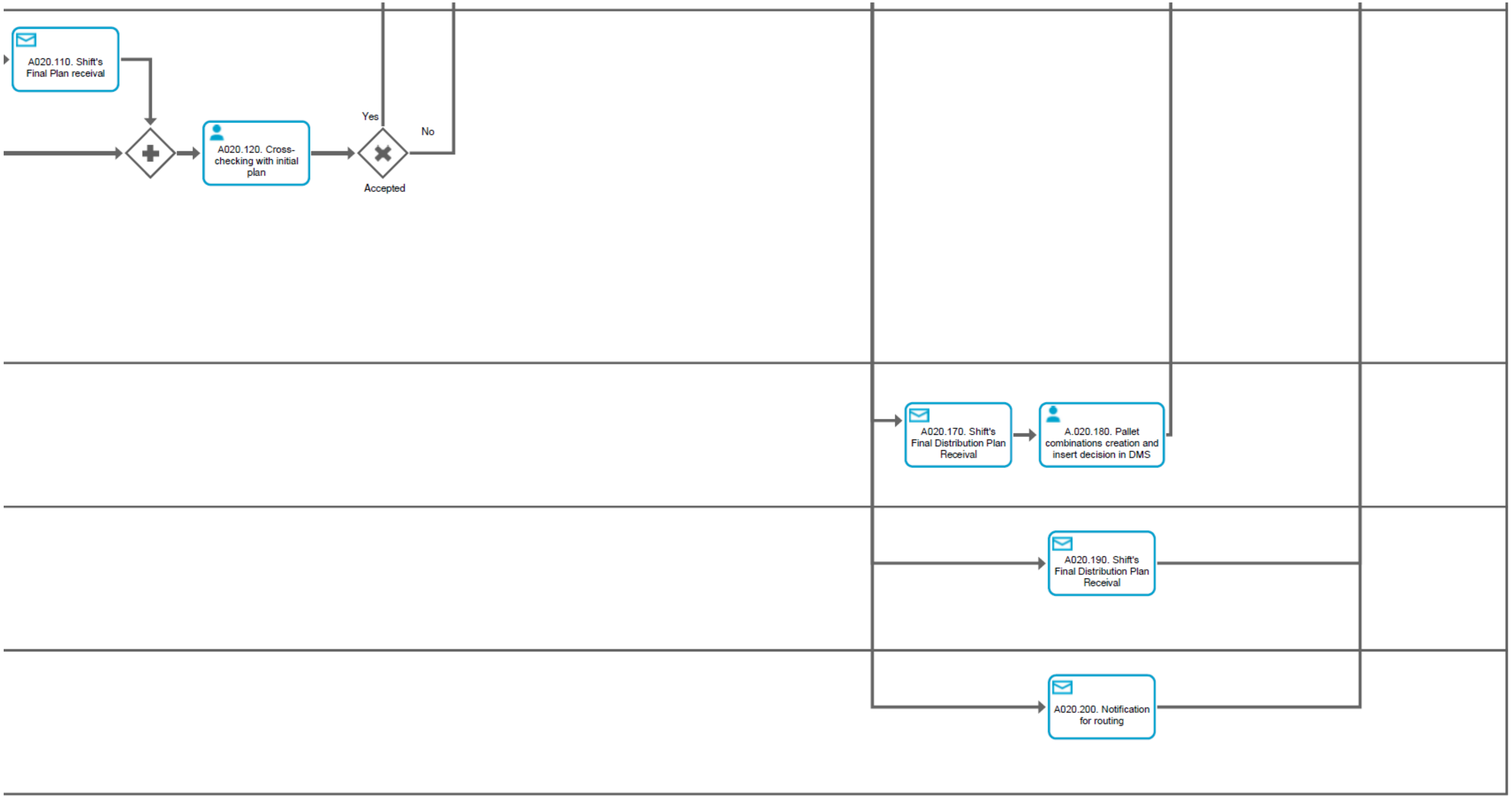
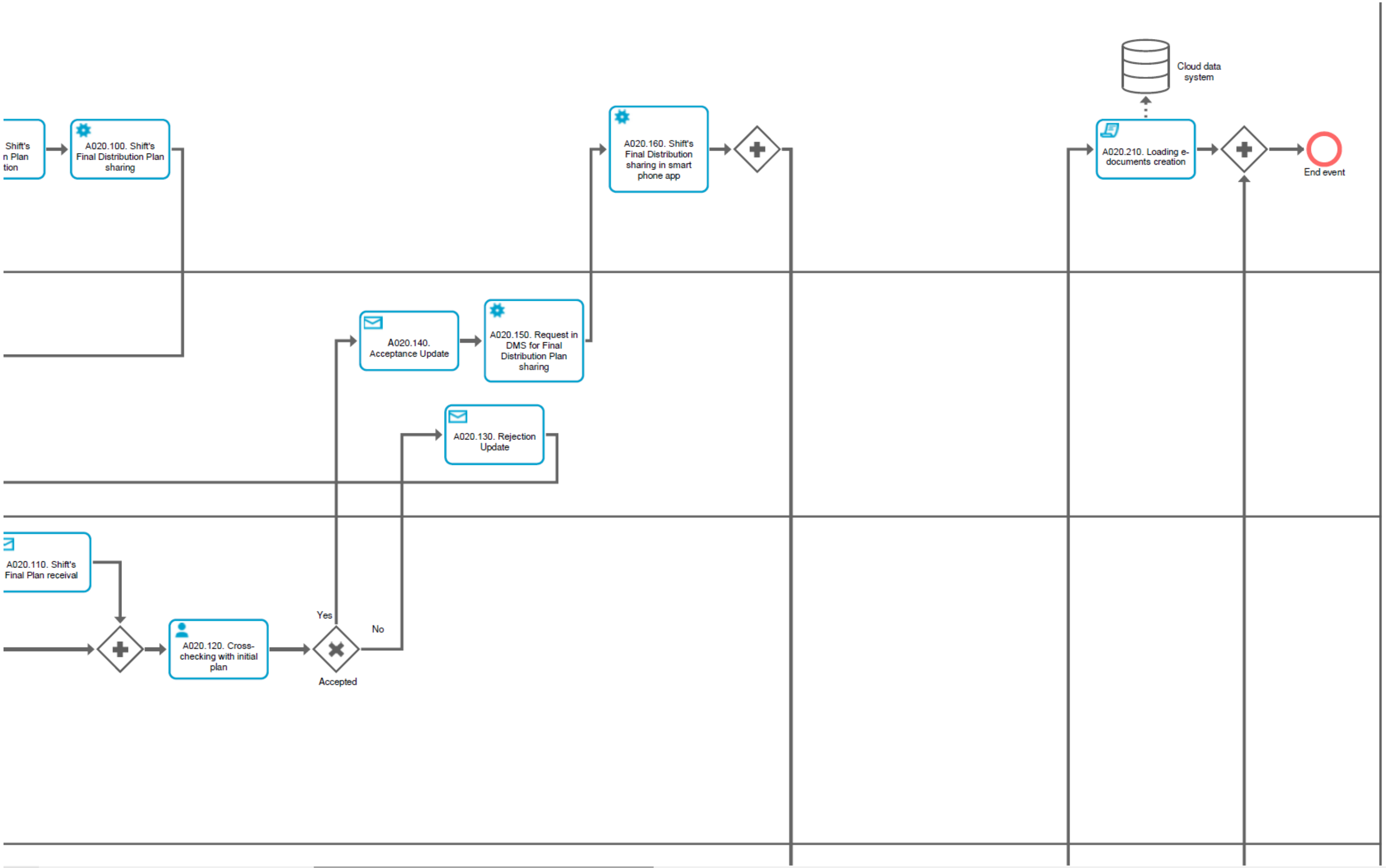

A020.110. Shift's Final Plan receival
A020.120. Cross-checking with initial plan
Yes
No
Accepted
A020.170. Shift's Final Distribution Plan Receival
A.020.180. Pallet combinations creation and insert decision in DMS
A020.190. Shift's Final Distribution Plan Receival
A020.200. Notification for routing


Cloud data system
Shift's
n Plan
tion
A020.100. Shift's Final Distribution Plan sharing
A020.160. Shift's Final Distribution sharing in smart phone app
A020.210. Loading e-documents creation
End event
A020.140. Acceptance Update
A020.150. Request in DMS for Final Distribution Plan sharing
A020.130. Rejection Update
A020.110. Shift's Final Plan receival
A020.120. Cross-checking with initial plan
Yes
No
Accepted

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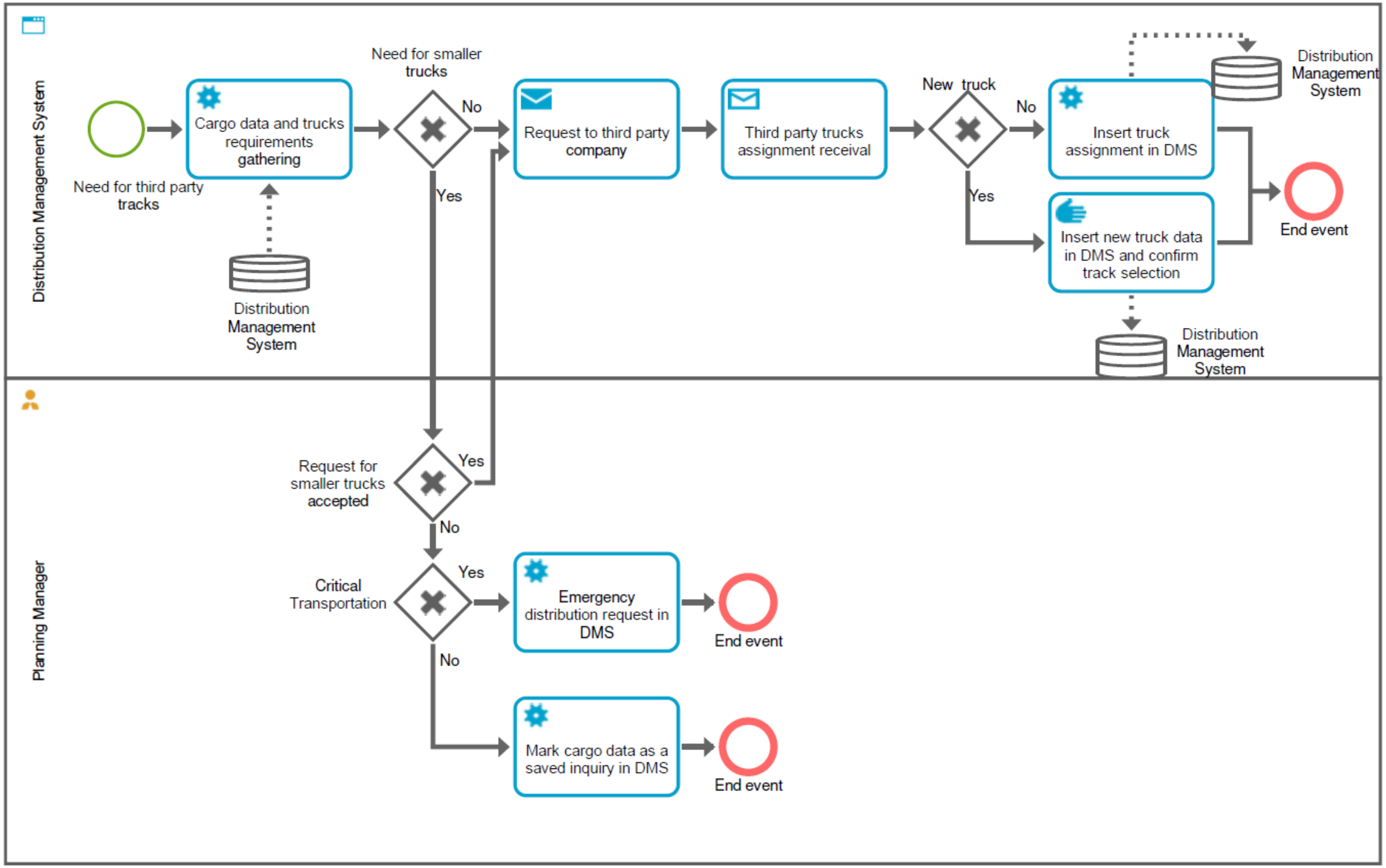
A020.060. Third Party Logistics Companies Truck Assignment (Subprocess)


Distribution Management System
Need for third party tracks
Cargo data and trucks requirements gathering
Distribution Management System
Need for smaller trucks
No
Yes
Request to third party company
Third party trucks assignment receival
New truck
No
Yes
Insert truck assignment in DMS
Insert new truck data in DMS and confirm track selection
Distribution Management System
Distribution Management System
End event
Planning Manager
Request for smaller trucks accepted
Yes
No
Critical Transportation
Yes
No
Emergency distribution request in DMS
End event
Mark cargo data as a saved inquiry in DMS
End event

Main Changes

- ✓ All participants get informed automatically via smartphone application
- ✓ Automated assignment of trucks and drivers
- ✓ The participants duties are mainly decision making, correcting the system and inserting new data
- ✓ Automated communication with third-party logistics company

Table 4-6: Process Comparison A020

	As-Is Model	To-Be Model
Process Participants	• Distribution Director • Planning Manager • Distribution Planner • Loading Coordinator	• Planning Manager • Distribution Planner • Distribution Management System • Shift Coordinator • Loading Coordinator • Drivers
#e-mails exchanged	5	2
#Automated activities	1/10	11/19

Process Description

The Distribution Management System shares the Initial Shift's Distribution Plan to the Distribution Planner and the Planning Manager.

The Distribution Planner checks that the assigned trucks and drivers are assigned according to the company's rules and the legal restrictions and also the correctness regarding the truck's availability in the Fleet Management System. If needed, the Distribution Planner makes manual changes in the DMS and save them.

In case third-party logistic companies are needed, the DMS sends them the requirements of the trucks and the transportations, and they reply with the truck's assignment. The DMS automatically searches with the plate number if the truck is new and creates a new entity in the Fleet Database in the DMS otherwise uses the information from the existing entity.

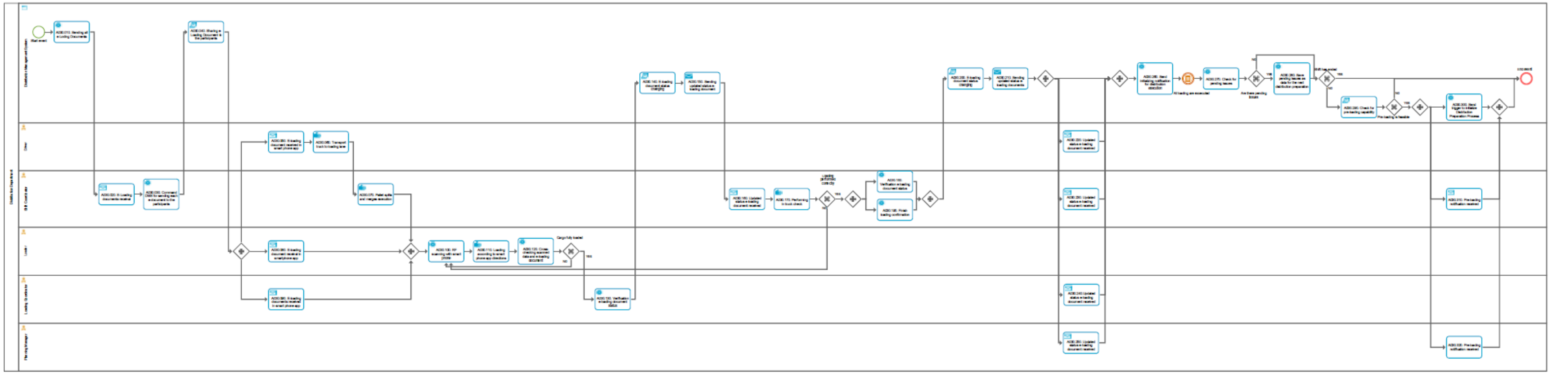
If a smaller truck is needed, the Planning Manager reviews the need. If it is accepted the same process is followed. Otherwise, the Planning Manager evaluates the criticality of the transportation and if it is critical, but the assignment of a smaller truck is rejected, he orders an emergency transportation. If it is not critical the transportations' data are saved as a pending inquiry for the next Distribution Preparation.

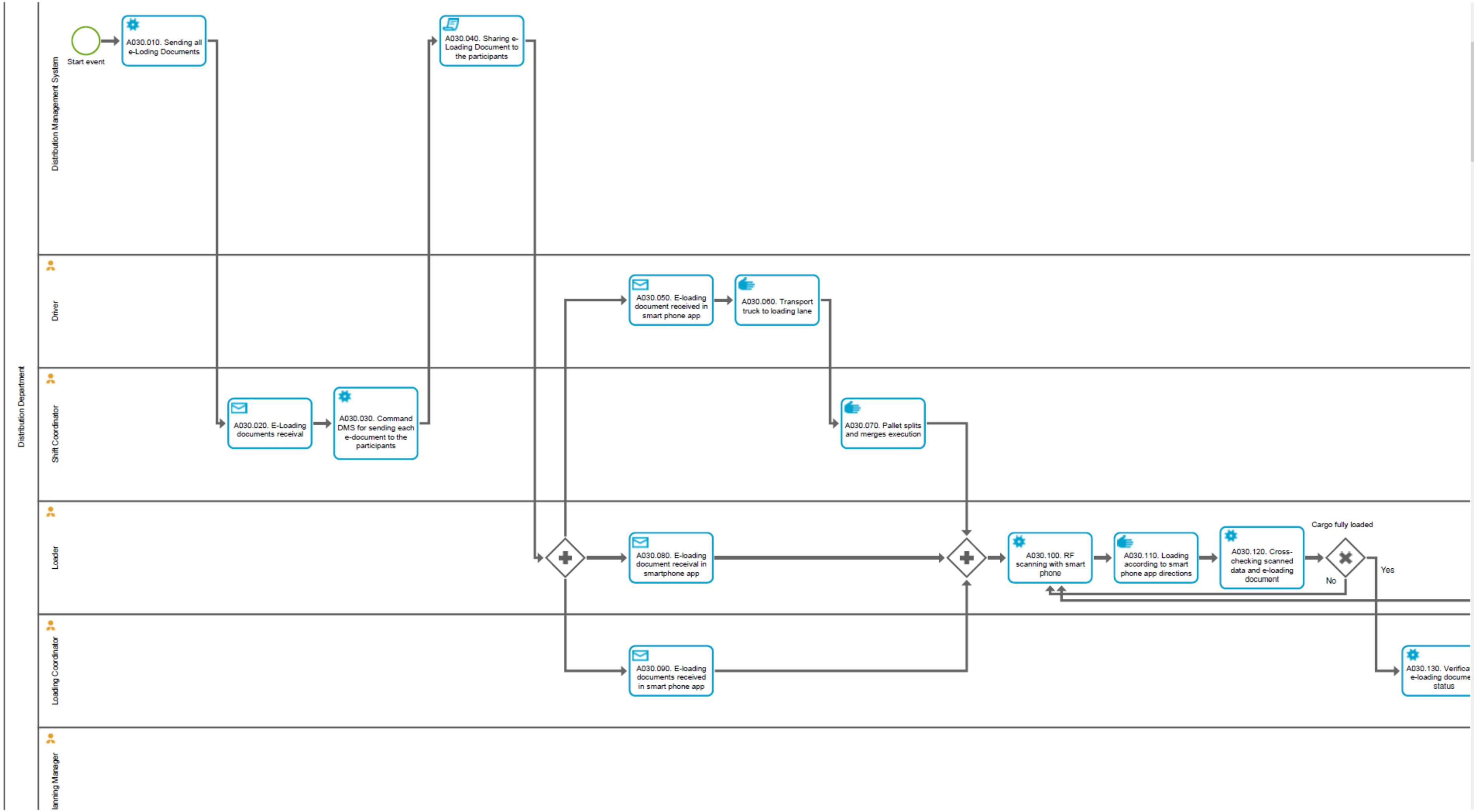
After approving the trucks' and drivers' assignment, the Distribution Planner finalizes the Distribution Plan in the DMS and the Planning Manager receives in the smart phone application the finalized Distribution Plan. The Planning Manager reviews it and if he disagrees, he presses the reject button and automatically the Distribution Planner has to make new assignments. If he agrees he presses the accept button and the DMS sends the Distribution Plan for this shift to all participants.

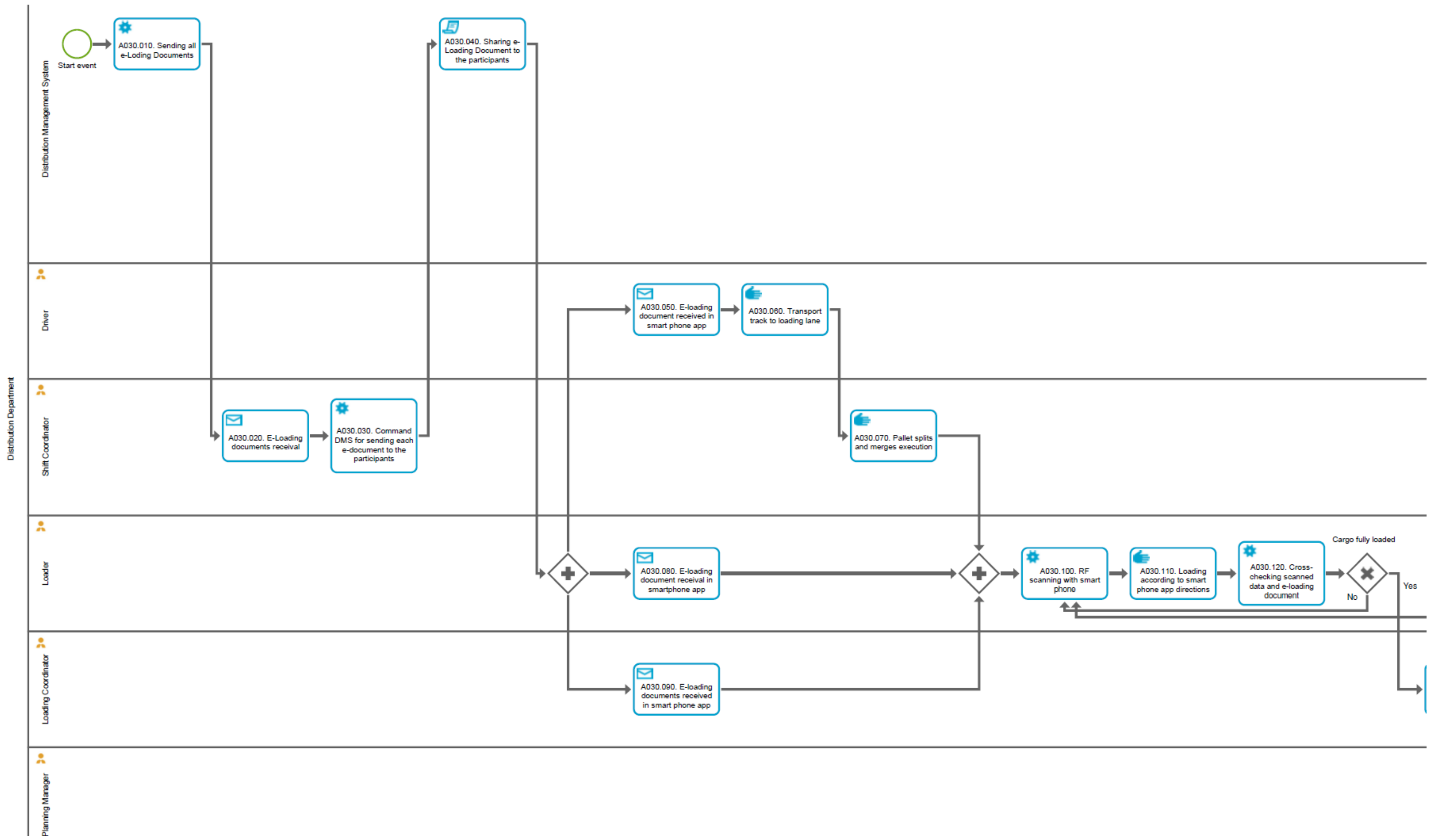
So, the Shift Coordinator and the Loading Coordinator receive the finalized Distribution Plan for the shift. The Loading Coordinator taking under consideration the cargo and the trucks decides the pallet splits and merges and inserts the decision in the DMS. The Drivers also receive their scheduled transportations.

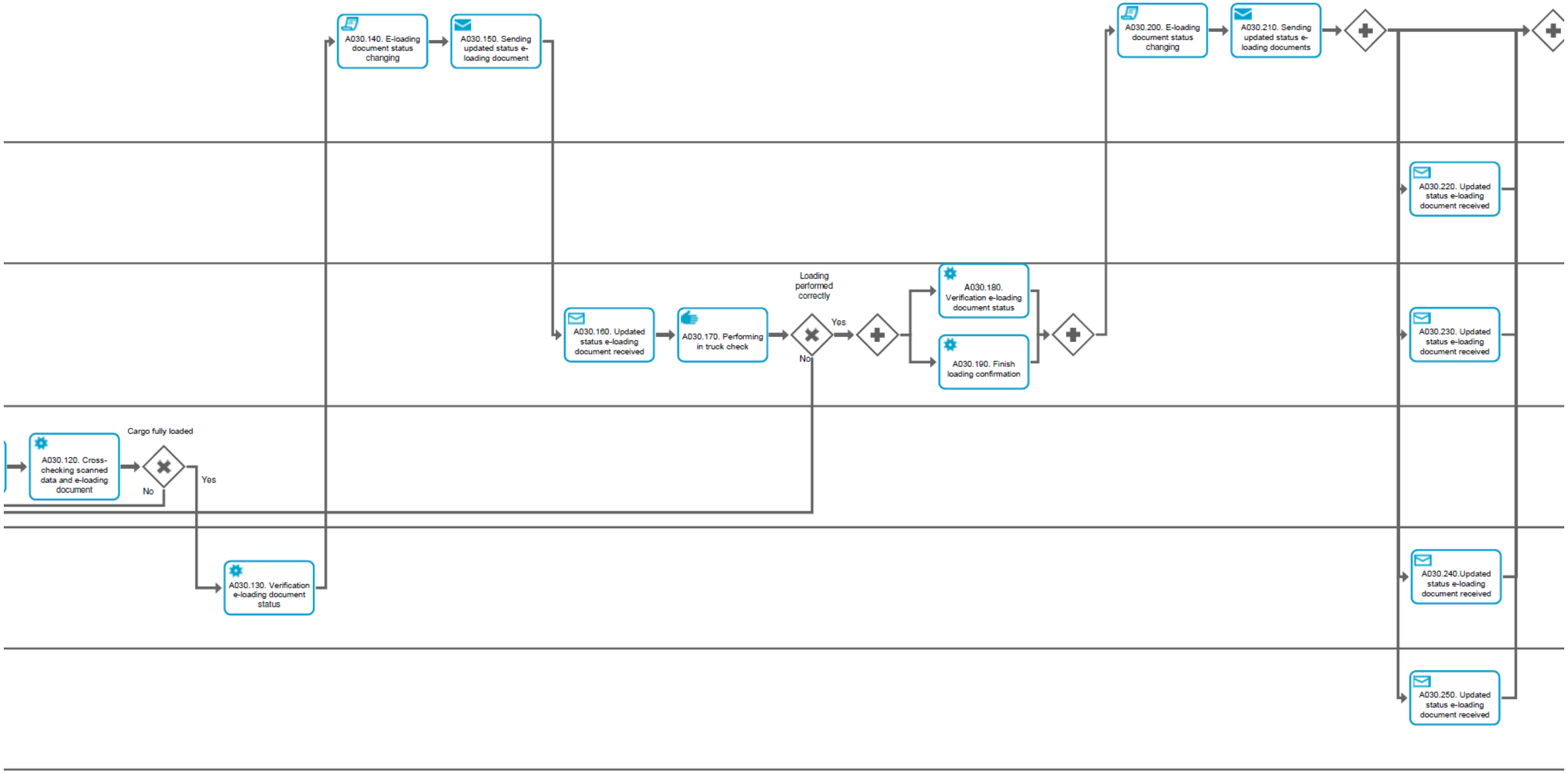
Finally, all e-loading documents for the distributions are automatically created in the DMS and once picking is also completed the Loading Process starts.

4.2.5.3. A030.Loading




Distribution Department
Distribution Management System
Start event
A030.010. Sending all e-Loding Documents
A030.040. Sharing e-Loading Document to the participants
Driver
A030.050. E-loading document received in smart phone app
A030.060. Transport truck to loading lane
Shift Coordinator
A030.020. E-Loading documents receival
A030.030. Command DMS for sending each e-document to the participants
A030.070. Pallet splits and merges execution
Loader
A030.080. E-loading document receival in smartphone app
A030.100. RF scanning with smart phone
A030.110. Loading according to smart phone app directions
A030.120. Cross-checking scanned data and e-loading document
Cargo fully loaded
Yes
No
Loading Coordinator
A030.090. E-loading documents received in smart phone app
A030.130. Verifica
e-loading docume
status
lanning Manager


Distribution Department
Distribution Management System
Driver
Shift Coordinator
Loader
Loading Coordinator
Planning Manager
Start event
A030.010. Sending all e-Loding Documents
A030.020. E-Loading documents receival
A030.030. Command DMS for sending each e-document to the participants
A030.040. Sharing e-Loading Document to the participants
A030.050. E-loading document received in smart phone app
A030.060. Transport track to loading lane
A030.070. Pallet splits and merges execution
A030.080. E-loading document receival in smartphone app
A030.090. E-loading documents received in smart phone app
A030.100. RF scanning with smart phone
A030.110. Loading according to smart phone app directions
A030.120. Cross-checking scanned data and e-loading document
Cargo fully loaded
Yes
No


A030.140. E-loading document status changing
A030.150. Sending updated status e-loading document
A030.200. E-loading document status changing
A030.210. Sending updated status e-loading documents
A030.220. Updated status e-loading document received
A030.160. Updated status e-loading document received
A030.170. Performing in truck check
Loading performed correctly
Yes
No
A030.180. Verification e-loading document status
A030.190. Finish loading confirmation
A030.230. Updated status e-loading document received
A030.120. Cross-checking scanned data and e-loading document
Cargo fully loaded
Yes
No
A030.130. Verification e-loading document status
A030.240.Updated status e-loading document received
A030.250. Updated status e-loading document received

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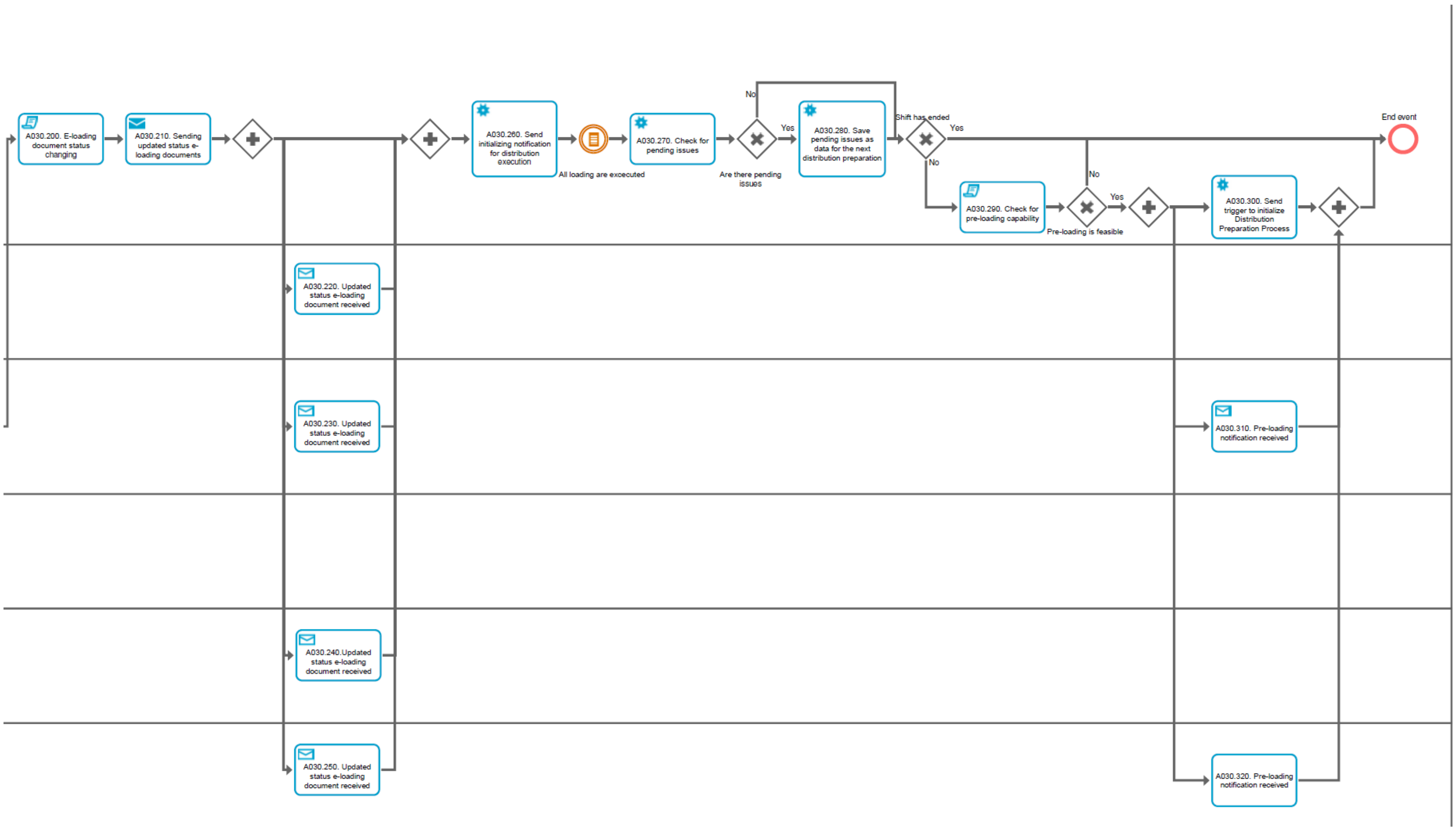

A030.200. E-loading document status changing
A030.210. Sending updated status e-loading documents
A030.220. Updated status e-loading document received
A030.230. Updated status e-loading document received
A030.240.Updated status e-loading document received
A030.250. Updated status e-loading document received
A030.260. Send initializing notification for distribution execution
All loading are excecuted
A030.270. Check for pending issues
Are there pending issues
No
Yes
A030.280. Save pending issues as data for the next distribution preparation
Shift has ended
Yes
No
A030.290. Check for pre-loading capability
Pre-loading is feasible
Yes
No
A030.300. Send trigger to initialize Distribution Preparation Process
A030.310. Pre-loading notification received
A030.320. Pre-loading notification received
End event

Main Changes

- ✓ All participants get informed automatically via smartphone application
- ✓ Loading Documents have digital form and are using blockchain technology and have verification stages
- ✓ E-loading documents are not going from hand to hand and do not require signing. They are shared via the smart phone application and have different statuses.
- ✓ Loaders are provided with directions in their smart phones
- ✓ RF scanning communicates with the e-loading documents
- ✓ Duration of all activities is monitored and stored
- ✓ The participants duties are mainly decision making, correcting the system and inserting new data
- ✓ Pre-loading are not used only for productivity and time reasons but also in case the scheduled distributions in one shift are already completed

Table 4-7: Process Comparison A030

	As-Is Model	To-Be Model
Process Participants	• Shift Coordinator • Loading Coordinator • Loaders • Drivers	• Planning Manager • Distribution Management System • Shift Coordinator • Loading Coordinator • Loaders • Drivers
#e-mails exchanged	N/A (Loading document is printed)	N/A (e-loading document is shared)
#Automated activities	0/21	24/32

Process Description

The Distribution Management System shares the e-loading documents via the smartphone application to the Shift Coordinator for the final overview and then the Shift Coordinator presses the share button to send the e-loading documents to the appropriate participants, Loaders, Drivers and Loading Coordinator.

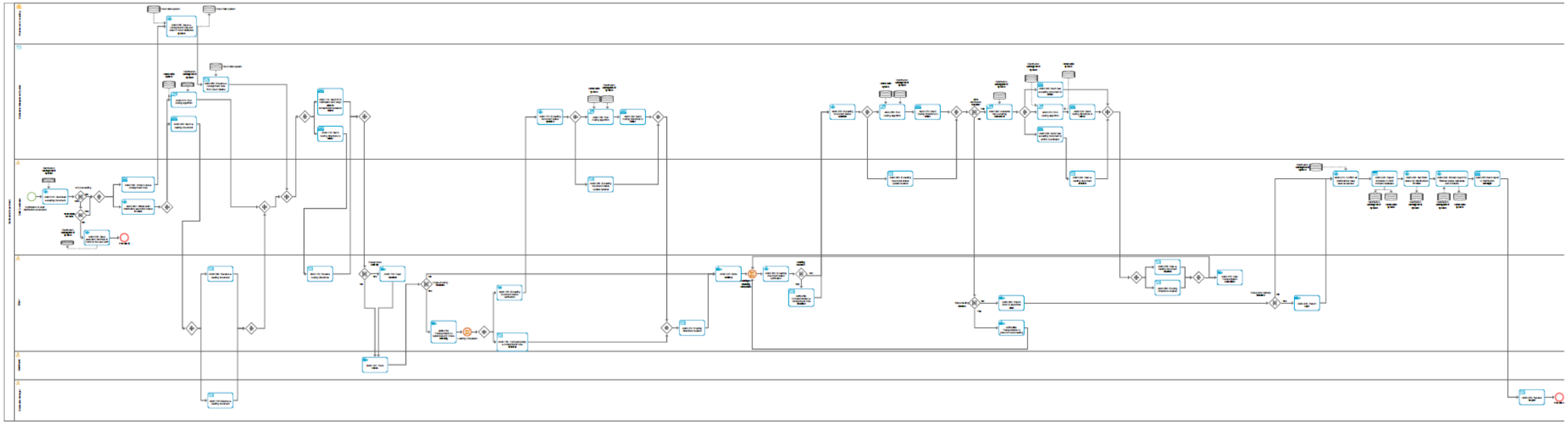
The Drivers transfer the trucks to the loading/picking lanes dictated by the e-loading document. The Shift Coordinator performs all pallets merges/splits according to the e-loading document and confirms the execution in the smartphone application. Then, the Loaders start scanning the barcodes with the smartphone and afterwards they start loading the truck according to the directions on the smartphone. For example, super fresh products go in first etc. Once all products of the e-loading document are scanned, the application requests the Loading Coordinator to verify the status.

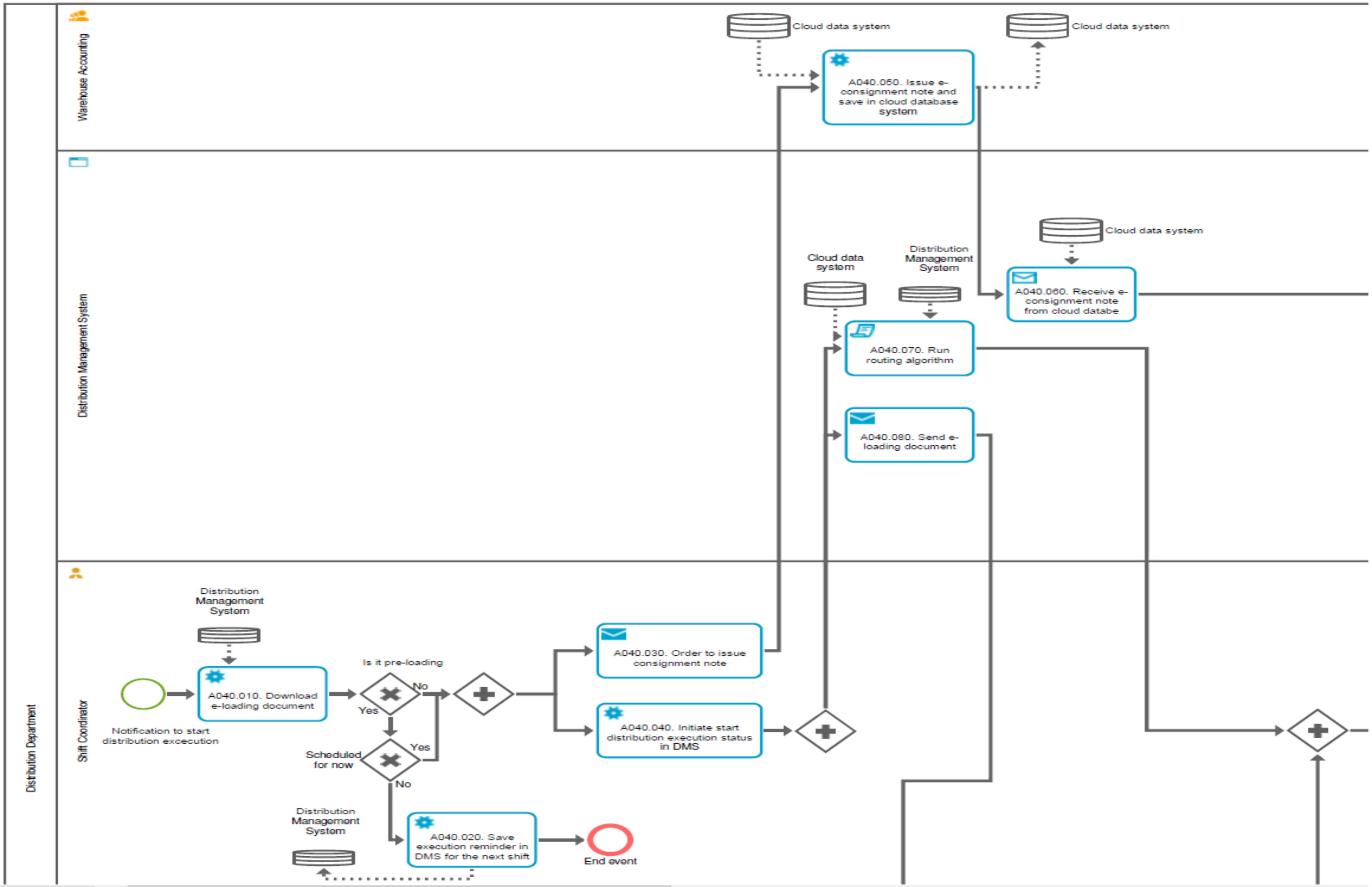
Once the Loading Coordinator verifies the status, the updated e-loading document is displayed to all participants. The Shift Coordinator performs in truck check to ensure that truck is fully loaded with the correct cargo. If the loading is incorrect the process is repeated. When loading is correctly performed, the Shift Coordinator verifies the status of the e-loading document and confirms that loading is completed, changing the status in DMS to finished. Once again, the updated e-loading document is displayed to the smartphone application of all participants.

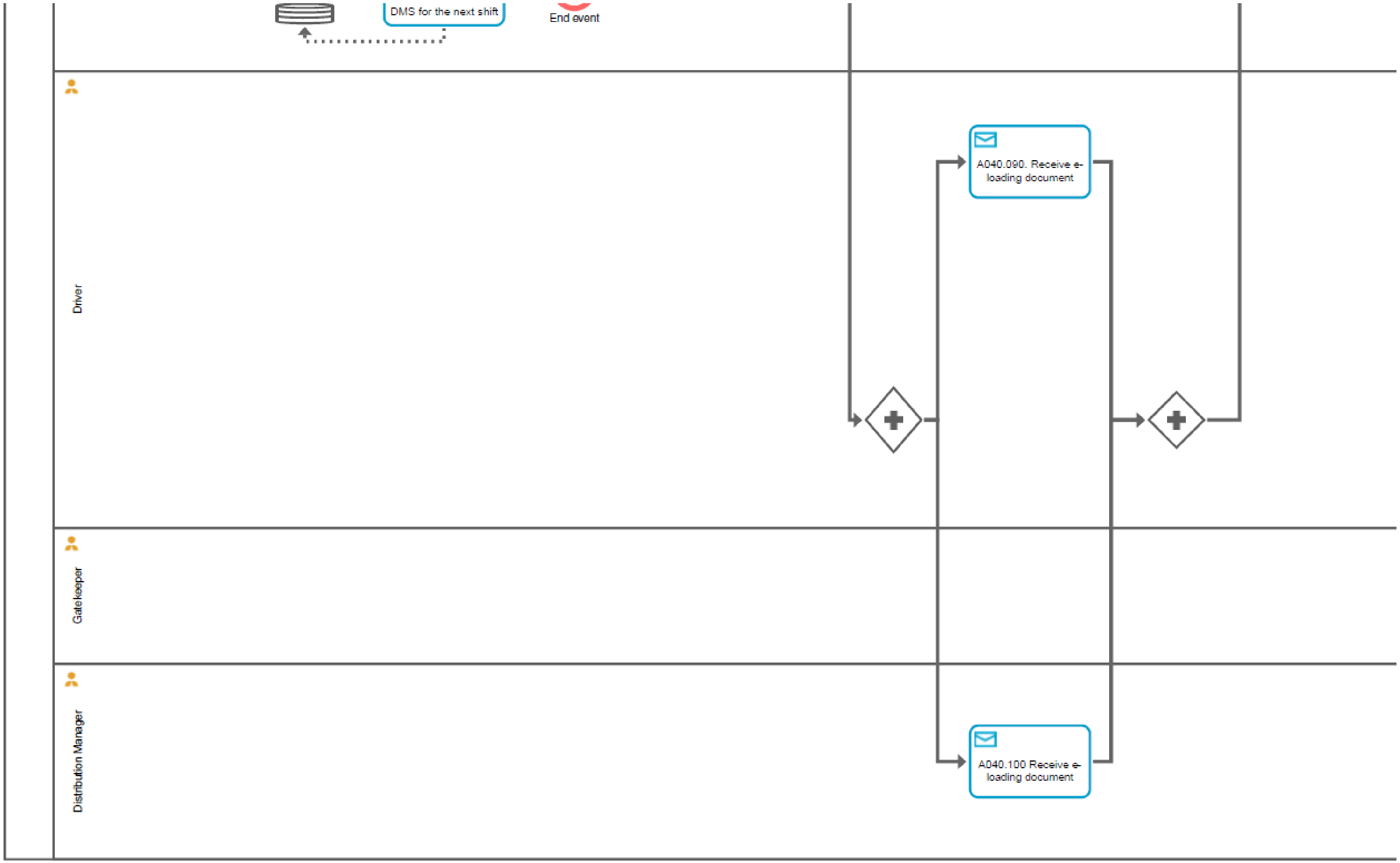
The Distribution Management System sends a notification and automatically changes the status to Distribution Execution status for the finished loading. When, all shift's loadings are finished, the System automatically saves all the pending issues as pending inquiries for the next Shift's Distribution Preparation. If the current shift has not ended and the time left is enough for another loading, the DMS examines the possibility of a pre-loading using the Fleet Management Data to find available trucks in the Warehouse or nearby, and saved inquiries and if possible, it triggers the Distribution Preparation Process for a pre-loading sending simultaneously notification for a pre-loading to the Shift and Loading Coordinators.

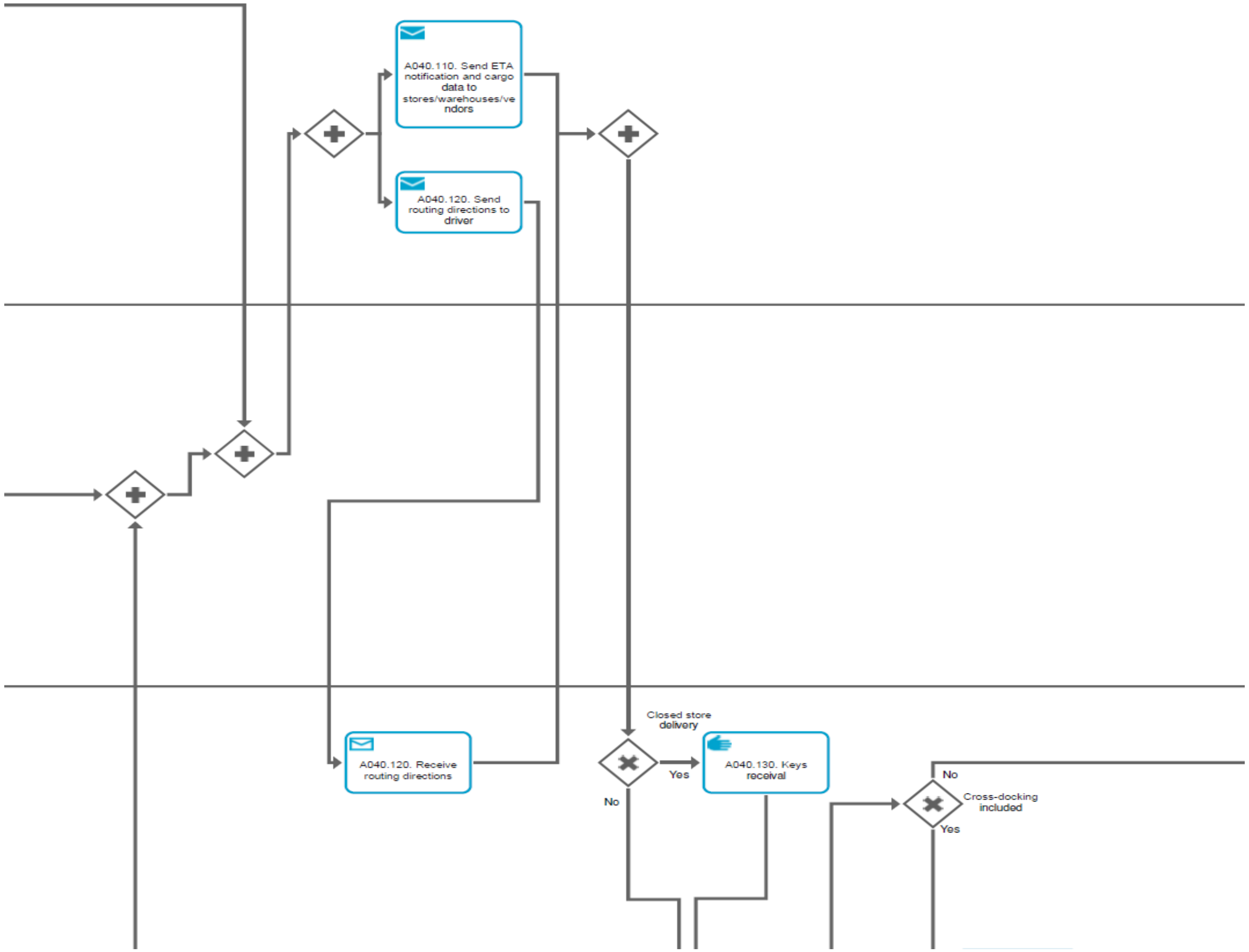
By using the digital e-loading document and the smartphone application for the loading process there is a systematic way to perform the loading, the capability to track the duration and easily identify in which step the most errors occur, and which steps are the most time consuming. In this way also the loading document does not change hands and time is saved in minimizing employees motion and communication.

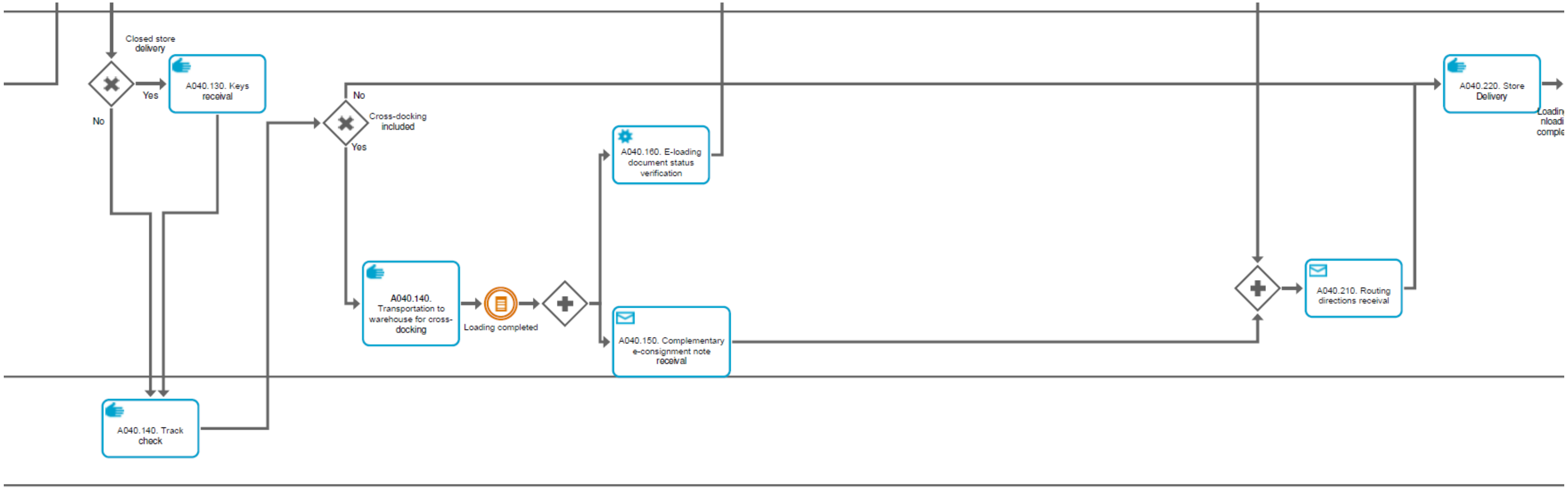
4.2.5.4. A040.Distribution Execution

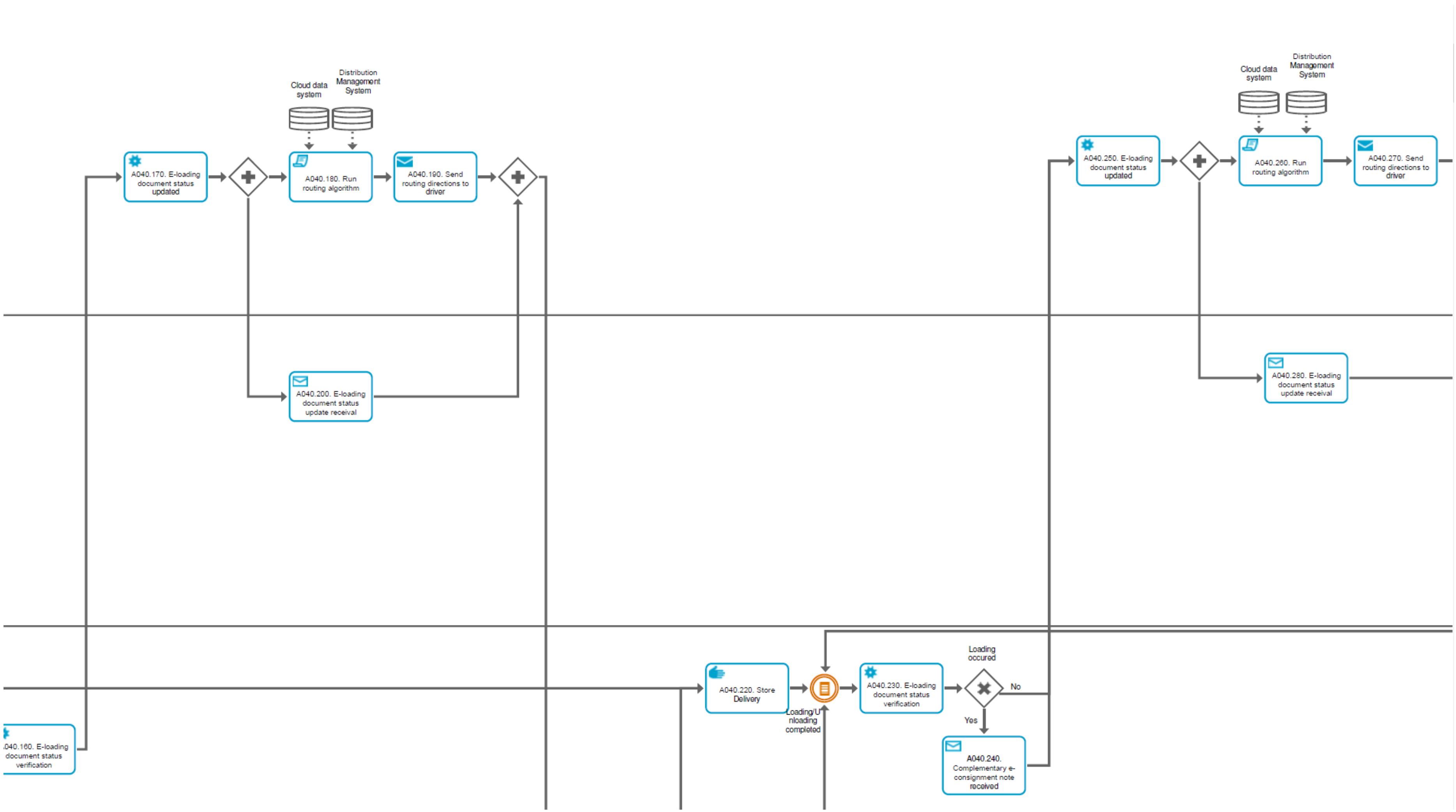


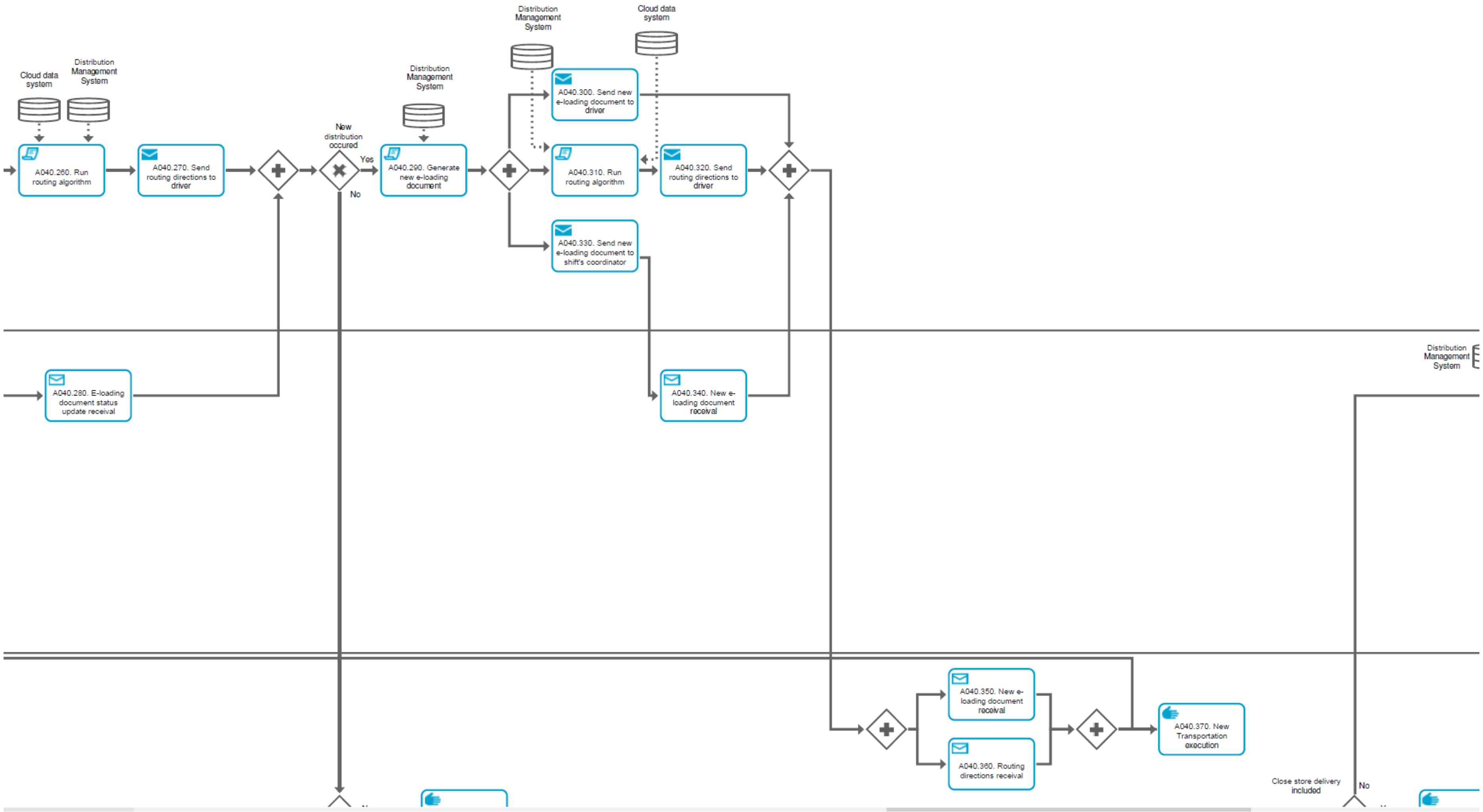

Warehouse Accounting
Distribution Management System
Distribution Department
Shift Coordinator
Cloud data system
A040.050. Issue e-consignment note and save in cloud database system
Cloud data system
Cloud data system
Cloud data system
Distribution Management System
A040.060. Receive e-consignment note from cloud databe
A040.070. Run routing algorithm
A040.080. Send e-loading document
Distribution Management System
Notification to start distribution excecution
A040.010. Download e-loading document
Is it pre-loading
No
Yes
Scheduled for now
Yes
No
A040.030. Order to issue consignment note
A040.040. Initiate start distribution execution status in DMS
Distribution Management System
A040.020. Save execution reminder in DMS for the next shift
End event

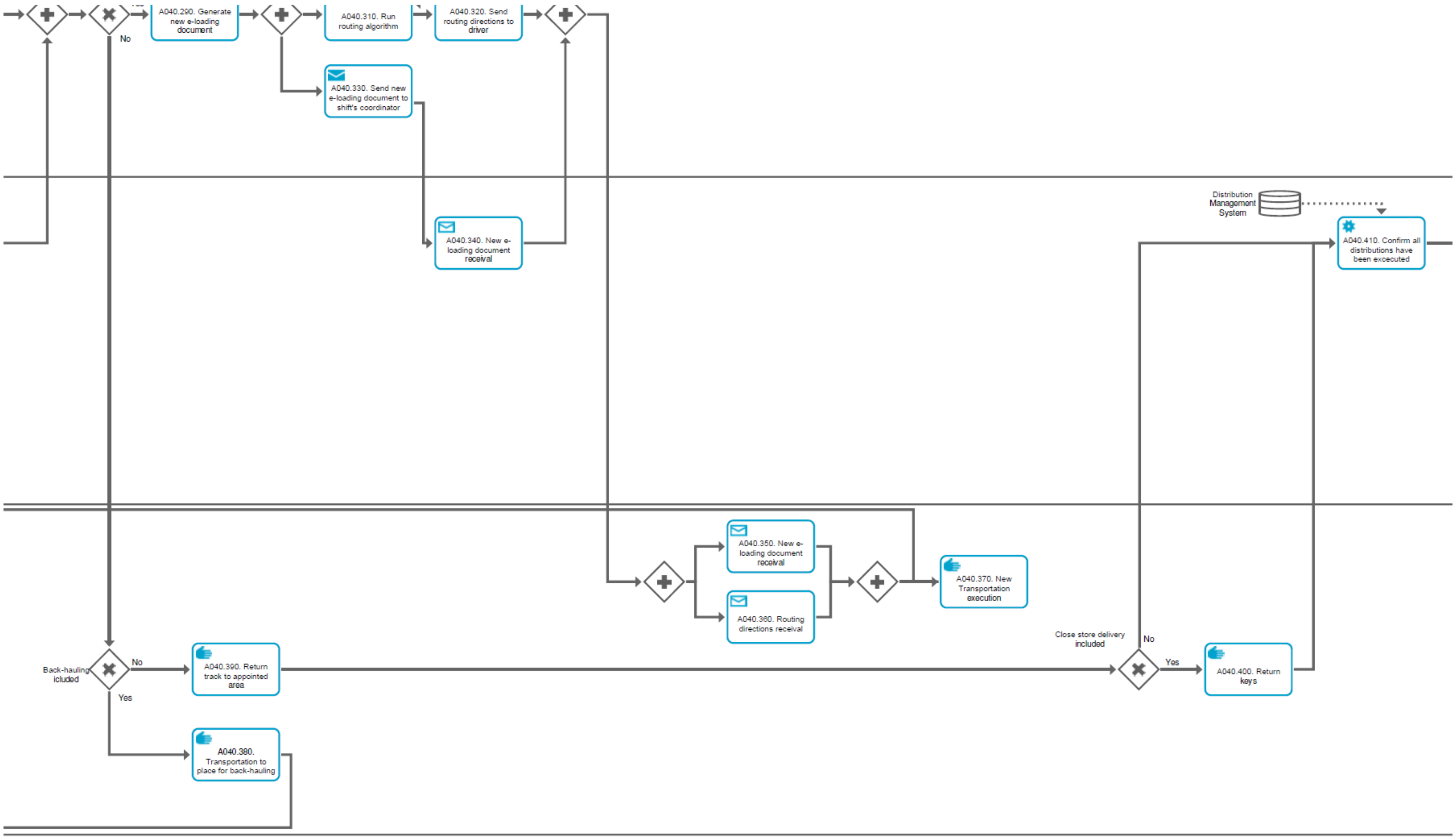

DMS for the next shift
End event
Driver
A040.090. Receive e-loading document
Gatekeeper
Distribution Manager
A040.100 Receive e-loading document


A040.110. Send ETA notification and cargo data to stores/warehouses/vendors
A040.120. Send routing directions to driver
A040.120. Receive routing directions
Closed store delivery
Yes
No
A040.130. Keys receival
No
Cross-docking included
Yes

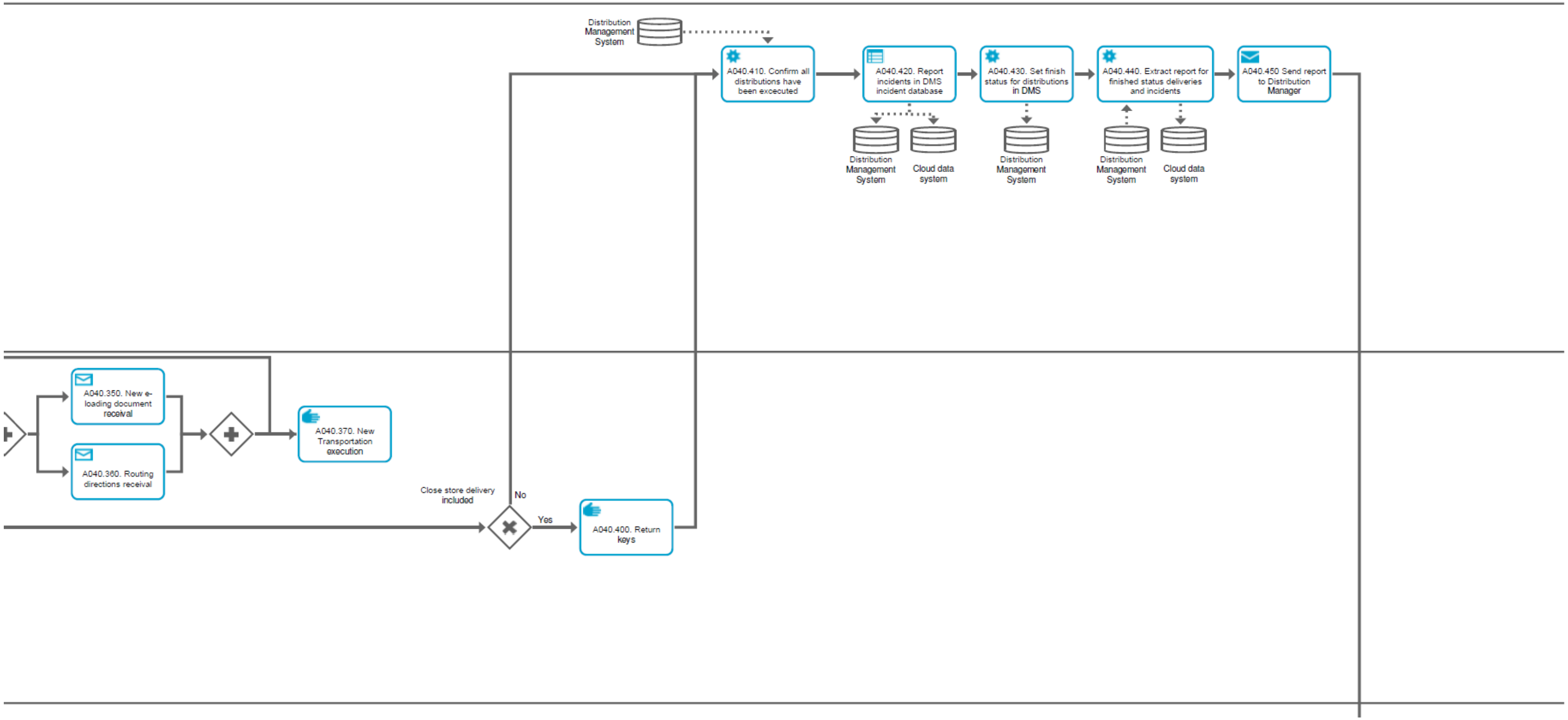

Closed store delivery
Yes
No
A040.130. Keys receival
No
Cross-docking included
Yes
A040.160. E-loading document status verification
A040.140. Transportation to warehouse for cross-docking
Loading completed
A040.150. Complementary e-consignment note receival
A040.210. Routing directions receival
A040.220. Store Delivery
A040.140. Track check

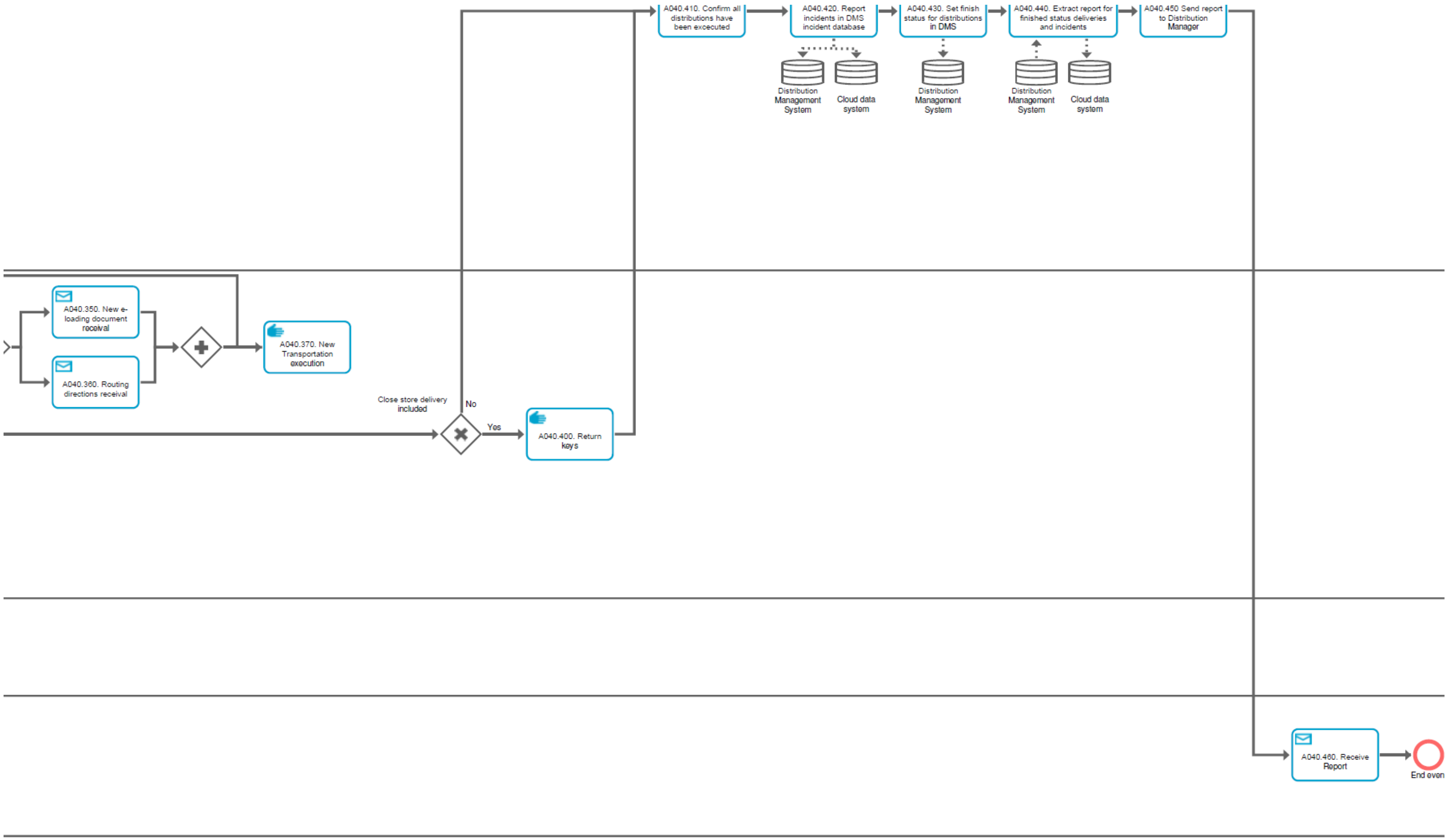

Cloud data system
Distribution Management System
A040.170. E-loading document status updated
A040.180. Run routing algorithm
A040.190. Send routing directions to driver
A040.200. E-loading document status update receival
A040.250. E-loading document status updated
A040.260. Run routing algorithm
A040.270. Send routing directions to driver
A040.280. E-loading document status update receival
A040.160. E-loading document status verification
A040.220. Store Delivery
Loading/Unloading completed
A040.230. E-loading document status verification
Loading occured
No
Yes
A040.240. Complementary e-consignment note received


Cloud data system
Distribution Management System
A040.260. Run routing algorithm
A040.270. Send routing directions to driver
New distribution occured
Yes
No
Distribution Management System
A040.290. Generate new e-loading document
Distribution Management System
Cloud data system
A040.300. Send new e-loading document to driver
A040.310. Run routing algorithm
A040.320. Send routing directions to driver
A040.330. Send new e-loading document to shift's coordinator
A040.280. E-loading document status update receival
A040.340. New e-loading document receival
Distribution Management System
A040.350. New e-loading document receival
A040.360. Routing directions receival
A040.370. New Transportation execution
Close store delivery included
No



No
A040.290. Generate new e-loading document
A040.310. Run routing algorithm
A040.320. Send routing directions to driver
A040.330. Send new e-loading document to shift's coordinator
A040.340. New e-loading document receival
Distribution Management System
A040.410. Confirm all distributions have been excecuted
A040.350. New e-loading document receival
A040.360. Routing directions receival
A040.370. New Transportation execution
Close store delivery included
No
Yes
Back-hauling icluded
No
Yes
A040.390. Return track to appointed area
A040.400. Return keys
A040.380. Transportation to place for back-hauling


Distribution Management System
A040.410. Confirm all distributions have been excecuted
A040.420. Report incidents in DMS incident database
A040.430. Set finish status for distributions in DMS
A040.440. Extract report for finished status deliveries and incidents
A040.450 Send report to Distribution Manager
Distribution Management System
Cloud data system
Distribution Management System
Distribution Management System
Cloud data system
A040.350. New e-loading document receival
A040.360. Routing directions receival
A040.370. New Transportation execution
Close store delivery included
No
Yes
A040.400. Return keys


A040.410. Confirm all distributions have been excecuted
A040.420. Report incidents in DMS incident database
A040.430. Set finish status for distributions in DMS
A040.440. Extract report for finished status deliveries and incidents
A040.450 Send report to Distribution Manager
Distribution Management System
Cloud data system
Distribution Management System
Distribution Management System
Cloud data system
A040.350. New e-loading document receival
A040.360. Routing directions receival
A040.370. New Transportation execution
Close store delivery included
No
Yes
A040.400. Return keys
A040.460. Receive Report
End even

Main Changes

- ✓ All participants get informed automatically via smartphone application
- ✓ Routing algorithms are used to decide which transportation will be executed using data from the cloud database including real time stores' stock levels, traffic data etc.
- ✓ Loading Documents have digital form and are using blockchain technology and have verification stages
- ✓ E-loading documents are not going from hand to hand and do not require signing. They are shared via the smart phone application and have different statuses.
- ✓ E-consignment notes have digital form
- ✓ Distribution Execution is a dynamic process, while it is performed new transportations might get included
- ✓ Duration of all activities is monitored and stored
- ✓ Problems are described at the end of each Distribution Execution

Table 4-8: Process Comparison A040

	As-Is Model	To-Be Model
Process Participants	• Shift Coordinator • Distribution Office Employee • Drivers • Warehouse accounting • Gatekeeper	• Distribution Management System • Shift Coordinator • Distribution Manager • Drivers • Warehouse accounting • Gatekeeper
#e-mails exchanged	N/A (Loading document and consignment note is printed)	N/A (e-loading document and e-consignment note are shared)
#Automated activities	1/13	33/46

Process Description

The Shift Coordinator receives the notification for the Distribution Execution when loading is completed. He opens the notification with the e-loading document and checks if it is a regular loading or a pre-loading and if it refers to a pre-loading if it is scheduled for the current shift.

If it is scheduled for the next shift it is saved to notify again at the next shift, otherwise the process is continued.

If it scheduled for the current shift, he accepts the notification and the system signals the beginning of the execution.

The Warehouse accounting automatically receives request for e-consignment note issuance. The e-consignment notes take all information from the cloud database and DMS and it is issued through the ERP System and saved again in the cloud database to be used from the DMS.

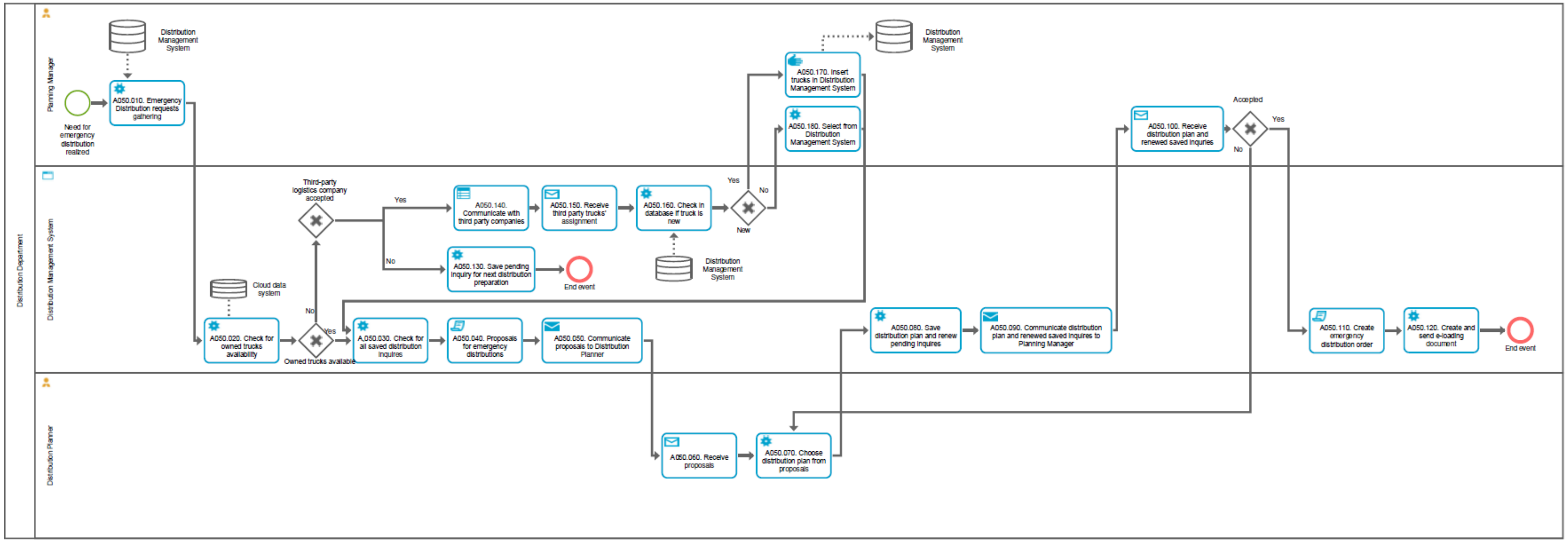
The DMS uses the e-consignment note from the Cloud Database and sends notification for the Estimated Time of Arrival (ETA) to all distribution points, warehouses, stores, suppliers etc.

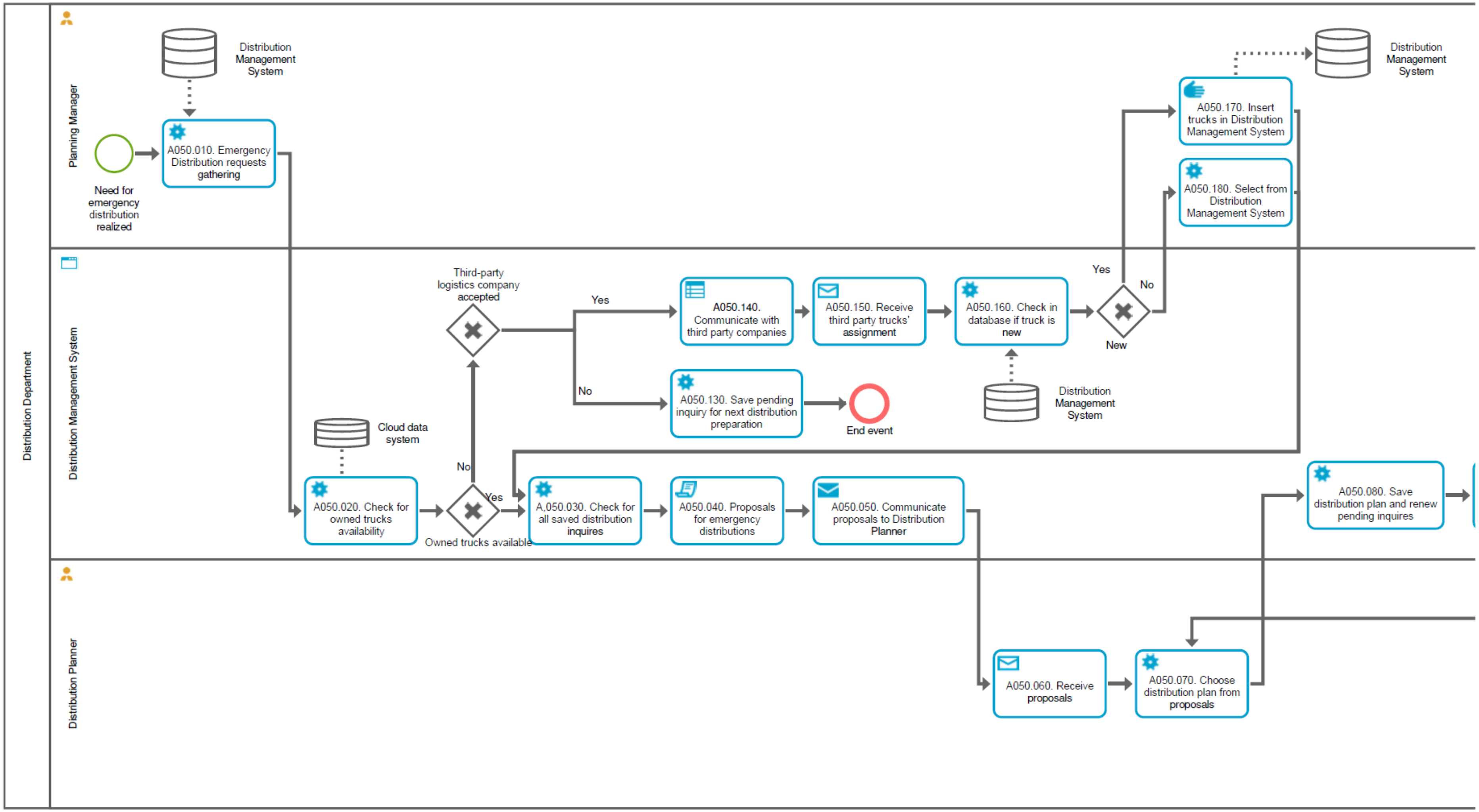
The Driver receives the e-loading document, the consignment notes and routing directions in the smartphone application. The next steps are the same in the new model as the ones in the current model, keys receival, truck check etc. Then, the driver starts with the transportations according to the directions and the e-loading document.

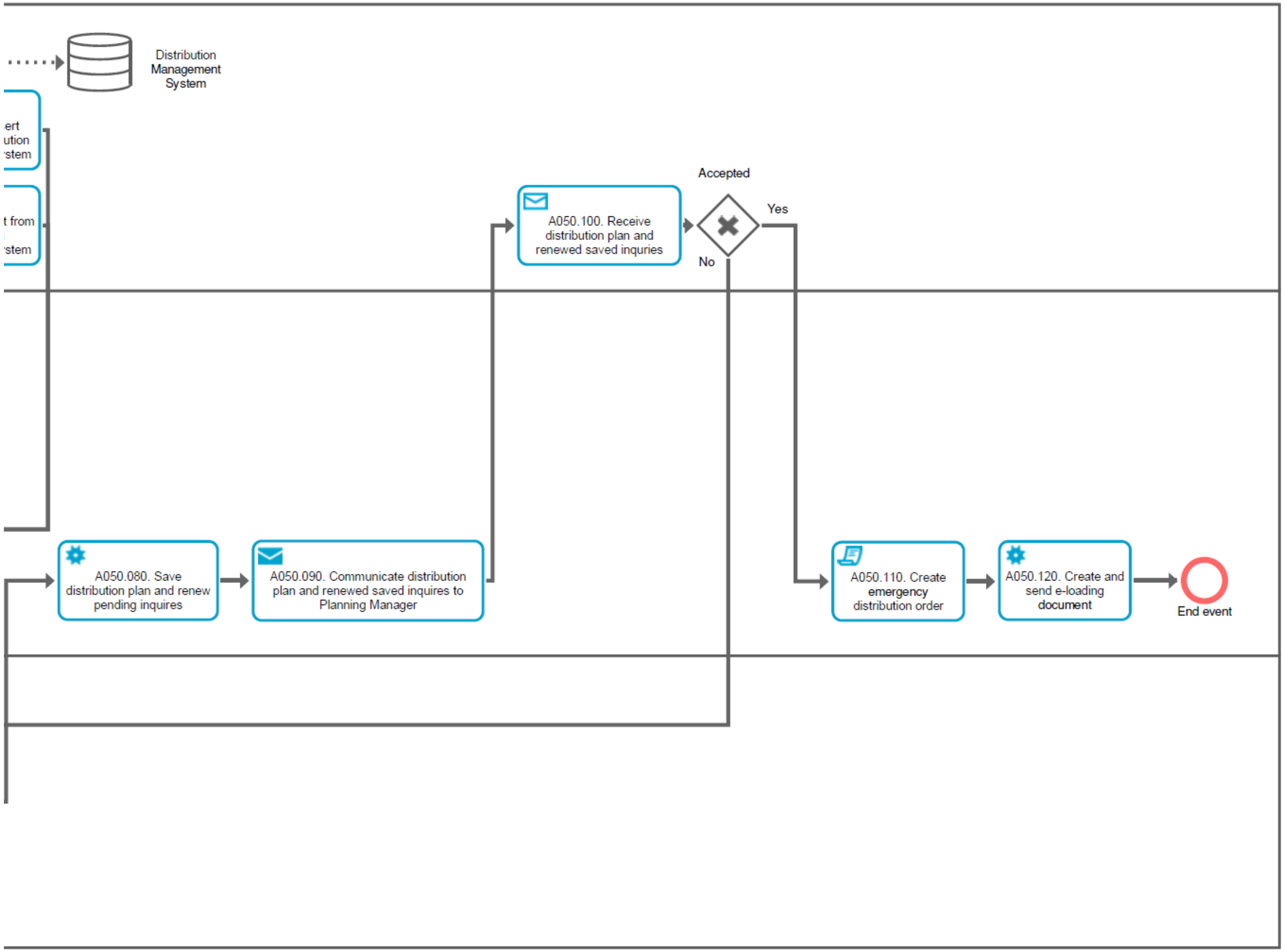
At the end of each transportation, the Driver confirms the status of the e-loading document and according to new requests and the new traffic data, the Driver receives information for the next transportation. If there is a new transportation, the Driver receives a new e-loading document and routing directions and if it is loaded with new cargo the Driver also receives a new e-consignment note and then the Distribution Execution continues until all scheduled deliveries and pickups are completed.

Once all transportations have been completed and the truck is back to appointed area, the Shift Coordinator checks all e-loading documents and e-consignment notes to ensure that the Distribution Execution have been completed according to the documents and all statuses are correctly confirmed and then, the Shift Coordinator changes the status in DMS in completed. After the completion, the Shift Coordinator reports any incident in the DMS in the incident database and then, he automatically extracts the report for the Distributions which includes duration of each step, kilometers and incidents and sends the report to the Distribution Manager. This way all Distributions are monitored systematically, and the Distribution Department has constant overview of all incidents.

4.2.5.5. A050.Emergency Distribution




Distribution Department
Planning Manager
Distribution Management System
Distribution Management System
Need for emergency distribution realized
A050.010. Emergency Distribution requests gathering
A050.170. Insert trucks in Distribution Management System
A050.180. Select from Distribution Management System
Distribution Management System
Third-party logistics company accepted
Yes
No
A050.140. Communicate with third party companies
A050.150. Receive third party trucks' assignment
A050.160. Check in database if truck is new
Yes
No
New
Distribution Management System
A050.130. Save pending inquiry for next distribution preparation
End event
Cloud data system
No
Yes
Owned trucks available
A050.020. Check for owned trucks availability
A,050.030. Check for all saved distribution inquires
A050.040. Proposals for emergency distributions
A050.050. Communicate proposals to Distribution Planner
A050.080. Save distribution plan and renew pending inquires
Distribution Planner
A050.060. Receive proposals
A050.070. Choose distribution plan from proposals


Distribution Management System
ert
ution
stem
t from
stem
A050.100. Receive distribution plan and renewed saved inquries
Accepted
Yes
No
A050.080. Save distribution plan and renew pending inquires
A050.090. Communicate distribution plan and renewed saved inquires to Planning Manager
A050.110. Create emergency distribution order
A050.120. Create and send e-loading document
End event

Main Changes

The current Distribution Processes Model does not involve clear activities for an emergency distribution, and it is not described as a process. In the suggested Distribution Processes Model due to the dynamic distributions' scheduling there is the need for a separate process and clear activities for the emergency distributions.

- ✓ All participants get informed automatically via smartphone application
- ✓ Loading Documents have digital form and are using blockchain technology and have verification stages
- ✓ E-loading documents are not going from hand to hand and do not require signing. They are shared via the smart phone application and have different statuses.
- ✓ Emergency Distribution is a dynamic process
- ✓ Distribution Plans are automatically created
- ✓ Communication with third-party companies is more automated

Table 4-9: Process Comparison A050

	As-Is Model	To-Be Model
Process Participants	N/A	• Distribution Management System • Planning Manager • Distribution Planner
#e-mails exchanged	N/A	2
#Automated activities	N/A	12/18

Process Description

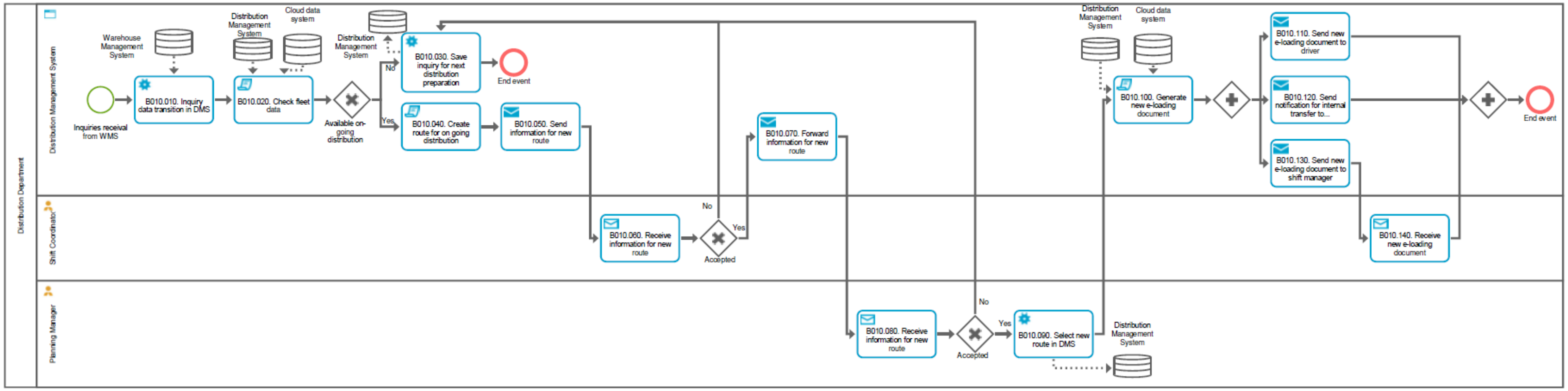
During each shift, the Planning Manager gathers all saved requests for emergency distributions in the DMS and when he decides it is the appropriate time to start an emergency distribution, he initiates the process in the DMS.

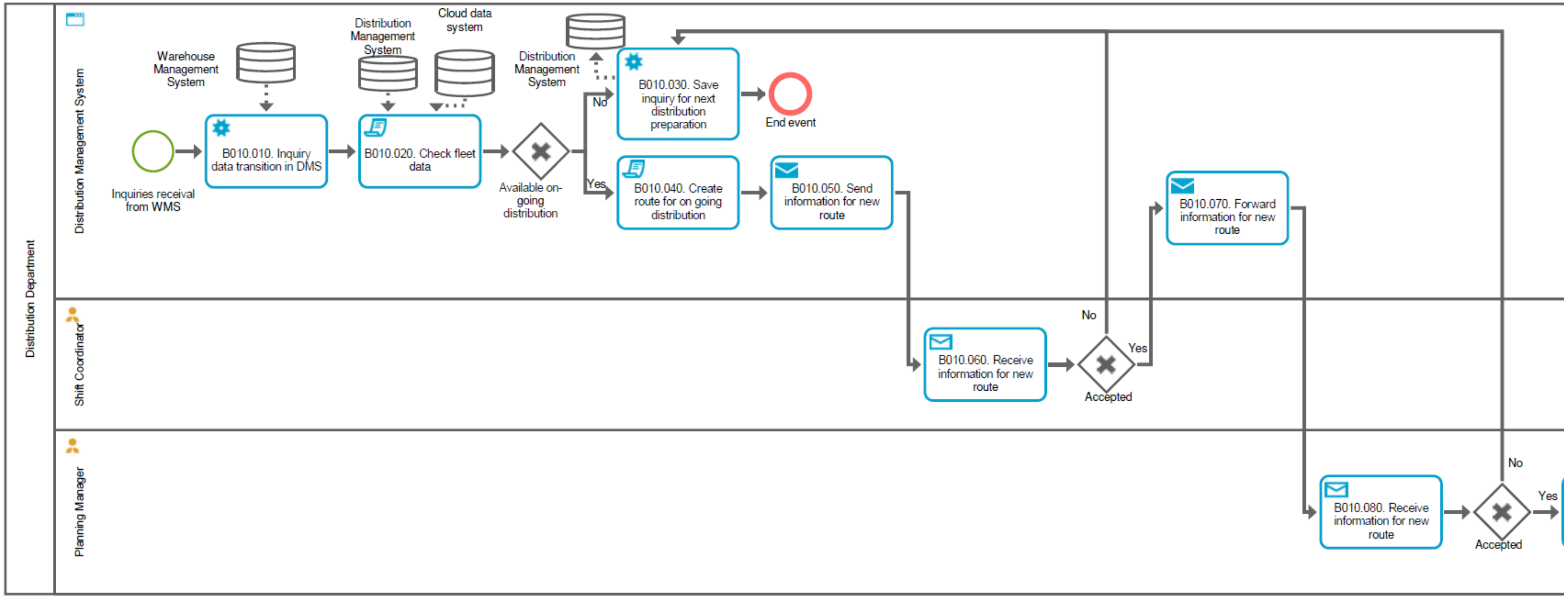
The Distribution Management System examines if the emergency distribution can be performed by owned trucks. If that is the case, the DMS using the data for the available trucks, the emergency distributions and other saved inquiries which can be included in the emergency distribution and runs the algorithms to propose emergency distribution plans which are send to the Distribution Planner to make a decision.

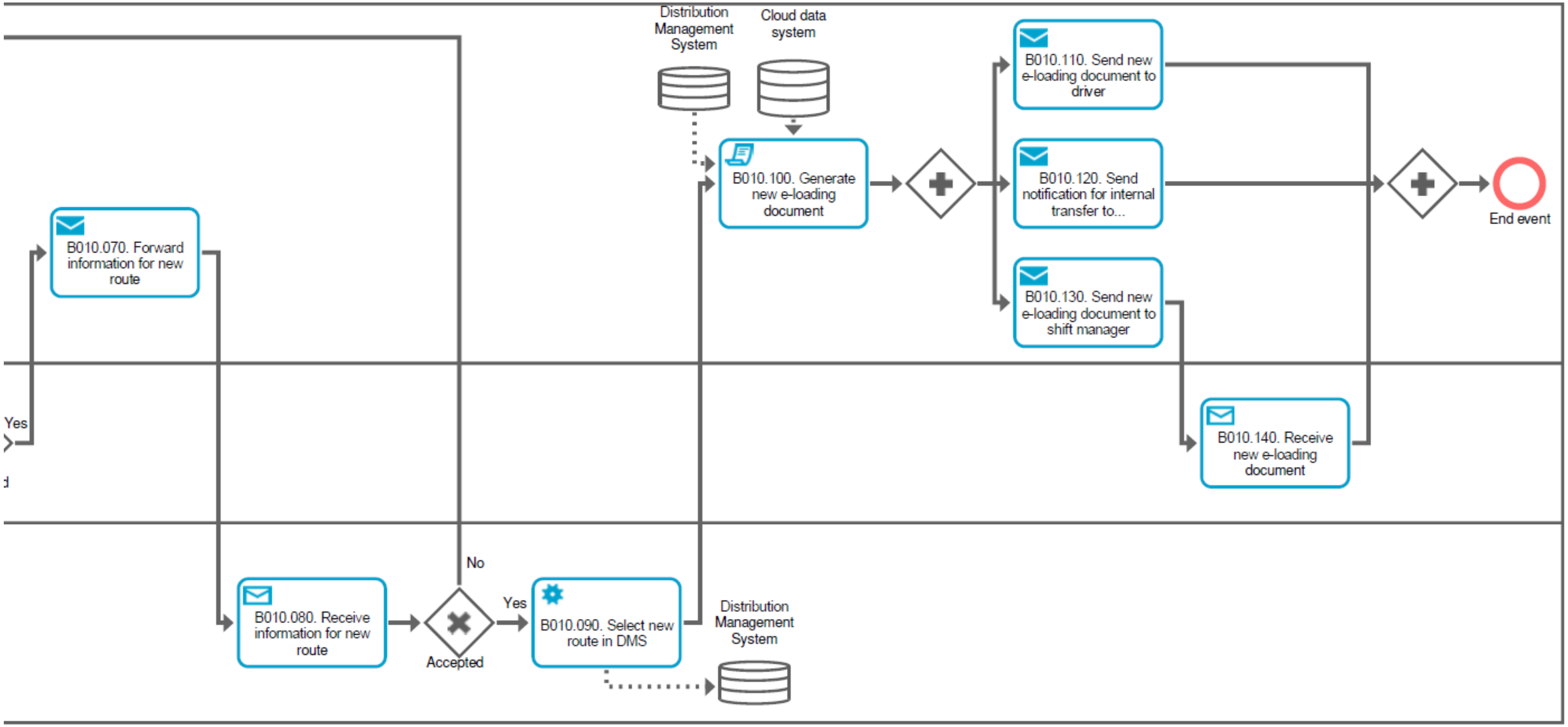
The Distribution Planner chooses a plan and according to the chosen plan the Distribution Management System saves the new data changing the saved inquiries and trucks' and drivers availability. Then the saved plan is shared to the Planning Manager. If the Planning Manager disagrees the plan selection activities are repeated. If the Planning Manager agrees an emergency distribution order is created in the DMS and an e-loading document is also created, and the Loading process starts immediately according to the created e-loading document.

In case the emergency distribution cannot be performed by owned trucks, the Planning Manager receives notification for the situation, and he allows the DMS to communicate with the third-party companies for truck's assignment. The DMS sends to the companies the needs for the emergency distributions, and they reply with the truck assignment. The DMS searches using truck's plate number if the truck is new. If the truck is new the truck's data are saved and the Planning Manager requests further information to insert in the DMS and if it is not new the DMS uses the truck's data from the Fleet Database. Then, the DMS continues with the described activities for final emergency distribution plan selection.

4.2.5.6. B010.Internal Transfers




Distribution Department
Distribution Management System
Shift Coordinator
Planning Manager
Warehouse Management System
Distribution Management System
Cloud data system
Distribution Management System
Inquiries receival from WMS
B010.010. Inquiry data transition in DMS
B010.020. Check fleet data
Available on-going distribution
No
Yes
B010.030. Save inquiry for next distribution preparation
End event
B010.040. Create route for on going distribution
B010.050. Send information for new route
B010.060. Receive information for new route
No
Yes
Accepted
B010.070. Forward information for new route
B010.080. Receive information for new route
No
Yes
Accepted


Distribution Management System
Cloud data system
B010.110. Send new e-loading document to driver
B010.100. Generate new e-loading document
B010.120. Send notification for internal transfer to...
End event
B010.070. Forward information for new route
B010.130. Send new e-loading document to shift manager
Yes
B010.140. Receive new e-loading document
No
Yes
B010.080. Receive information for new route
Accepted
B010.090. Select new route in DMS
Distribution Management System

Main Changes

- ✓ Internal transfers process is a dynamic process and it is not planned only separately from other distributions but also included if possible in on-going distributions
- ✓ Loading Documents have digital form and are using blockchain technology and have verification stages
- ✓ E-loading documents are not going from hand to hand and do not require signing. They are shared via the smart phone application and have different statuses.
- ✓ Trucks' availability is automatically checked by the DMS and the exact location of the trucks
- ✓ The inquiries are not received externally via e-mails but internally as notifications in the system

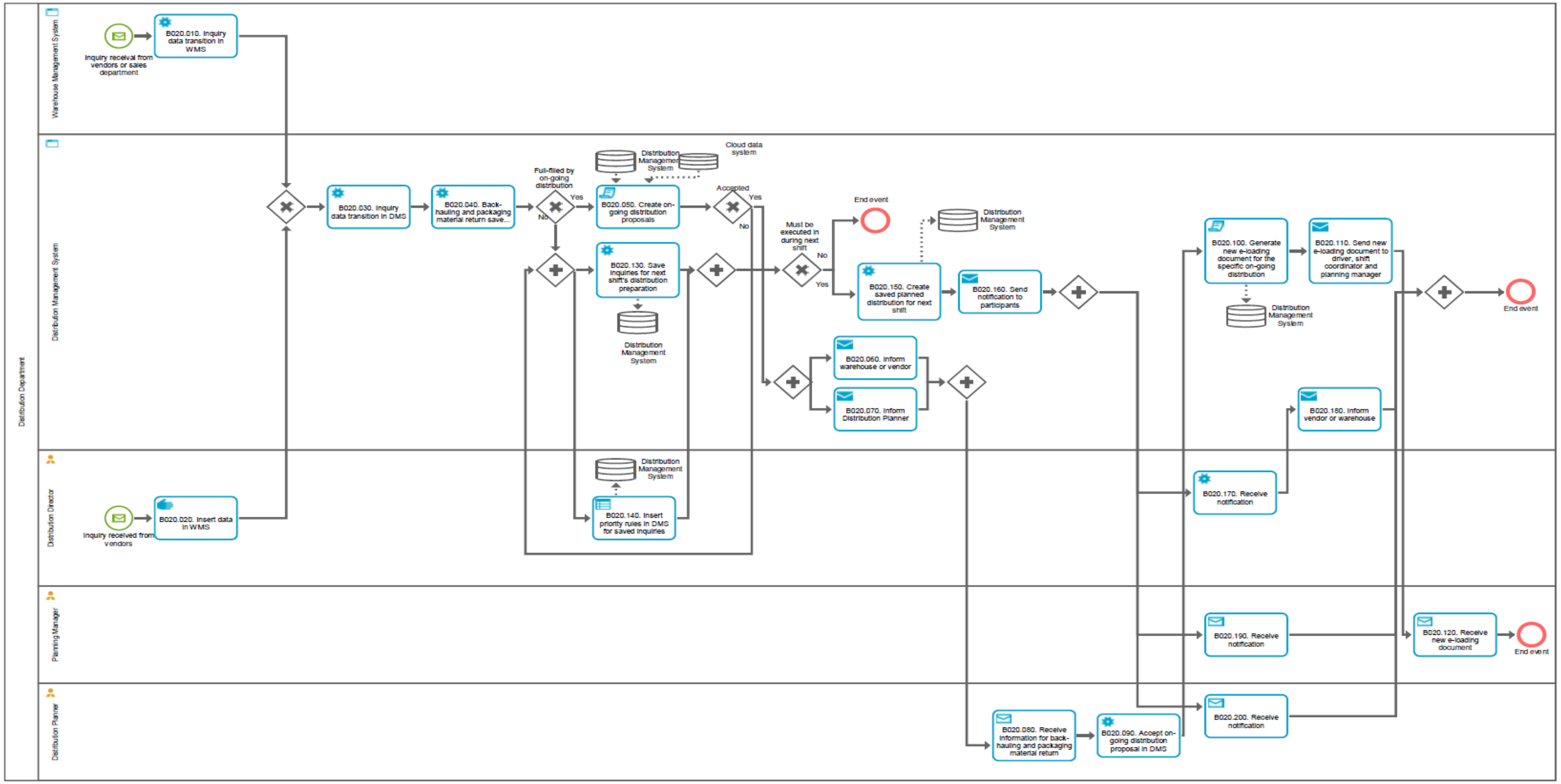
Table 4-10: Process Comparison B010

	As-Is Model	To-Be Model
Process Participants	• Shift Coordinator • Driver	• Distribution Management System • Planning Manager • Distribution Planner
#e-mails exchanged	1	0
#Automated activities	0/3	12/14

Process Description

The Distribution Management System receives request for internal transfer from the Warehouse Management System. Automatically, the DMS the Fleet Management data for available on-going or scheduled distribution. In case such availability is not applicable the request is saved for the next Distribution Preparation. If there is available distribution, the DMS sends a notification in the smartphone application to the Shift Coordinator, if the Shift Coordinator rejects the distribution, the request is saved for the next Distribution Preparation. If the Shift Coordinator accepts the distribution, the DMS sends it to the Planning Manager for finalization. If the Planning Manager rejects the distribution, the request is saved for the next Distribution Preparation, otherwise it is selected in the DMS and the DMS generates the new e-loading document and it shares it via the smartphone application to the process’s participants i.e. Driver, Shift Coordinator etc. The DMS also sends a confirmation for the requests status to the requesting party, such as another warehouse.

4.2.5.7. B020.Backhauling and packaging material returns Planning



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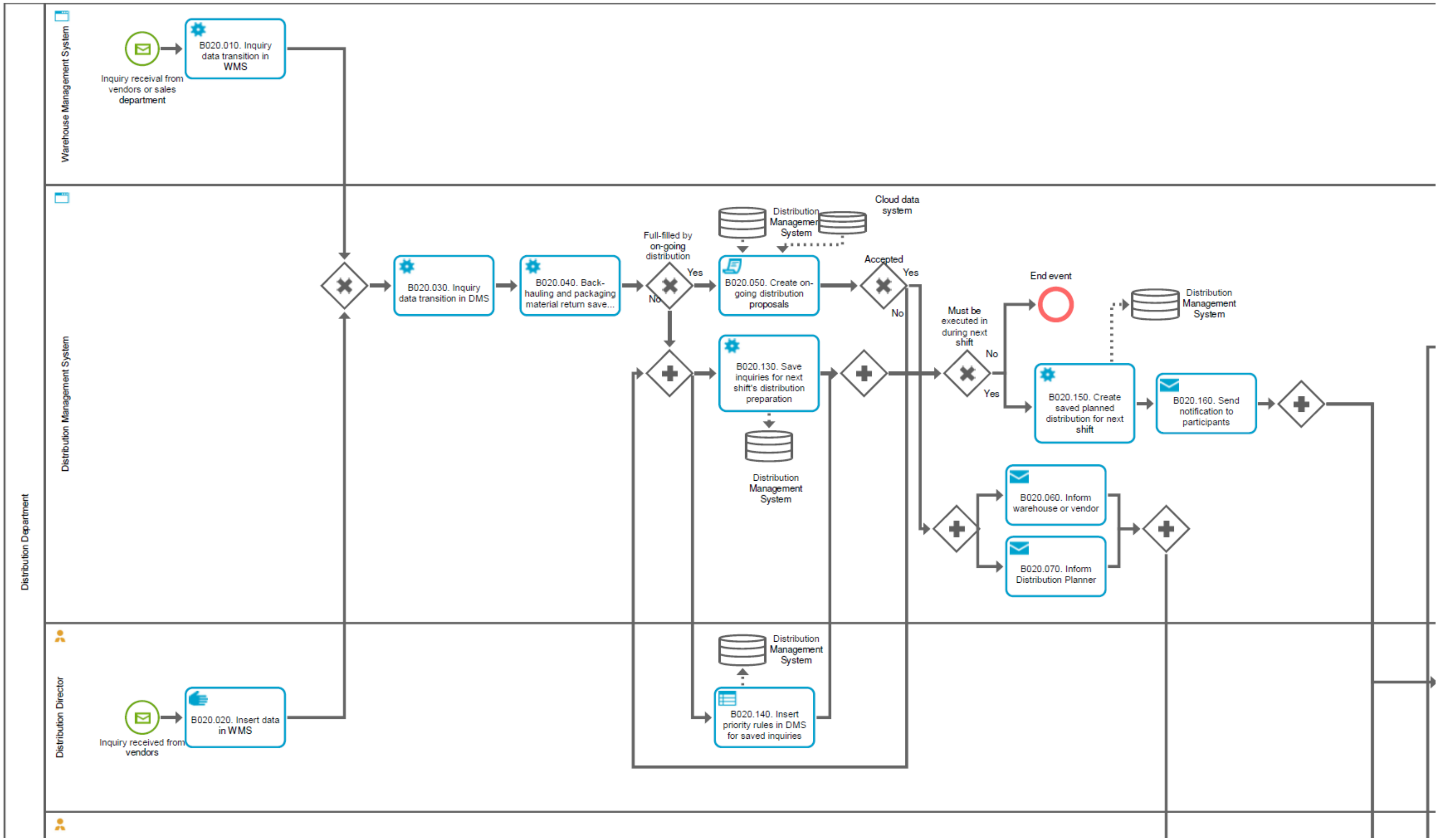
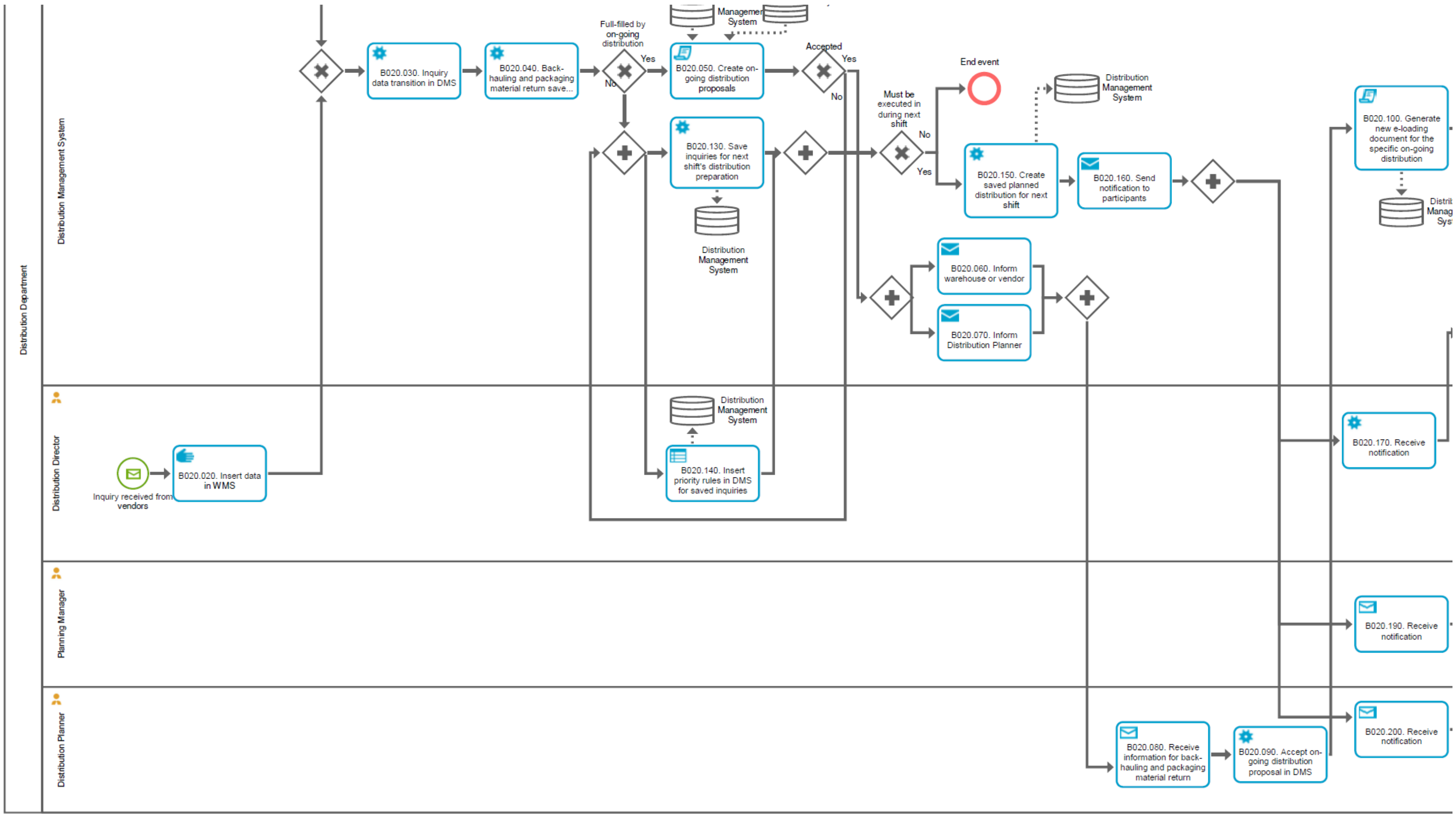

Distribution Department
Warehouse Management System
Inquiry receival from vendors or sales department
B020.010. Inquiry data transition in WMS
Distribution Management System
B020.030. Inquiry data transition in DMS
B020.040. Back-hauling and packaging material return save...
Full-filled by on-going distribution
Yes
No
Distribution Management System
Cloud data system
B020.050. Create on-going distribution proposals
Accepted
Yes
No
B020.130. Save inquiries for next shift's distribution preparation
Distribution Management System
Must be executed in during next shift
No
Yes
End event
Distribution Management System
B020.150. Create saved planned distribution for next shift
B020.160. Send notification to participants
B020.060. Inform warehouse or vendor
B020.070. Inform Distribution Planner
Distribution Director
Distribution Management System
Inquiry received from vendors
B020.020. Insert data in WMS
B020.140. Insert priority rules in DMS for saved inquiries



Distribution Department
Distribution Management System
Distribution Director
Planning Manager
Distribution Planner
Inquiry received from vendors
B020.020. Insert data in WMS
B020.030. Inquiry data transition in DMS
B020.040. Back-hauling and packaging material return save...
Full-filled by on-going distribution
Yes
No
Management System
B020.050. Create on-going distribution proposals
Accepted
Yes
No
B020.130. Save inquiries for next shift's distribution preparation
Distribution Management System
B020.140. Insert priority rules in DMS for saved inquiries
Must be executed in during next shift
No
Yes
End event
Distribution Management System
B020.150. Create saved planned distribution for next shift
B020.160. Send notification to participants
B020.060. Inform warehouse or vendor
B020.070. Inform Distribution Planner
B020.100. Generate new e-loading document for the specific on-going distribution
B020.170. Receive notification
B020.190. Receive notification
B020.200. Receive notification
B020.080. Receive information for back-hauling and packaging material return
B020.090. Accept on-going distribution proposal in DMS

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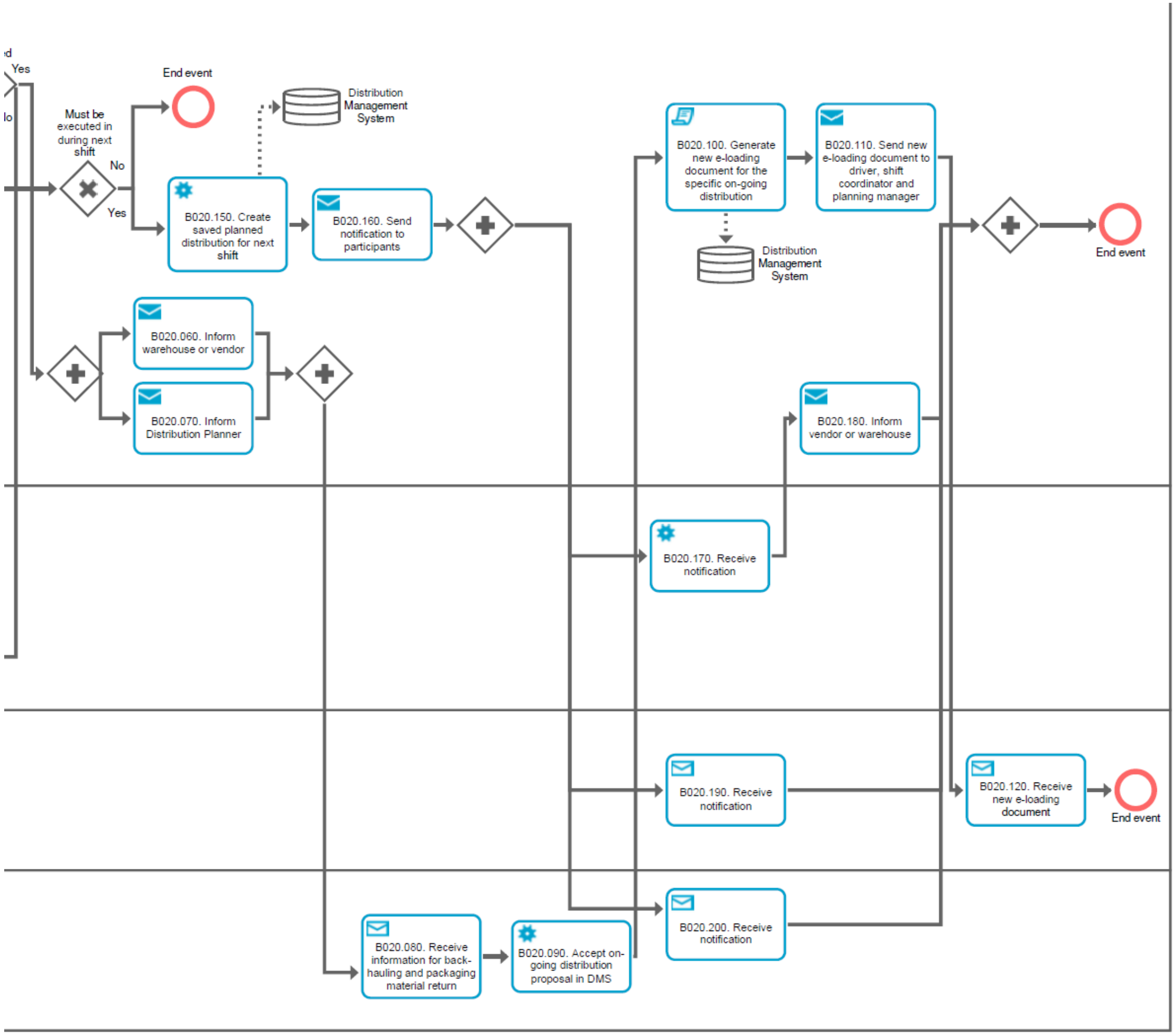


Yes
End event
Distribution Management System
Must be executed in during next shift
No
Yes
B020.150. Create saved planned distribution for next shift
B020.160. Send notification to participants
B020.060. Inform warehouse or vendor
B020.070. Inform Distribution Planner
B020.100. Generate new e-loading document for the specific on-going distribution
Distribution Management System
B020.110. Send new e-loading document to driver, shift coordinator and planning manager
End event
B020.180. Inform vendor or warehouse
B020.170. Receive notification
B020.190. Receive notification
B020.120. Receive new e-loading document
End event
B020.200. Receive notification
B020.080. Receive information for back-hauling and packaging material return
B020.090. Accept on-going distribution proposal in DMS

Main Changes

- ✓ Backhauling and empty materials return Planning is a dynamic process and the inquiries can be supported immediately if there is availability
- ✓ Loading Documents have digital form and are using blockchain technology and have verification stages
- ✓ E-loading documents are not going from hand to hand and do not require signing. They are shared via the smart phone application and have different statuses.
- ✓ Trucks' availability is automatically checked by the DMS and the exact location of the trucks
- ✓ The inquiries are not received externally via e-mails but internally as notifications in the system
- ✓ The system sends automatically e-mails to inform the suppliers, warehouses and stores
- ✓ Distribution Proposals are created in the system and selected by the person in charge

Table 4-11: Process Comparison B020

	As-Is Model	To-Be Model
Process Participants	• Distribution Manager • Distribution Planner • Planning Manager	• Distribution Management System • Warehouse Management System • Distribution Manager • Planning Manager • Distribution Planner
#e-mails exchanged	6	0
#Automated activities	0/10	15/20

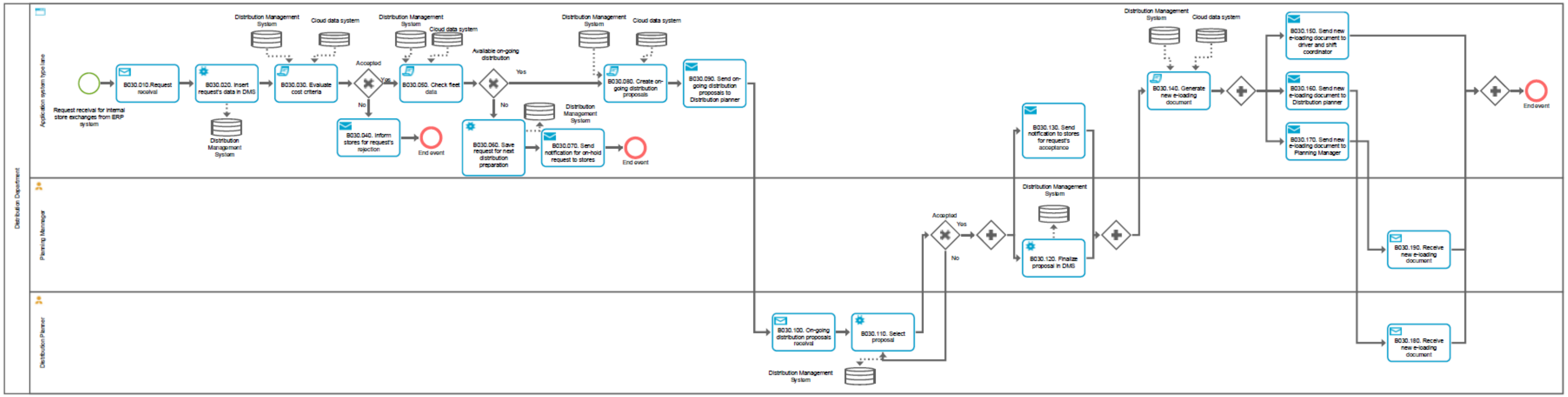
Process Description

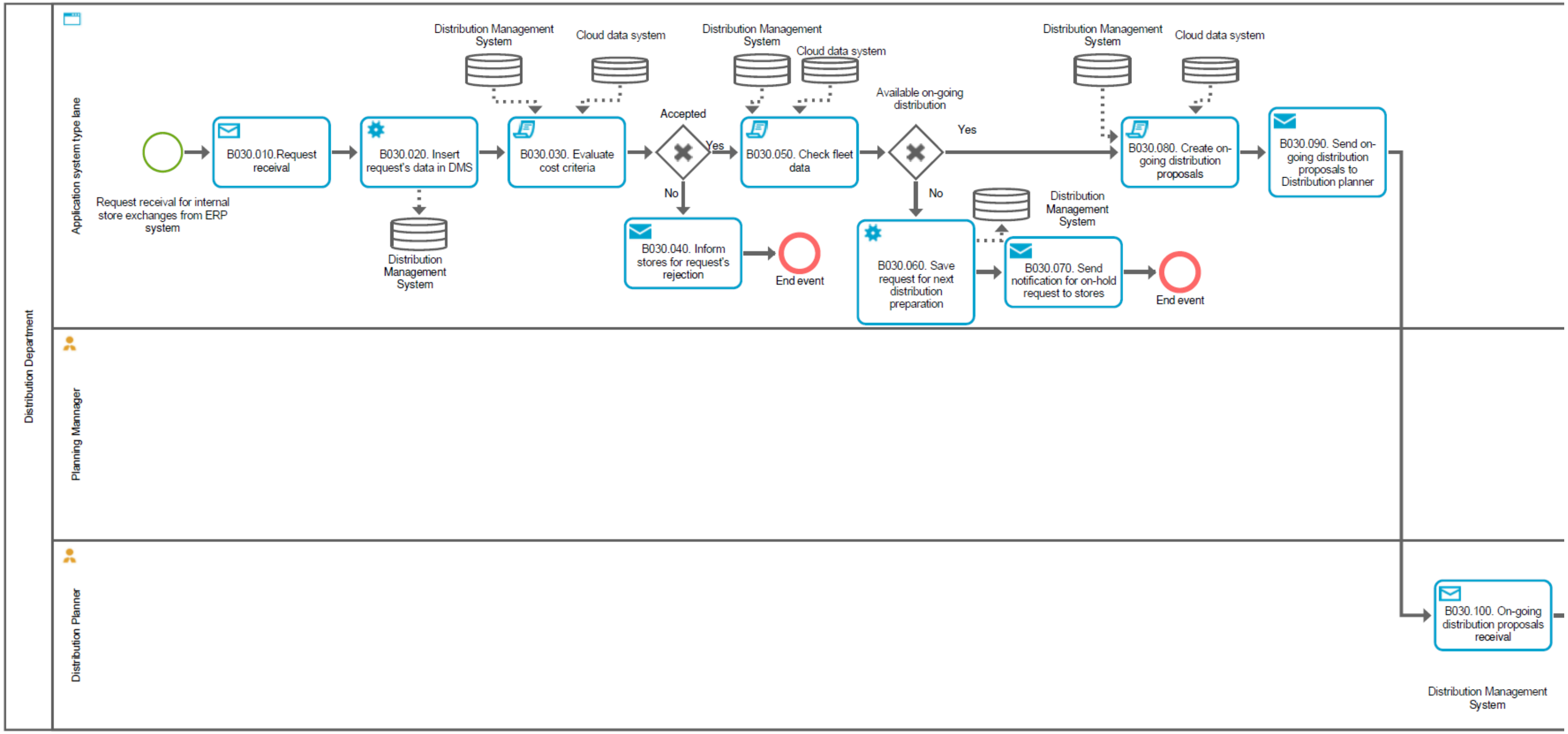
The goal is to intergrade the Warehouse Management System to all vendors/suppliers, so all orders/requests are supported by the same system internally. With that in mind, the requests for backhauling or empty material returns are mainly submitted in the WMS or via e-mail to the Distribution Manager who submits them in the WMS. The inquiries' data are automatically transitioned in the Distribution Management System and saved. The DMS searches if they can be fulfilled by an ongoing distribution.

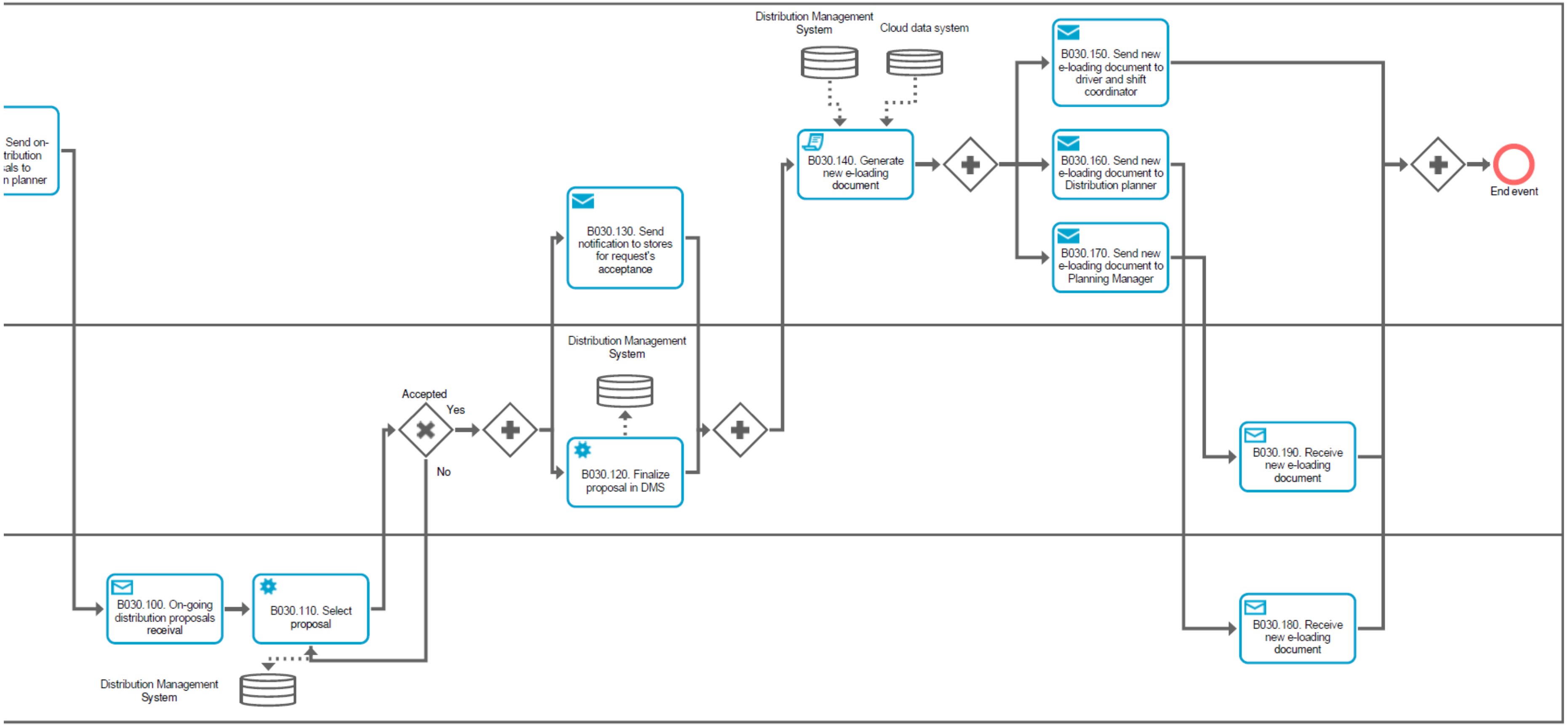
If there is such possibility, the DMS creates on-going distribution proposal which is send through the smartphone application to the Distribution Manager. If accepted by the Distribution Manager, it is automatically shared with the Distribution Planner and the involved party, namely store, supplier etc. Once, the Distribution is accepted by the Distribution Manager, the DMS generates the new e-loading documents which are shared with the Drive, Shift Coordinator, Distribution Planner and Planning Manager.

If the Distribution Manager rejects the proposal the next activities are the same with the scenario of not having the possibility for an on-going distribution to fulfill the inquiry. In those cases, the inquiry is saved in the DMS for the next Distribution Preparation and the Planning Manager inserts the priority rules. If the inquiry is required to be executed in the next distribution, it is saved as a planned distribution for the next shift and a notification is sent to the interested party (store, warehouse, supplier etc.)and the Distribution Planner.

4.2.5.8. B030. Internal Store Exchanges




Distribution Department
Application system type lane
Planning Manager
Distribution Planner
Request receival for internal store exchanges from ERP system
B030.010.Request receival
B030.020. Insert request's data in DMS
Distribution Management System
Distribution Management System
Cloud data system
B030.030. Evaluate cost criteria
Accepted
Yes
No
B030.040. Inform stores for request's rejection
End event
Distribution Management System
Cloud data system
B030.050. Check fleet data
Available on-going distribution
Yes
No
B030.060. Save request for next distribution preparation
Distribution Management System
B030.070. Send notification for on-hold request to stores
End event
Distribution Management System
Cloud data system
B030.080. Create on-going distribution proposals
B030.090. Send on-going distribution proposals to Distribution planner
B030.100. On-going distribution proposals receival
Distribution Management System



Send on-
tribution
als to
n planner
Distribution Management System
Cloud data system
B030.150. Send new e-loading document to driver and shift coordinator
B030.140. Generate new e-loading document
B030.160. Send new e-loading document to Distribution planner
End event
B030.130. Send notification to stores for request's acceptance
B030.170. Send new e-loading document to Planning Manager
Distribution Management System
Accepted
Yes
No
B030.120. Finalize proposal in DMS
B030.190. Receive new e-loading document
B030.100. On-going distribution proposals receival
B030.110. Select proposal
B030.180. Receive new e-loading document
Distribution Management System

Main Changes

- ✓ Internal Store Exchanges is a dynamic process and the inquiries can be supported immediately if there is availability
- ✓ Loading Documents have digital form and are using blockchain technology and have verification stages
- ✓ E-loading documents are not going from hand to hand and do not require signing. They are shared via the smart phone application and have different statuses.
- ✓ Trucks' availability is automatically checked by the DMS and the exact location of the trucks
- ✓ The inquiries are not received externally via e-mails but internally as notifications in the system
- ✓ The system sends automatically e-mails to inform the suppliers, warehouses and stores
- ✓ Distribution Proposals are created in the system and selected by the person in charge
- ✓ The request's evaluation is automatically executed

Table 4-12: Process Comparison B030

	As-Is Model	To-Be Model
Process Participants	• Distribution Planner • Planning Manager	• Distribution Management System • Planning Manager • Distribution Planner
#e-mails exchanged	4 (manual e-mails)	3 (automated responses by the DMS)
#Automated activities	0/6	17/19

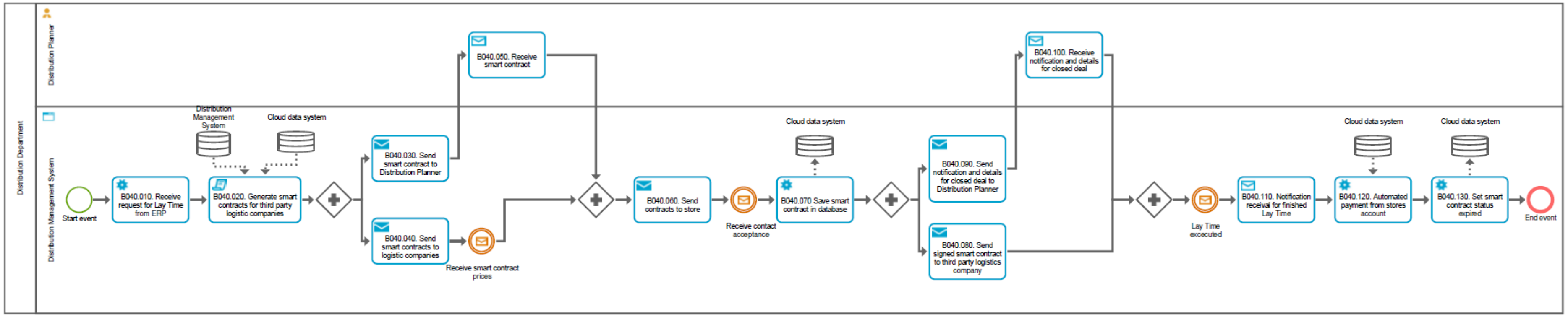
Process Description

The DMS receives a request from a store through the ERP system for an internal product exchange. The request's data are transitioning to the DMS and the DMS sends a notification for the request to the Planning Manager. The request is automatically evaluated according to the company's cost criteria. If the request is rejected the DMS sends a rejection e-mail to the store with the Planning Manager cc'd.

If the request is accepted the DMS examines if there is an on-going distribution available to support this request. If there is not such distribution available, the request is saved in the DMS as a pending inquiry for the next Distribution Preparation and sends a notification e-mail to the store with the Planning Manager cc'd.

If there are available on-going distributions, the DMS creates proposals and sends them to the Distribution Planner for overview and selection. The Distribution Planner selects a proposal through the smartphone application, and it is automatically shared to the Planning Manager for finalizing. If the Planning Manager is in agreement with the selection, the selection is finalized in the DMS and an acceptance e-mail is sent to the store automatically. Then the DMS generates a new e-loading document which is shared to the Distribution Planner, Planning Manager, Driver and Shist Coordinator via the smartphone application.

4.2.5.9. B040. Laytime Planning



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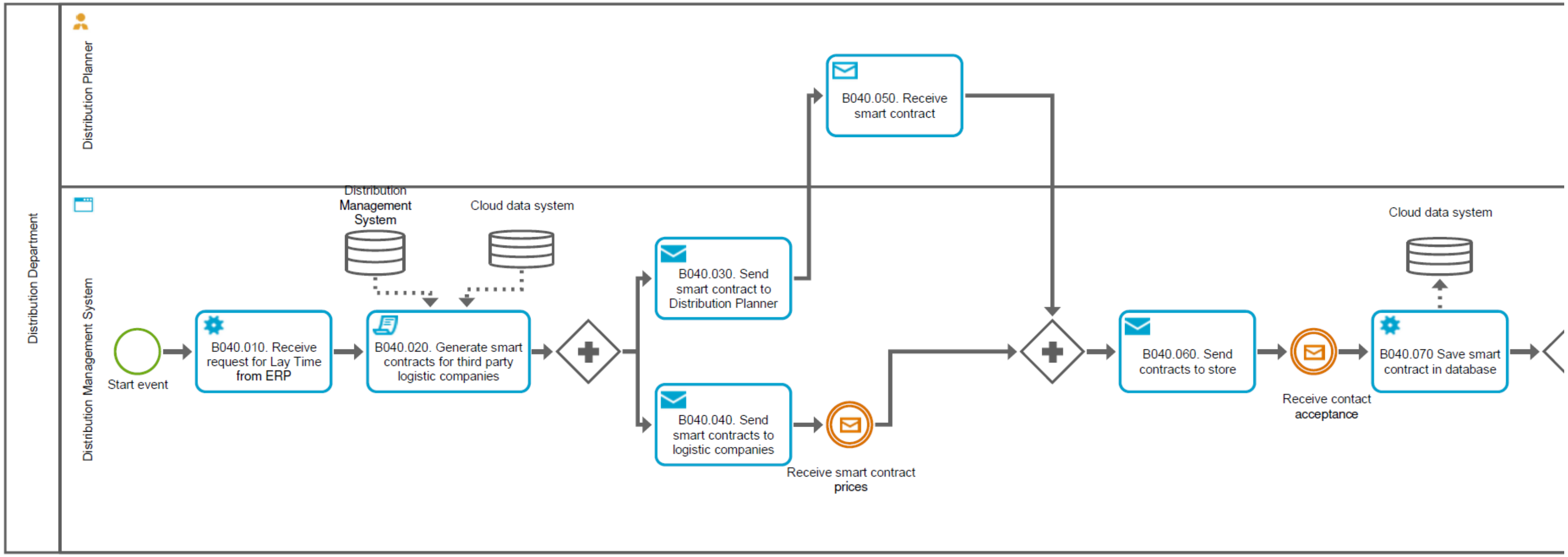
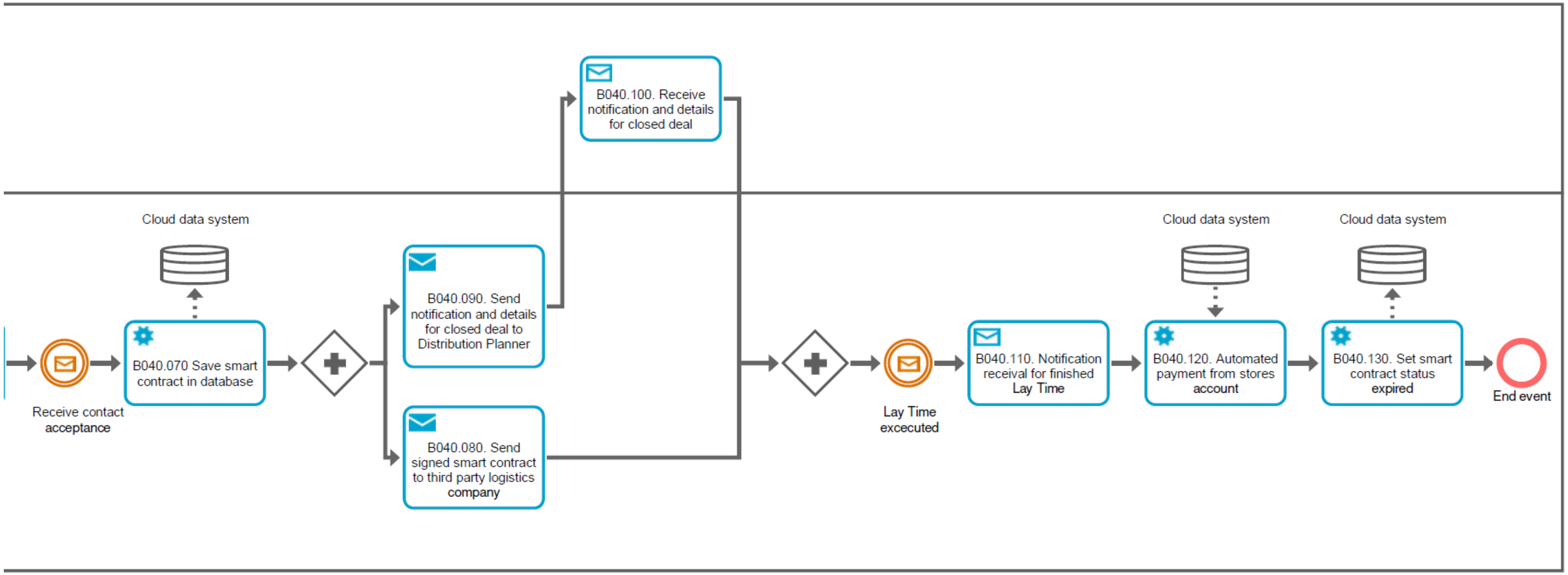

Distribution Department
Distribution Planner
Distribution Management System
Start event
B040.010. Receive request for Lay Time from ERP
Distribution Management System
Cloud data system
B040.020. Generate smart contracts for third party logistic companies
B040.030. Send smart contract to Distribution Planner
B040.040. Send smart contracts to logistic companies
Receive smart contract prices
B040.050. Receive smart contract
B040.060. Send contracts to store
Receive contact acceptance
Cloud data system
B040.070 Save smart contract in database


B040.100. Receive notification and details for closed deal
Cloud data system
B040.090. Send notification and details for closed deal to Distribution Planner
Cloud data system
Cloud data system
Receive contact acceptance
B040.070 Save smart contract in database
B040.080. Send signed smart contract to third party logistics company
Lay Time excecuted
B040.110. Notification receival for finished Lay Time
B040.120. Automated payment from stores account
B040.130. Set smart contract status expired
End event

Main Changes

- ✓ The inquiries are not received externally via e-mails but internally as notifications in the system
- ✓ Smart Contracts are used to close deals with the third-party companies and for payment execution at the end of the process
- ✓ The Distribution Management System generates the Smart Contract and sends it to all parties
- ✓ The Distribution Planner supervises the whole process to ensure that it was correctly executed

Table 4-13: Process Comparison B040

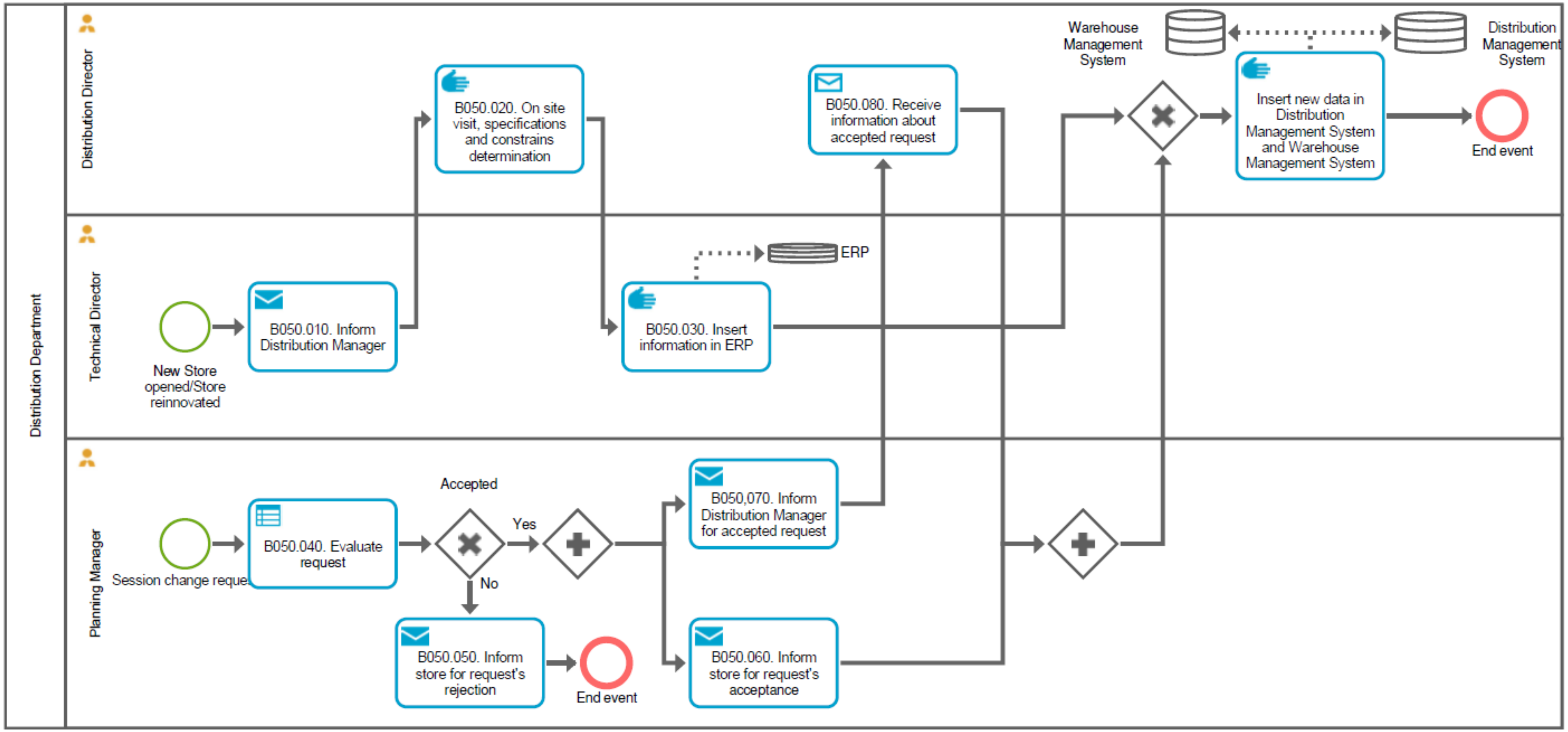
	As-Is Model	To-Be Model
Process Participants	• Store/Region Manager • Distribution Planner	• Distribution Management System • Distribution Planner
#e-mails exchanged	6	5
#Automated activities	0/7	13/13

Process Description

The DMS receives a Lay time request from the ERP with all the required information such as duration, type of products, further specifications etc. Automatically, the DMS generates a Smart Contract for the third-party logistics companies and shares the Smart Contract to them and the Distribution Planner. Once, the third-party company sends the Smart Contract with their price included the Smart Contract is sent to the Store/Region Manager for acceptance. After the Smart Contract is accepted it is saved in the database and the second verification stage is competed and the Contract is shared to the third-party logistics company and the Distribution Planner.

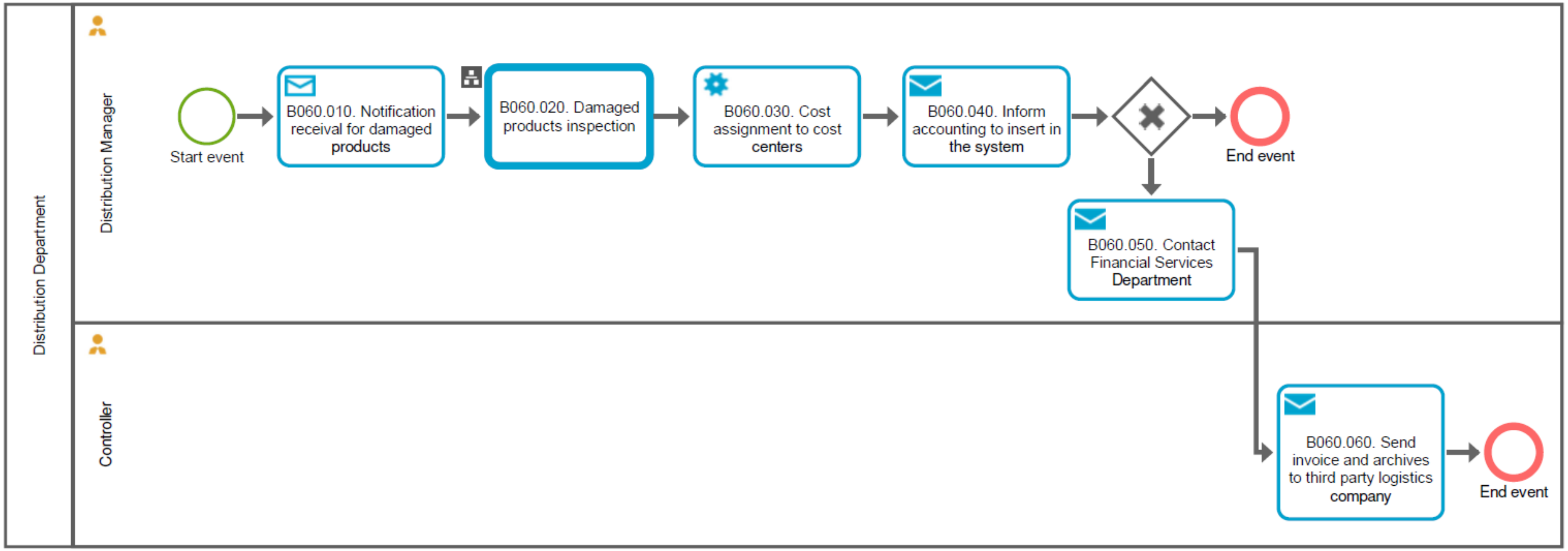
Then, the Lay time is executed and when the completion is verified in the DMS the payment is executed and the final stage of the Smart Contract verified and it is saved in the database as expired.

4.2.5.10. B050. New Stores/Info changing Entries

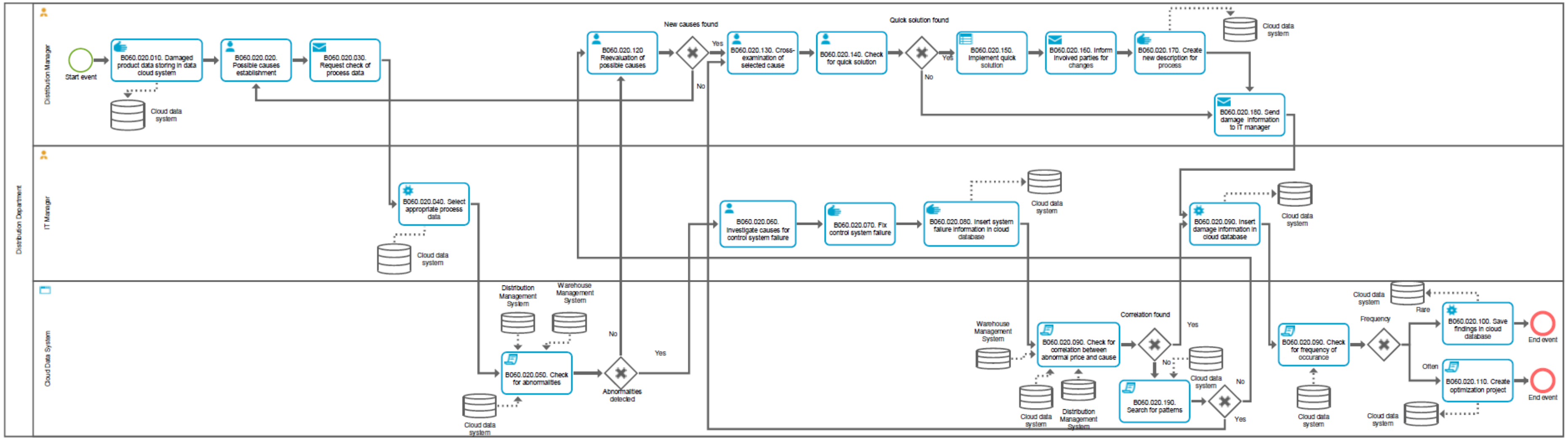


The process B050. New Stores/Info changing Entries is the same with C050. New store inserting in System in the as-is model.

4.2.5.11. B060.Damaged Products Handling



B060.020. Damaged Products Inspection (Call-Process)



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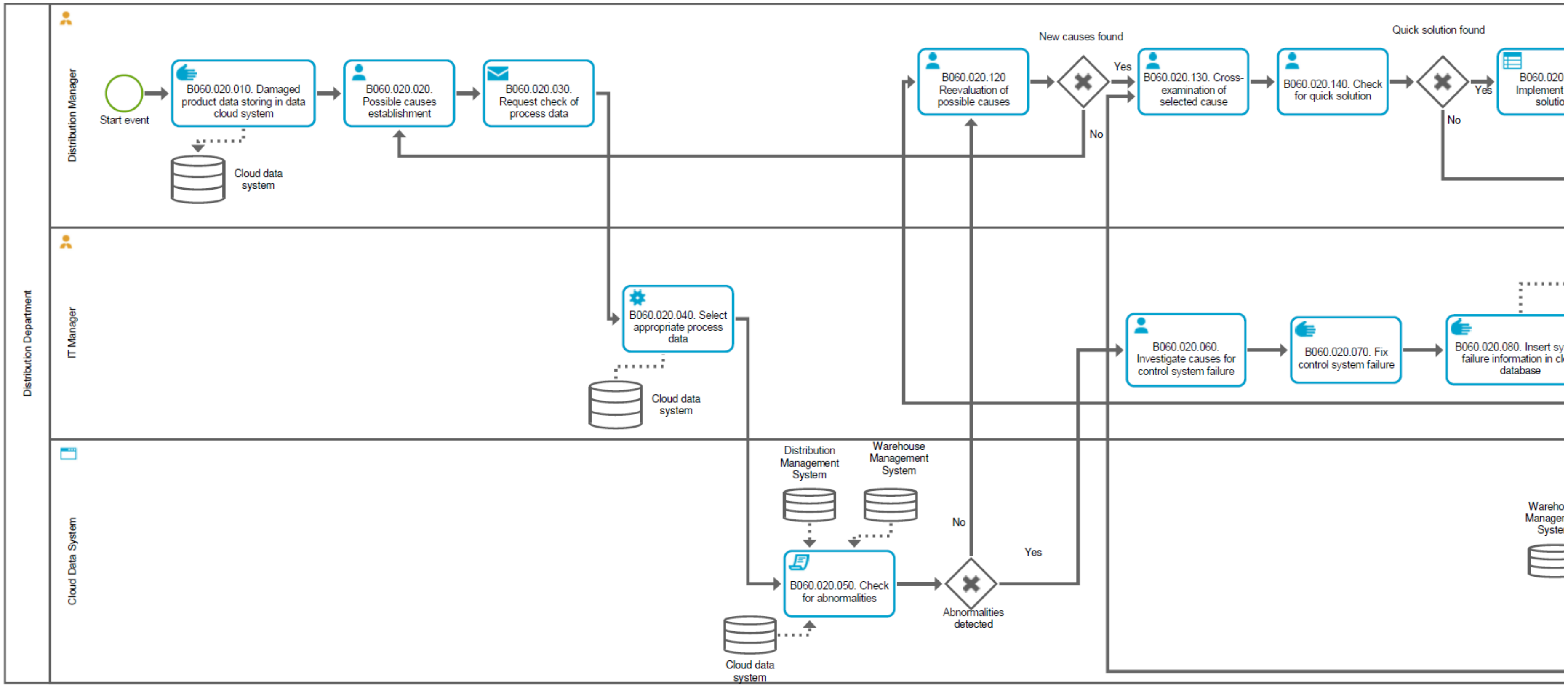
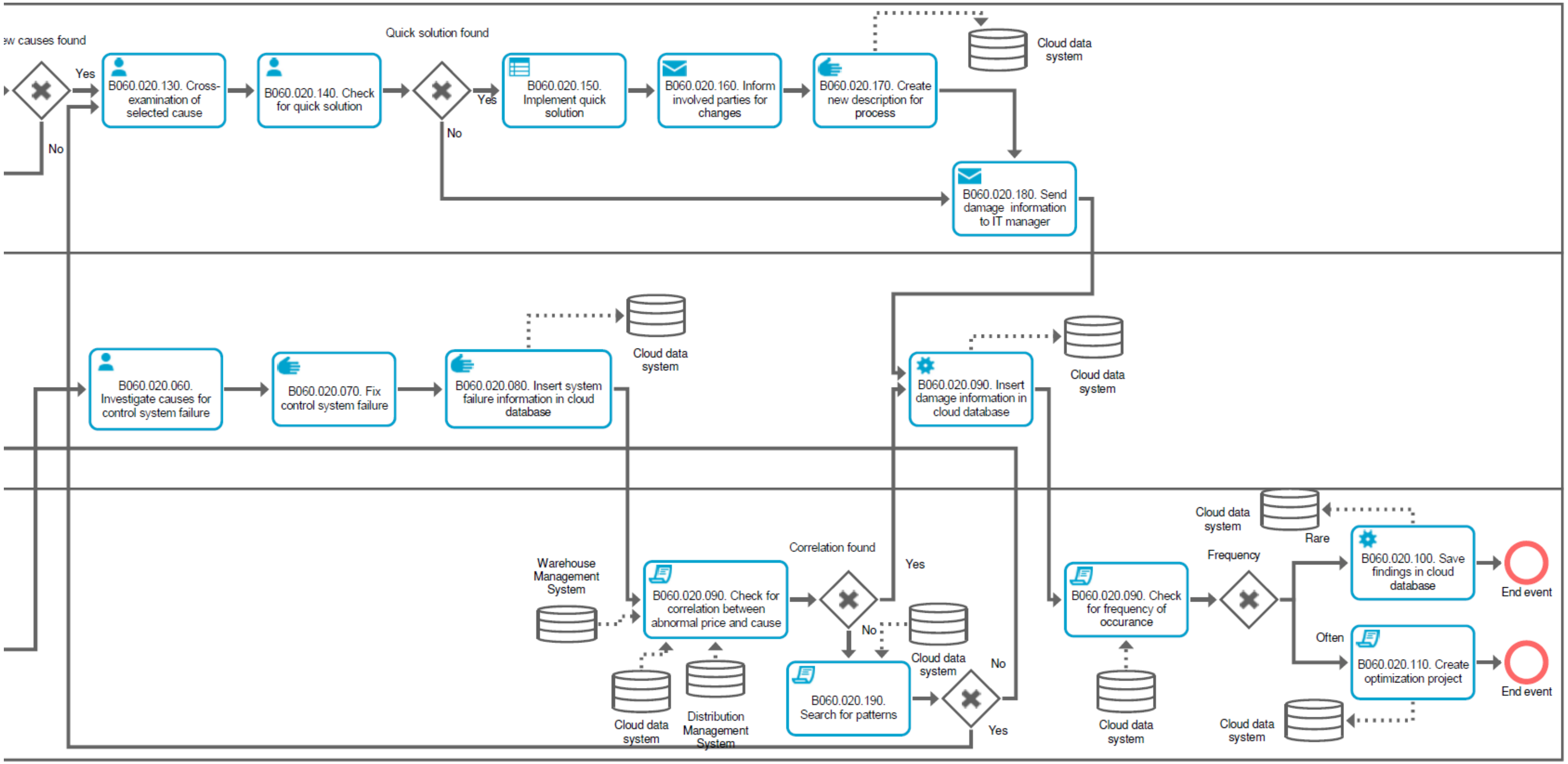

Distribution Department
Distribution Manager
IT Manager
Cloud Data System
Start event
B060.020.010. Damaged product data storing in data cloud system
B060.020.020. Possible causes establishment
B060.020.030. Request check of process data
Cloud data system
B060.020.040. Select appropriate process data
Cloud data system
Distribution Management System
Warehouse Management System
B060.020.050. Check for abnormalities
Cloud data system
Abnormalities detected
No
Yes
B060.020.120 Reevaluation of possible causes
New causes found
Yes
No
B060.020.130. Cross-examination of selected cause
B060.020.140. Check for quick solution
Quick solution found
Yes
No
B060.020.060. Investigate causes for control system failure
B060.020.070. Fix control system failure



ew causes found
Yes
No
B060.020.130. Cross-examination of selected cause
B060.020.140. Check for quick solution
Quick solution found
Yes
No
B060.020.150. Implement quick solution
B060.020.160. Inform involved parties for changes
B060.020.170. Create new description for process
Cloud data system
B060.020.180. Send damage information to IT manager
B060.020.060. Investigate causes for control system failure
B060.020.070. Fix control system failure
B060.020.080. Insert system failure information in cloud database
Cloud data system
B060.020.090. Insert damage information in cloud database
Cloud data system
Warehouse Management System
B060.020.090. Check for correlation between abnormal price and cause
Cloud data system
Distribution Management System
Correlation found
Yes
No
Cloud data system
B060.020.190. Search for patterns
No
Yes
B060.020.090. Check for frequency of occurance
Cloud data system
Frequency
Rare
Often
Cloud data system
B060.020.100. Save findings in cloud database
End event
B060.020.110. Create optimization project
End event
Cloud data system

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Main Changes

The only changes in the Damaged Products Handling Process are the participants and the Damaged Products inspection which in the suggested model is a call-process which takes place whenever damages in products occur. The as-is model instead of this call-process has a simple activity of causes investigation only to determine the cost assignment in the cost centers. In the new model the supervisor of the process is the Distribution Manager instead of the Shift Coordinator aiming to include his in the call-process B060.020. Damaged Products inspection. This new call-process aims to provide a systematic way to approach, investigate and report the causes for damage. It also helps in finding patterns, determine the frequency of its cause and help implement quick solutions to avoid further damages. Finally, the call-process supports the establishment of control systems, a continuous improvement mindset and more effective data exploitation.

Table 4-14, Call-Process Comparison B060.020

	As-Is Model	To-Be Model
Call-Process Participants	N/A	• Cloud Data System/Distribution Management System • IT Manager • Distribution Manager
#e-mails exchanged	N/A	2
#Automated activities	N/A	6/11

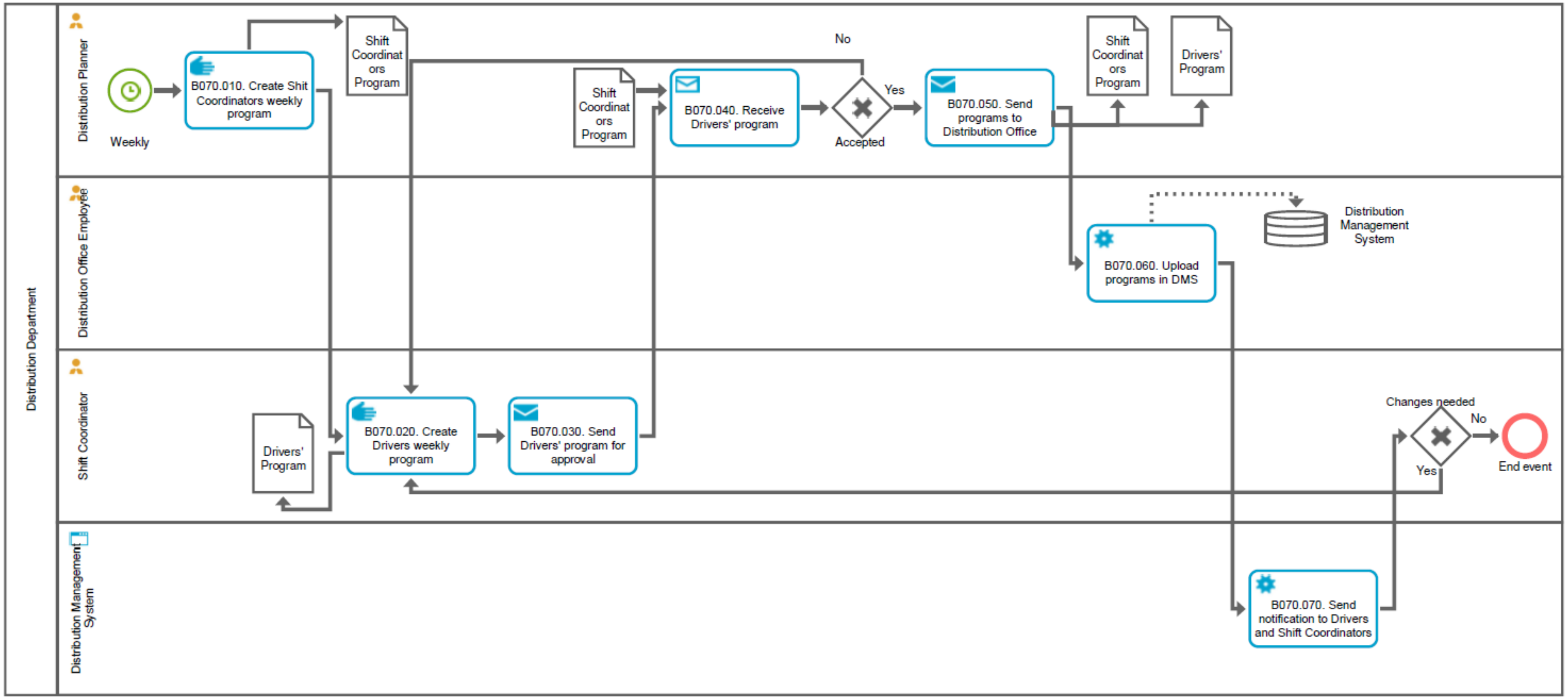
Call-Process Description

The Distribution Manager stores in the Cloud data system all information regarding the damaged products and the system associates them with the specific process. Then, the Distribution Manager searches for possible causes and requests from the IT Manager to extract from both Cloud data system and Distribution Management System all information for this specific process such as duration of each step, exact route of the truck, temperature in the truck and so on and so forth. The Cloud Data System runs an algorithm to search for abnormalities in the specific process and there are two scenarios.

First scenario, no abnormalities detected. In this case, the Distribution Manager reevaluates the possible causes using the extracted data and asking all involved parties. If still no causes are accepted, the Distribution Manager starts from the beginning and requests for further data. If the Distribution Manager concludes to some possible causes these are cross-checked to select the final cause of the damage. Then, the Distribution Manger searches for potential quick solutions to avoid the recurrence of the same incident. If there are potential quick solutions, the Distribution Manager implements them and informs all involved parties for the changes and saves the new description and directions in the Cloud System for them to be available in the whole organization. Next step is the damage information to the IT Manger to insert them in the Cloud Data System in the correct database so the system can examine the frequency of occurrence of these issues. If the occurrence rate is rare it is saved as an incident for future knowledge, otherwise if the occurrence rate is often an open optimization project is created. If no potential quick solutions are found, the Distribution Manager sends the damaged information to the IT Manager and the above activities are followed.

In the second scenario, the Cloud data system detects abnormalities. In this case, the IT Manager investigates the reason the control systems did not work and alerted on time, makes amendments as needful and inserts the systems failure reasons in the Cloud data system for failure recording. After that, the Cloud data system examines the correlation between the abnormal price and the cause of damage. If there is a strong correlation, the IT Manager inserts the damage information in the Cloud data system and the previously described activities are followed to examine frequency of occurrence etc. If no correlation is found, there is a second examination of the data to search for patterns. If patterns are not found, the Distribution Manager reevaluates the data to decide for other causes or to conclude to a cause. If patterns are found, the Distribution Manager examines the outcomes to find quick solution and the activities described above are followed.

4.2.5.12. B070. Distribution Personnel Program Planning



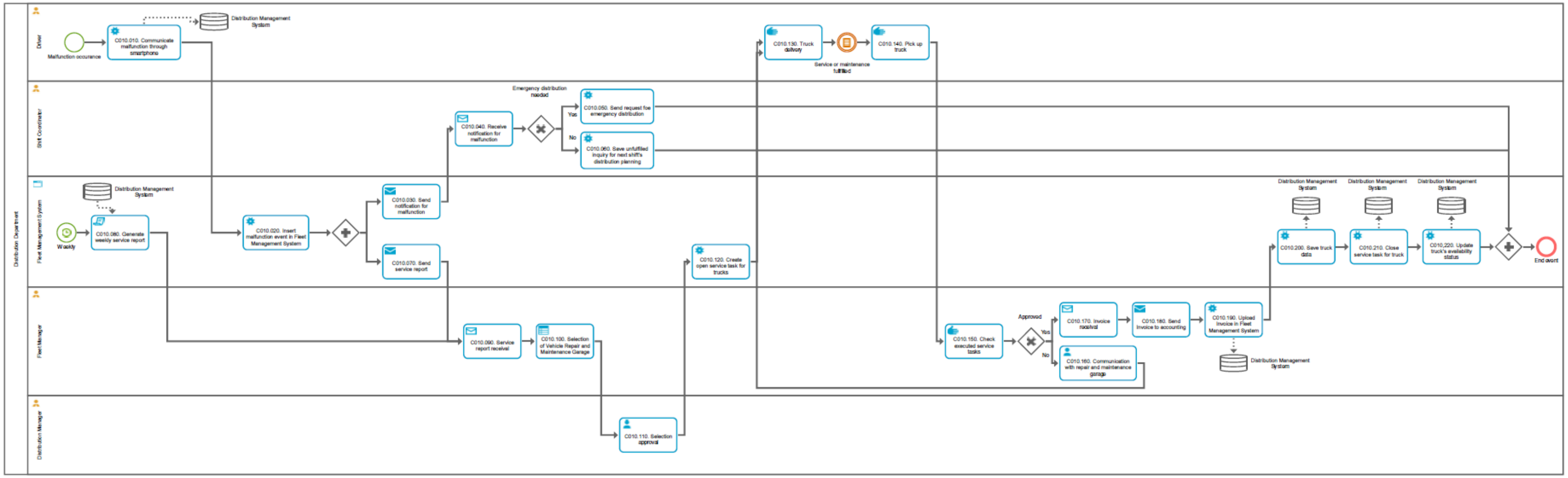
Main Changes

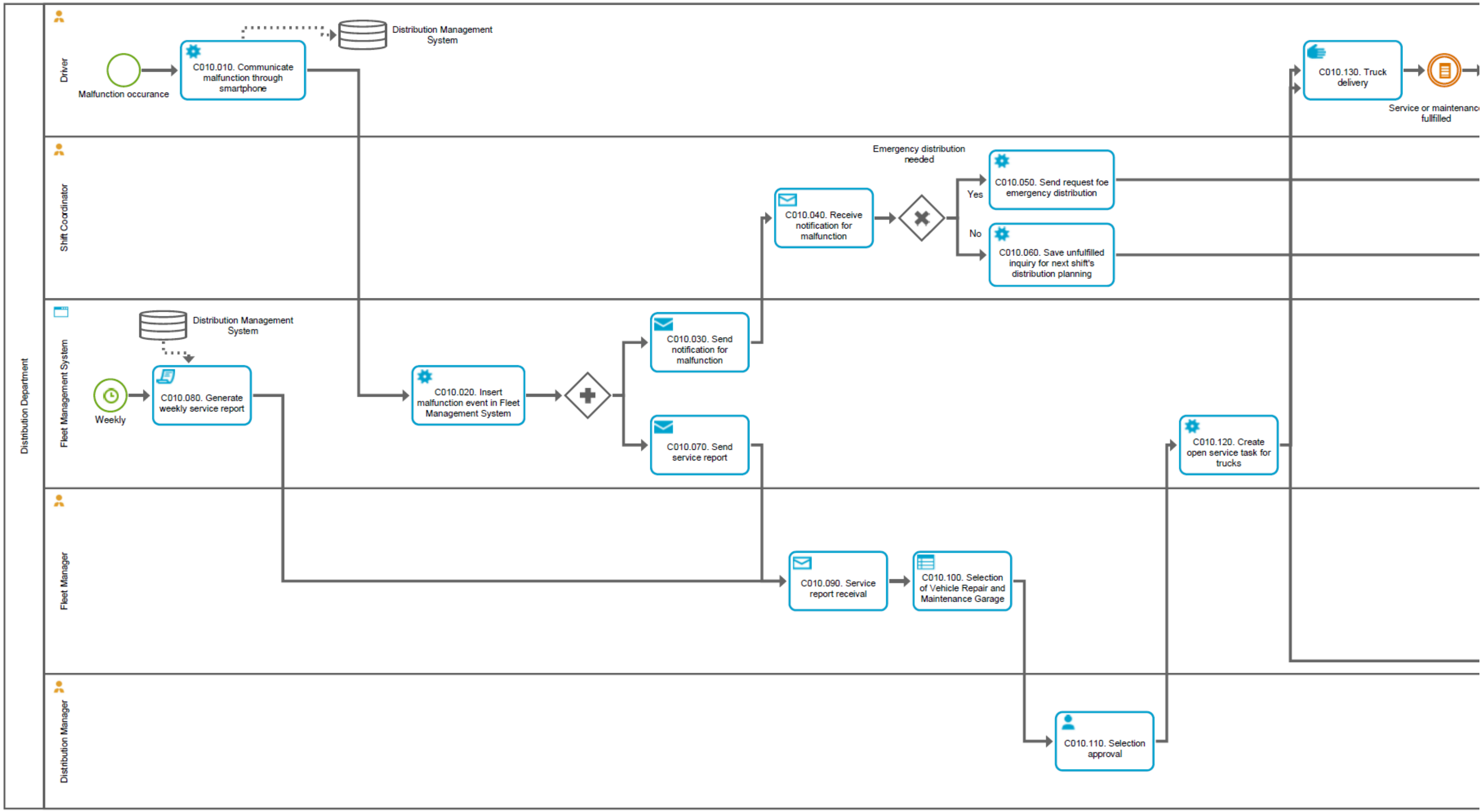
The Distribution Personnel Programming includes very minor changes mainly on the way that Drivers and Shift Coordinator are informed for their shifts. Instead of using e-mails or phone calls, they get informed via the smartphone application which displays their weekly program.

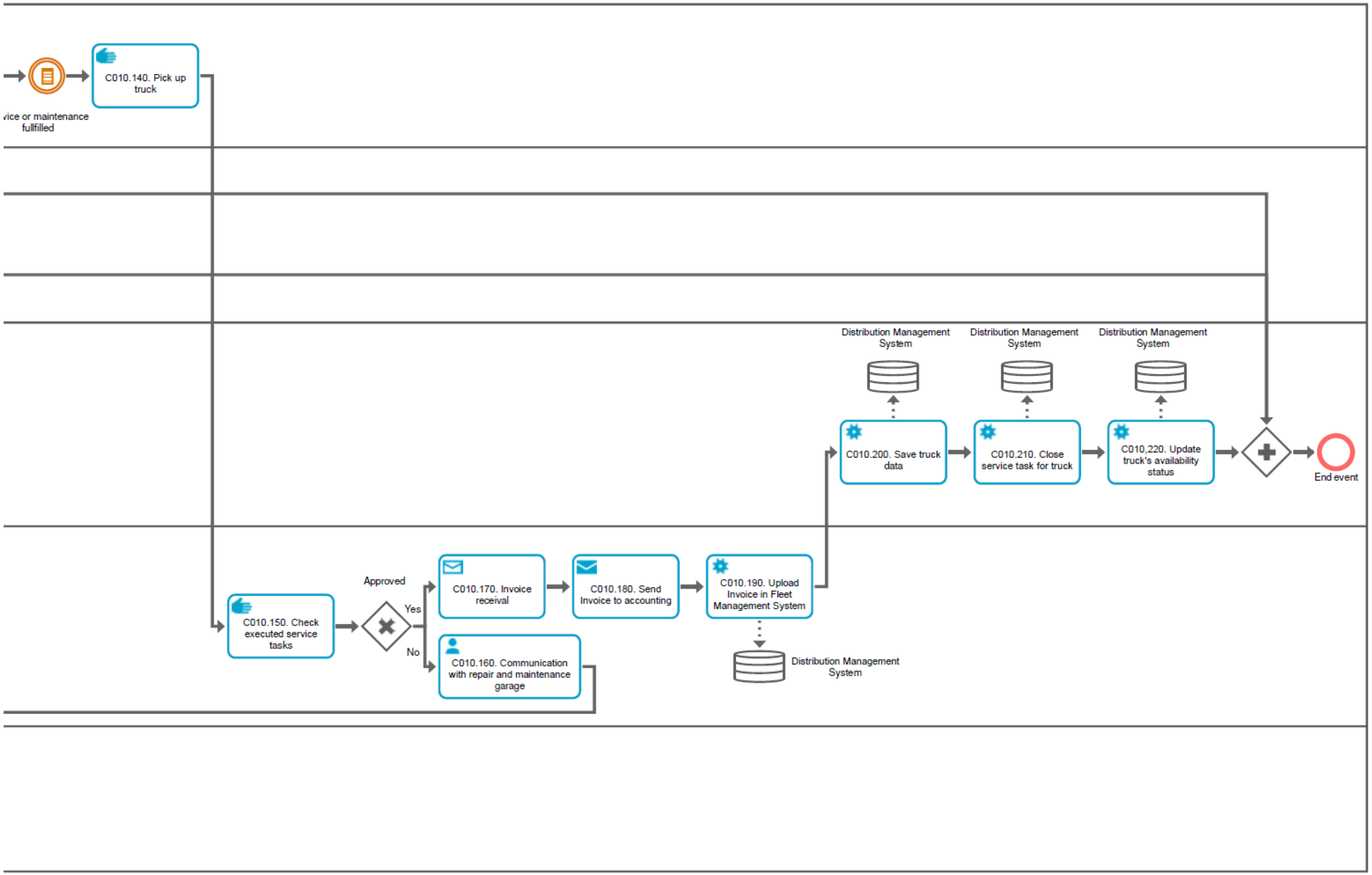
Table 4-15: Process Comparison B070

	As-Is Model	To-Be Model
Process Participants	• Distribution Planner • Shift Coordinator • Distribution office employee	• Distribution Management System • Distribution Planner • Shift Coordinator • Distribution office employee
#e-mails exchanged	5	4
#Automated activities	0/8	1/7

4.2.5.13. C010. Fleet Maintenance Planning




Distribution Department
Driver
Shift Coordinator
Fleet Management System
Fleet Manager
Distribution Manager
Malfunction occurance
C010.010. Communicate malfunction through smartphone
Distribution Management System
C010.130. Truck delivery
Service or maintenance fulfilled
Emergency distribution needed
C010.040. Receive notification for malfunction
Yes
No
C010.050. Send request foe emergency distribution
C010.060. Save unfulfilled inquiry for next shift's distribution planning
Distribution Management System
Weekly
C010.080. Generate weekly service report
C010.020. Insert malfunction event in Fleet Management System
C010.030. Send notification for malfunction
C010.070. Send service report
C010.120. Create open service task for trucks
C010.090. Service report receival
C010.100. Selection of Vehicle Repair and Maintenance Garage
C010.110. Selection approval


vice or maintenance fulfilled
C010.140. Pick up truck
Distribution Management System
Distribution Management System
Distribution Management System
C010.200. Save truck data
C010.210. Close service task for truck
C010,220. Update truck's availability status
End event
Approved
Yes
No
C010.150. Check executed service tasks
C010.170. Invoice receival
C010.180. Send Invoice to accounting
C010.190. Upload Invoice in Fleet Management System
C010.160. Communication with repair and maintenance garage
Distribution Management System

Main Changes

- ✓ All participants get informed automatically via smartphone application
- ✓ Trucks are independent entities in databases with their own profiles including all relevant information
- ✓ Reports are automatically created to inform the Fleet Manager
- ✓ Use of smart contracts with partners
- ✓ Fleet Management System tracks the process

Table 4-16: Process Comparison C010

	As-Is Model	To-Be Model
Process Participants	• Distribution Director • Fleet Manager • Distribution Manager • Driver	• Distribution Manager • Fleet Management System/ DMS • Shift Coordinator • Fleet Manager • Drivers
#e-mails exchanged	6	2
#Automated activities	0/19	10/19

Process Description

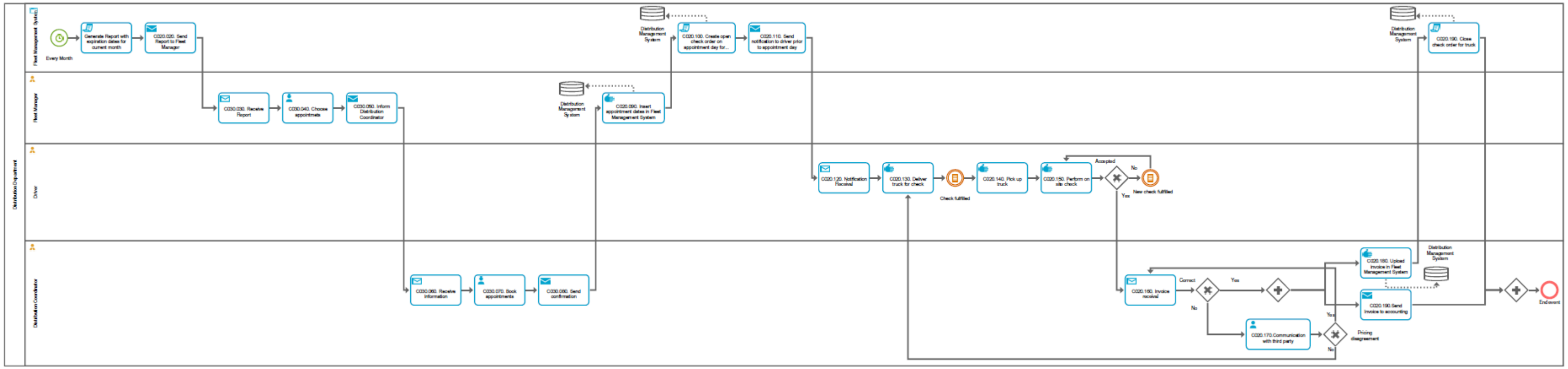
The Fleet Maintenance Planning Process start with two ways, either a scheduled service or because a malfunction occurred.

When a malfunction is realized by a Driver, the Driver reports it through the smartphone application, and it is automatically transferred in the Fleet Management System in the DMS flagging the truck as unavailable and in need of service. The Shift Coordinator receives notification for the malfunction and if the truck was scheduled for distribution, the Shift Coordinator decides if there is need for an emergency distribution or he saves the inquiries for the next Distribution Preparation and a service report is created automatically. Then, the process continues in the same way with the scheduled services.

Every week, the Fleet Management System creates a report with the services for the next week and the reports are sent to the Fleet Manager.

The Fleet Manager selects the Vehicle Repair &Service Garage according to the company's rules using the smart contracts they have with these partners. The Distribution Manager approves the selection through the smartphone application and the approval signals in the DMS the open service task for the trucks making them unavailable in the Fleet Management System for distribution assignments. Then, the service is performed and once the Fleet Manager's confirmation for correct service the invoice is received, forward to the accounting and uploaded in the trucks' profile in Fleet Management System. So, the cost, the last day of service and other data are automatically saved in the DMS and the status of the truck is changed to available. The payment is executed automatically once the Fleet Manager receives the invoice with the agreed amount of the smart contract and the accounting makes any appropriate changes regarding the invoice they receive.

4.2.5.14. C020. Tachograph, emission, and MOT certificate check



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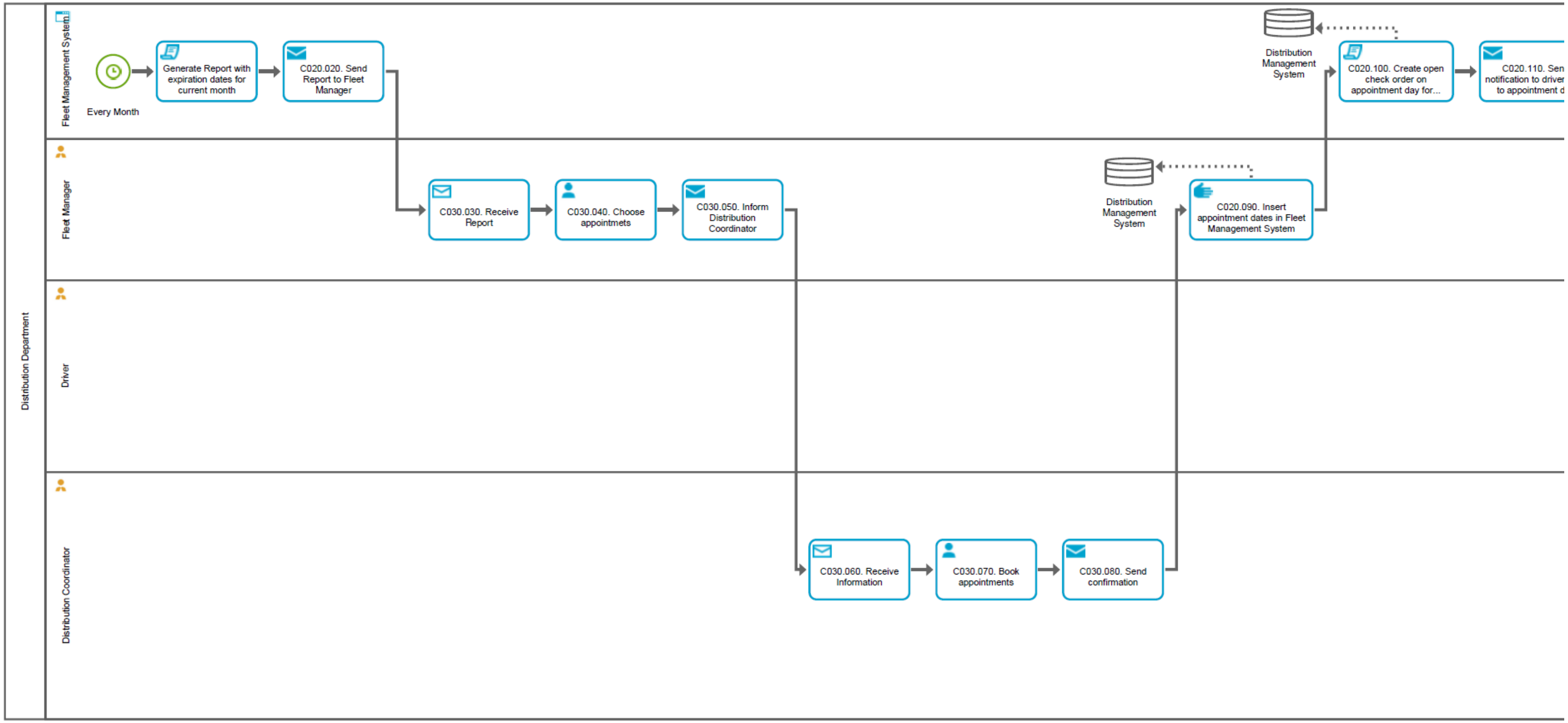
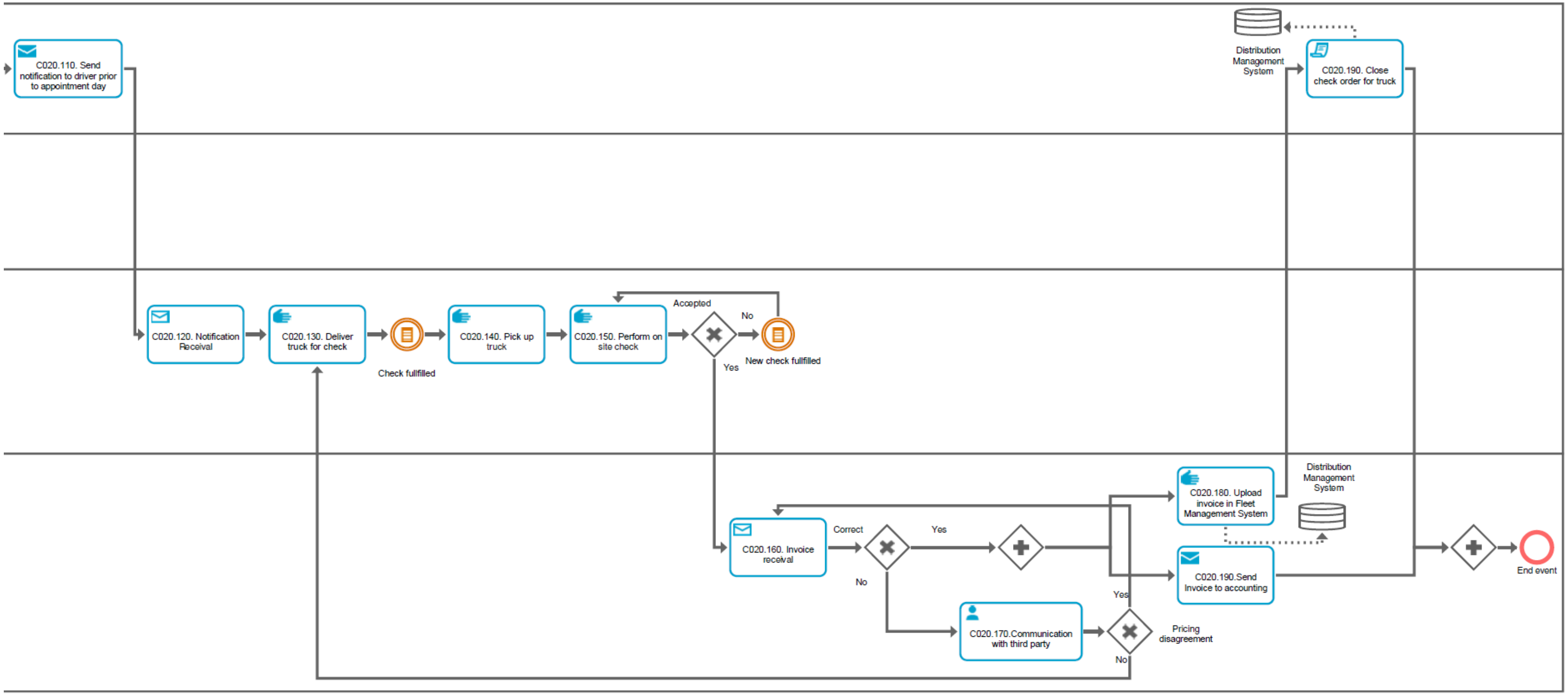


Distribution Department
Fleet Management System
Every Month
Generate Report with expiration dates for current month
C020.020. Send Report to Fleet Manager
Distribution Management System
C020.100. Create open check order on appointment day for...
C020.110. Sen notification to driver to appointment d
Fleet Manager
C030.030. Receive Report
C030.040. Choose appointmets
C030.050. Inform Distribution Coordinator
Distribution Management System
C020.090. Insert appointment dates in Fleet Management System
Driver
Distribution Coordinator
C030.060. Receive Information
C030.070. Book appointments
C030.080. Send confirmation


C020.110. Send notification to driver prior to appointment day
Distribution Management System
C020.190. Close check order for truck
C020.120. Notification Receival
C020.130. Deliver truck for check
Check fullfilled
C020.140. Pick up truck
C020.150. Perform on site check
Accepted
No
Yes
New check fullfilled
Distribution Management System
C020.180. Upload invoice in Fleet Management System
C020.160. Invoice receival
Correct
Yes
No
C020.190.Send Invoice to accounting
End event
Yes
C020.170.Communication with third party
Pricing disagreement
No

Main Changes

- ✓ All participants get informed automatically via smartphone application
- ✓ Trucks are independent entities in databases with their own profiles including all relevant information
- ✓ Reports are automatically created to inform the Fleet Manager
- ✓ Fleet Management System tracks the process
- ✓ Use of smart contracts with partners

Table 4-17: Process Comparison C020

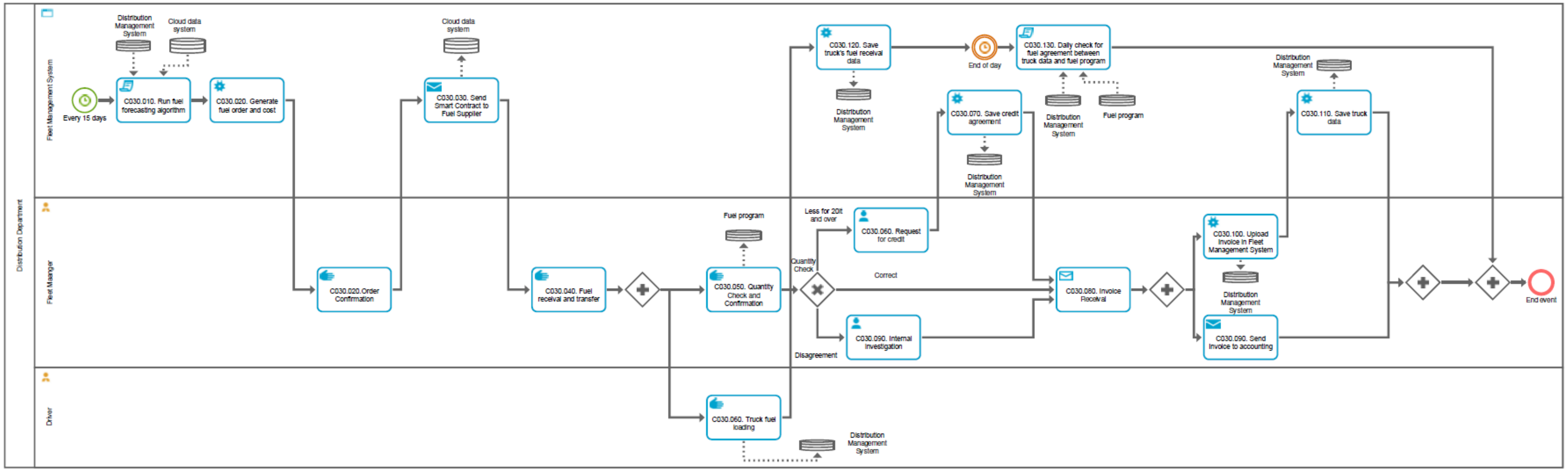
	As-Is Model	To-Be Model
Process Participants	• Fleet Manager • Driver	• Distribution Planner • Fleet Management System/ DMS • Fleet Manager • Drivers
#e-mails exchanged	4	2
#Automated activities	0/8	8/20

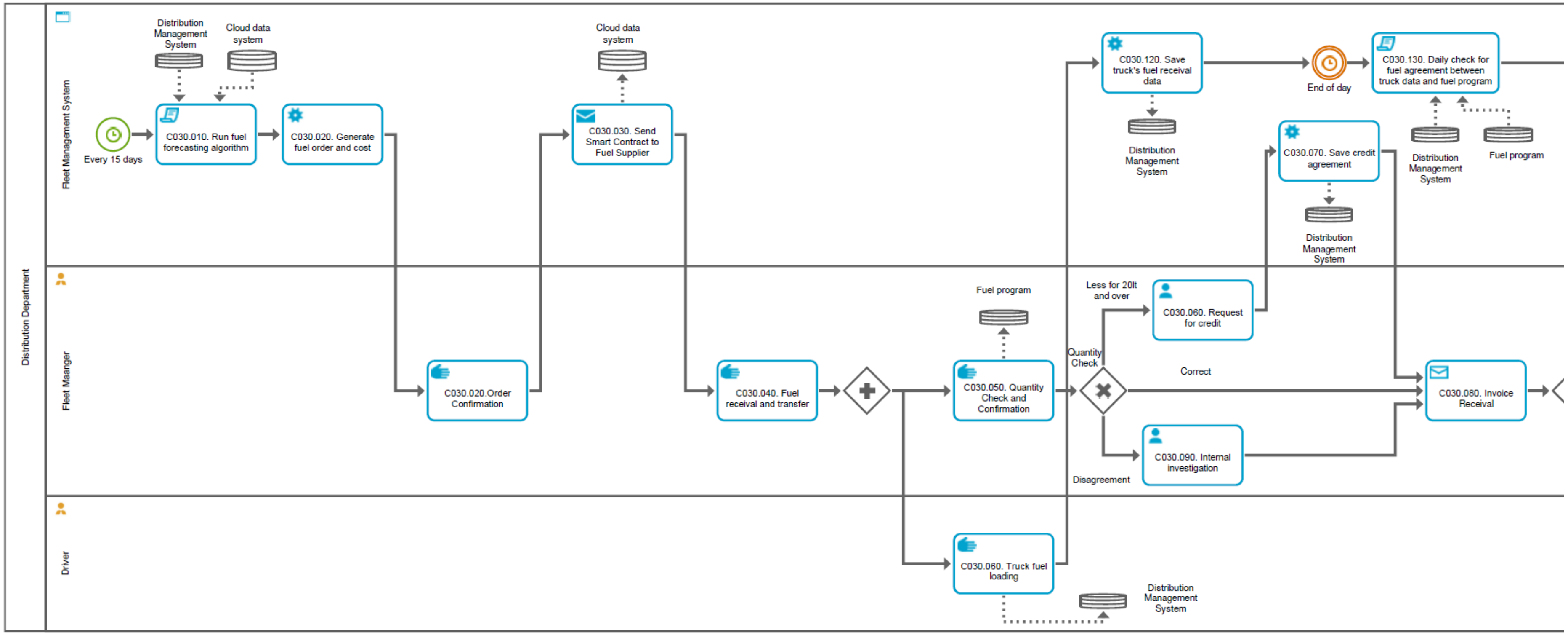
Process Description

Every month, the Fleet Management System generates a report for the current month's checks, and it is sent to the Fleet Manager. The Fleet Manager proposes dates for the appointments and the Distribution Planner makes the final decision. Once, the appointments are booked the Fleet Manager inserts the dates in the Fleet Management System and selects the active contracts.

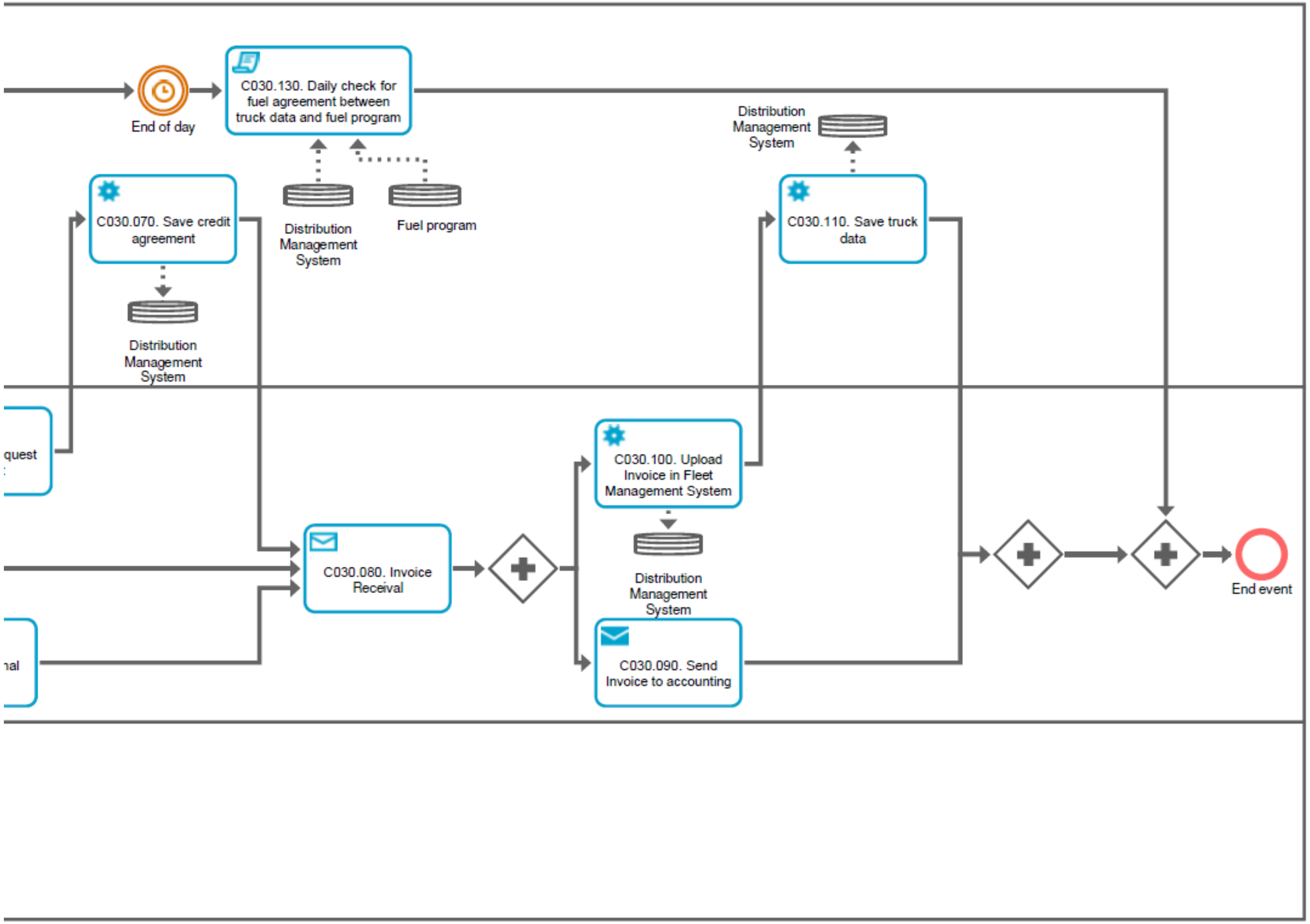
The Fleet Management System sends notification to the Driver one day before the appointment and the Driver transfers the truck for the checks. After all checks are completed the Distribution Planner receives the invoice and if it is correct it is sent to the accounting and uploaded on the Fleet Management. The payment is executed automatically by the amount on the smart contract which is the same with the invoice. The Distribution Management System automatically changes the truck's status once the invoice is uploaded.

4.2.5.15. C030. Fleet Fuel Loading




Distribution Department
Fleet Management System
Fleet Maanger
Driver
Distribution Management System
Cloud data system
Every 15 days
C030.010. Run fuel forecasting algorithm
C030.020. Generate fuel order and cost
C030.020.Order Confirmation
C030.030. Send Smart Contract to Fuel Supplier
C030.040. Fuel receival and transfer
Fuel program
C030.050. Quantity Check and Confirmation
C030.060. Truck fuel loading
Quantity Check
Less for 20lt and over
Correct
Disagreement
C030.060. Request for credit
C030.090. Internal investigation
C030.120. Save truck's fuel receival data
End of day
C030.070. Save credit agreement
C030.130. Daily check for fuel agreement between truck data and fuel program
C030.080. Invoice Receival

Athens 2021


End of day
C030.130. Daily check for fuel agreement between truck data and fuel program
Distribution Management System
Fuel program
C030.070. Save credit agreement
Distribution Management System
Distribution Management System
C030.110. Save truck data
quest
C030.100. Upload Invoice in Fleet Management System
C030.080. Invoice Receival
Distribution Management System
End event
nal
C030.090. Send Invoice to accounting

Main Changes

- ✓ Automated check for fuel usage systems agreement in the DMS
- ✓ Real time monitoring of fuel loading
- ✓ Use of smart contracts with suppliers
- ✓ Forecasting algorithm for fuel quantity
- ✓ Distribution Management System/Fleet Management System stores real time data for all trucks

Table 4-18: Process Comparison C030

	As-Is Model	To-Be Model
Process Participants	• Fleet Manager • Driver • Distribution Director	• Fleet Management System/ DMS • Fleet Manager • Drivers
#e-mails exchanged	4	0
#Automated activities	0/9	9/13

Process Description

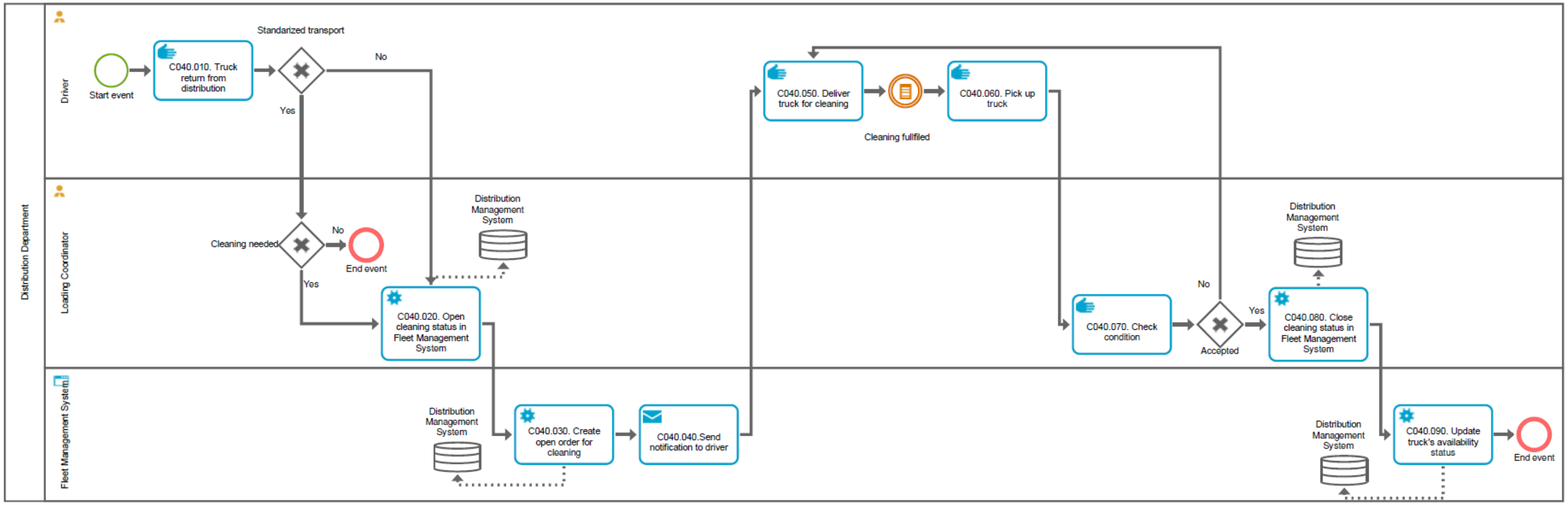
Every 15 days, the Fleet Management Systems runs the forecasting algorithm for the fuel usage using not only historic data but also weather data and other data for predictive algorithms. It then, creates an order with the corresponding cost according to the smart contracts with the suppliers.

The Fleet Manager confirms the order and the smart contract with the new order is sent automatically through the Fleet Management System. Then, the fuel is received and loaded in the company's depository and the process breaks down in two series of activities, the loading of the trucks and the confirmation of the fuel receival.

Regarding the fuel receival, the received quantity is measured and confirmed in the fuel program. If it is less for more than 20lt the Fleet Manager, requests the supplier for credit for the next order and the credit request is saved in the Fleet Management System. Once, the receival is conformed, the invoice is received, sent to the accounting, and uploaded in the DMS. The payment is executed automatically through the smart contract once the invoice is uploaded.

Regarding the trucks' fuel loading, the Driver transfers the truck to the depositor, and it is loaded. The loaded amount is automatically saved in the truck's data in the Fleet Management System. At the end of the day, the DMS extracts the report of the fuel loading of the day and does the check with the fuel program, to ensure that the quantities agree. In case of disagreement, they perform investigations to find the reason of the discrepancies.

4.2.5.16. C040. Fleet Cleaning



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Main Changes

- ✓ Distribution Management System/Fleet Management System stores real time data for all trucks
- ✓ Fleet Management System tracks the status of the process and notifies participants for activities

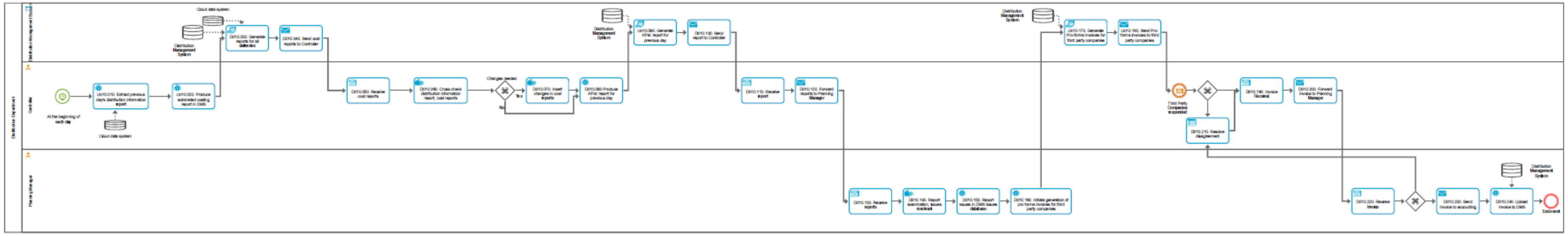
Table 4-19: Process Comparison C040

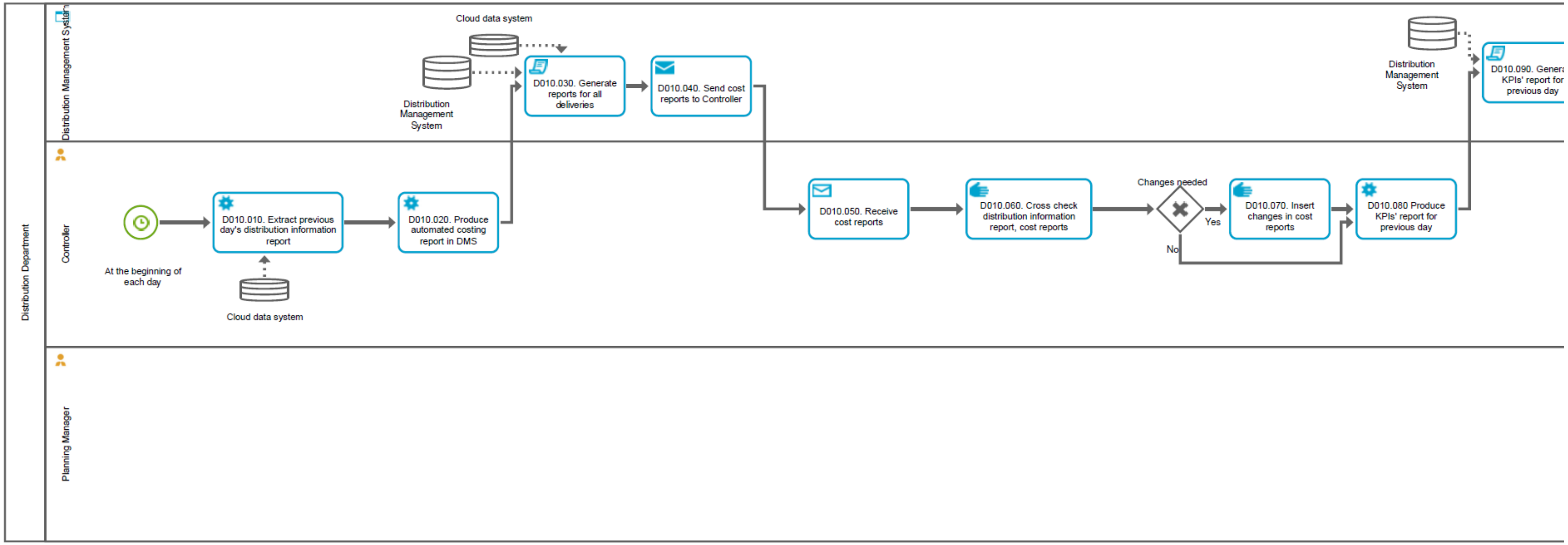
	As-Is Model	To-Be Model
Process Participants	• Drivers • Loading Coordinator	• Fleet Management System/ DMS • Loading Coordinator • Drivers
#e-mails exchanged	0	0
#Automated activities	0/3	3/9

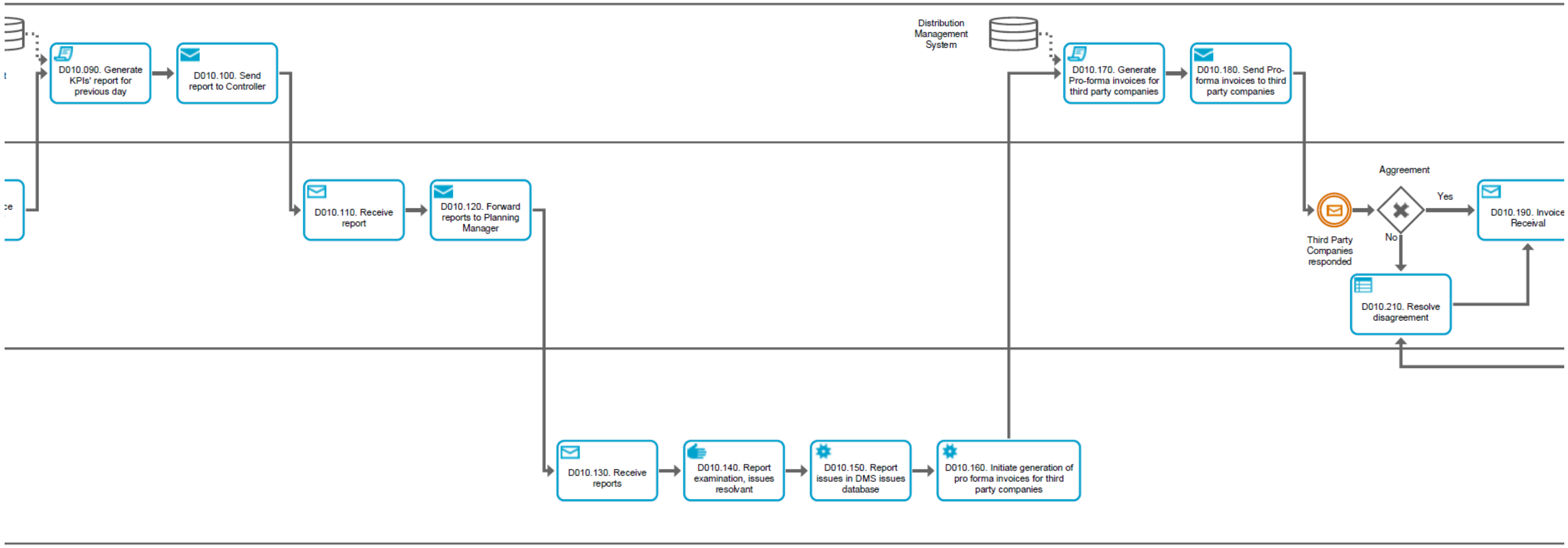
Process Description

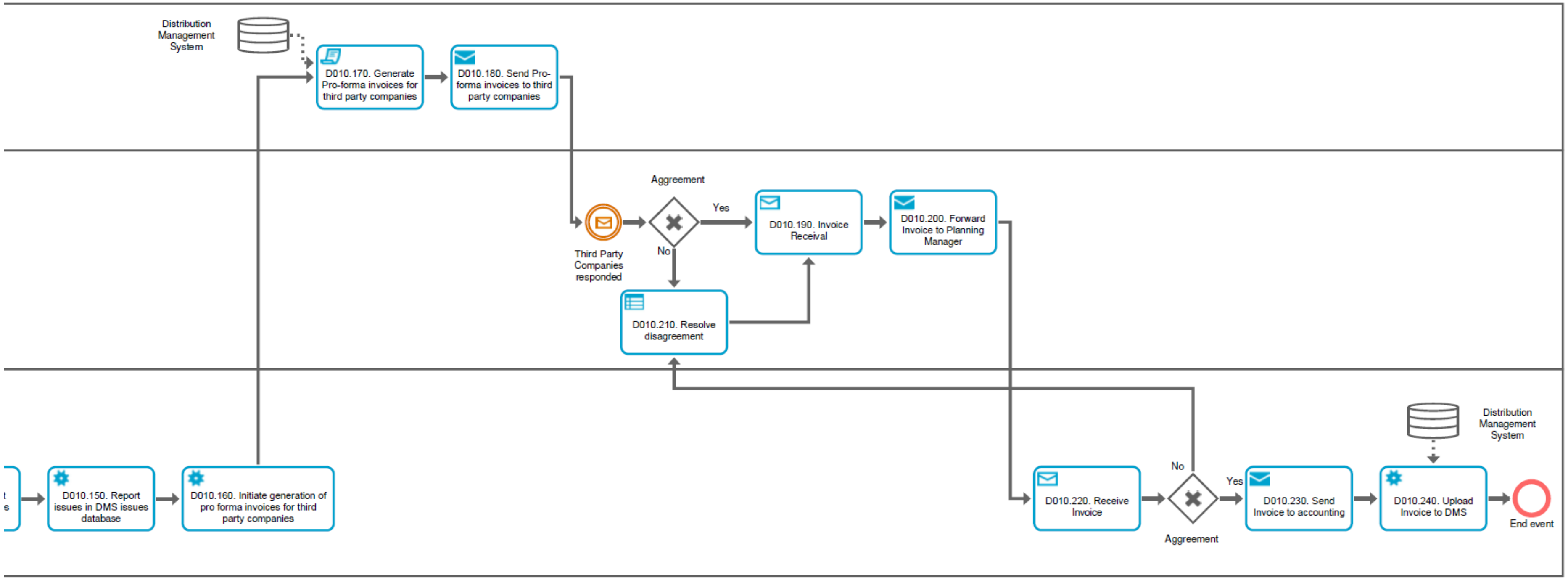
The Fleet Cleaning Process is not much different from the current process. The Driver returns the truck from the distributions and if the cargo is standardized, the Loading Coordinator decides if the truck needs cleaning. If the cargo is not standardized, cleaning is required. The Loading Coordinator opens in the Fleet Management System an open cleaning task for the truck. The Fleet Management System notifies the Driver to deliver the truck for cleaning. The Loading Coordinator checks the truck's condition after the cleaning and if it meets the standards, the Loading Coordinator closes the open cleaning task, and the truck is available again for assignment. The only change in this process is the use of the Fleet Management System for tracking the trucks' availability for assignment making more organized and systematic the processes.

4.2.5.17. D010. Distribution Costing






D010.090. Generate KPIs' report for previous day
D010.100. Send report to Controller
D010.110. Receive report
D010.120. Forward reports to Planning Manager
D010.130. Receive reports
D010.140. Report examination, issues resolvant
D010.150. Report issues in DMS issues database
D010.160. Initiate generation of pro forma invoices for third party companies
Distribution Management System
D010.170. Generate Pro-forma invoices for third party companies
D010.180. Send Pro-forma invoices to third party companies
Third Party Companies responded
Aggreement
Yes
No
D010.190. Invoice Receival
D010.210. Resolve disagreement



Distribution Management System
D010.170. Generate Pro-forma invoices for third party companies
D010.180. Send Pro-forma invoices to third party companies
Aggreement
Yes
No
Third Party Companies responded
D010.190. Invoice Receival
D010.200. Forward Invoice to Planning Manager
D010.210. Resolve disagreement
Distribution Management System
D010.150. Report issues in DMS issues database
D010.160. Initiate generation of pro forma invoices for third party companies
D010.220. Receive Invoice
No
Yes
Aggreement
D010.230. Send Invoice to accounting
D010.240. Upload Invoice to DMS
End event

Main Changes

- ✓ General report for all distributions, cost reports, KPIs' report and Pro-forma invoices for the third-party companies are automatically generated
- ✓ Any discrepancies in the reports are reported and investigated to ensure that manual changes are not needed and the correct information are always automatically retrieved
- ✓ Communication with third-party companies is minimized and only to resolve disagreements
- ✓ Smart contracts for automated payments

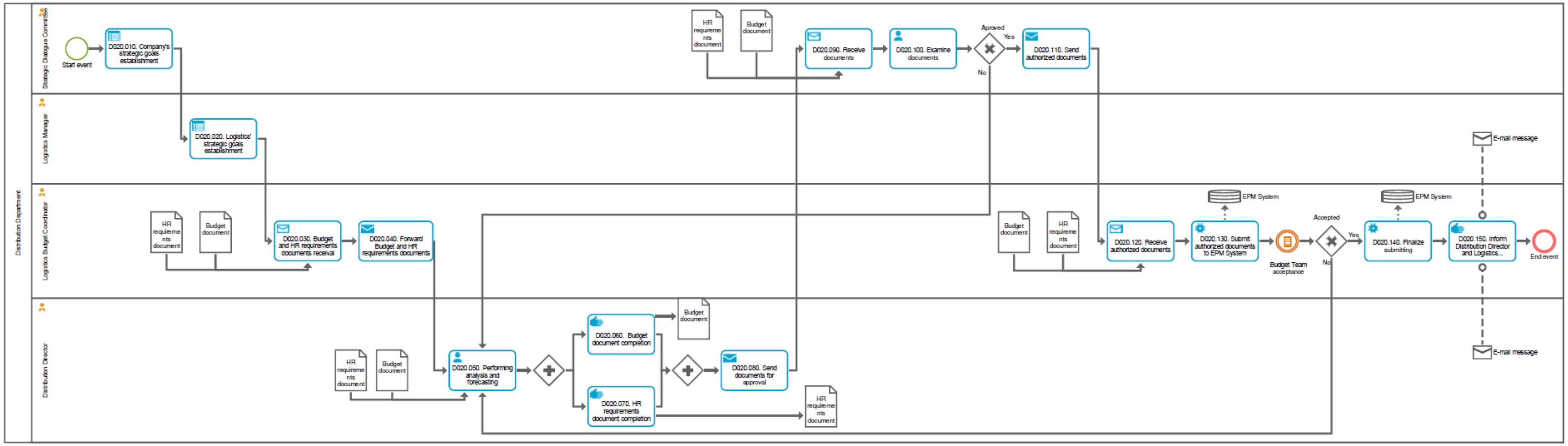
Table 4-20: Process Comparison D010

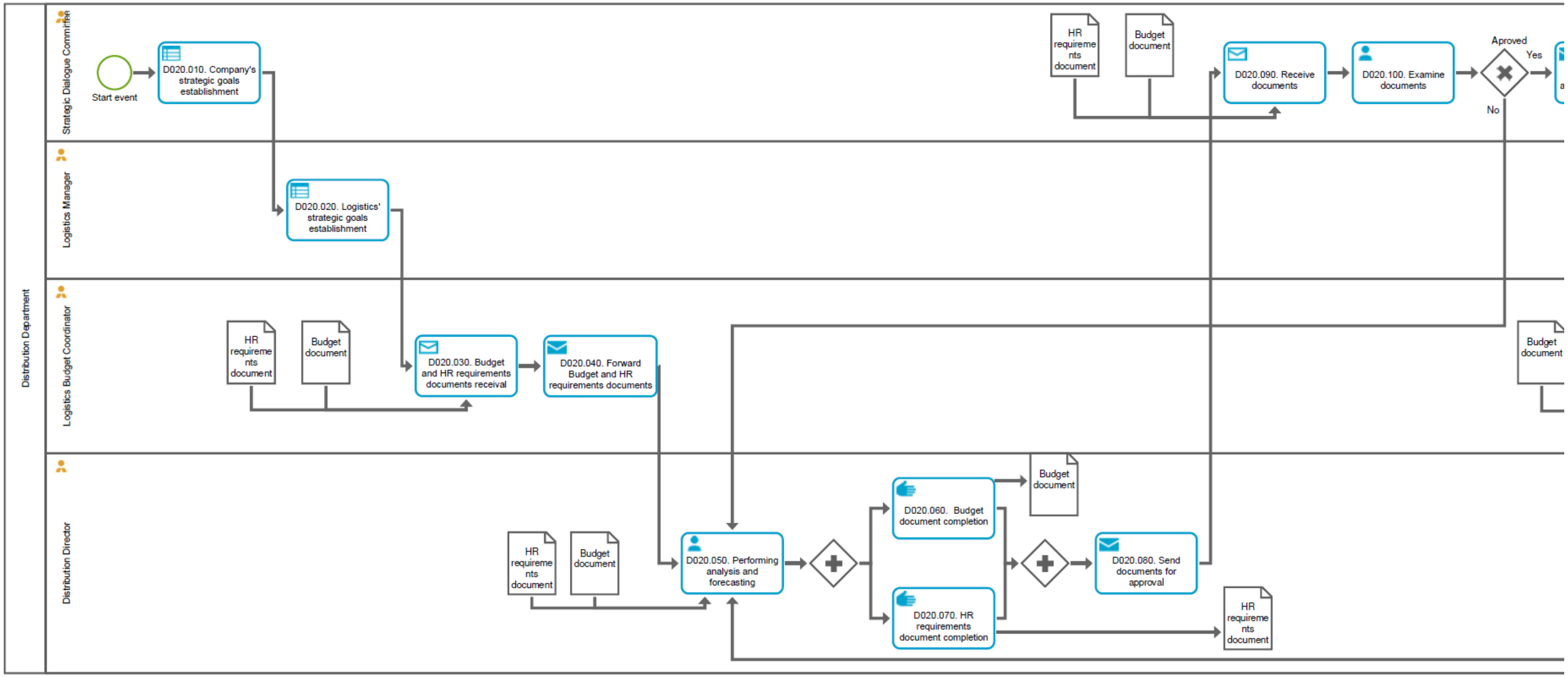
	As-Is Model	To-Be Model
Process Participants	• Planning Manager • Controller	• Distribution Management System • Planning Manager • Controller
#e-mails exchanged	5	2
#Automated activities	1/18	9/24

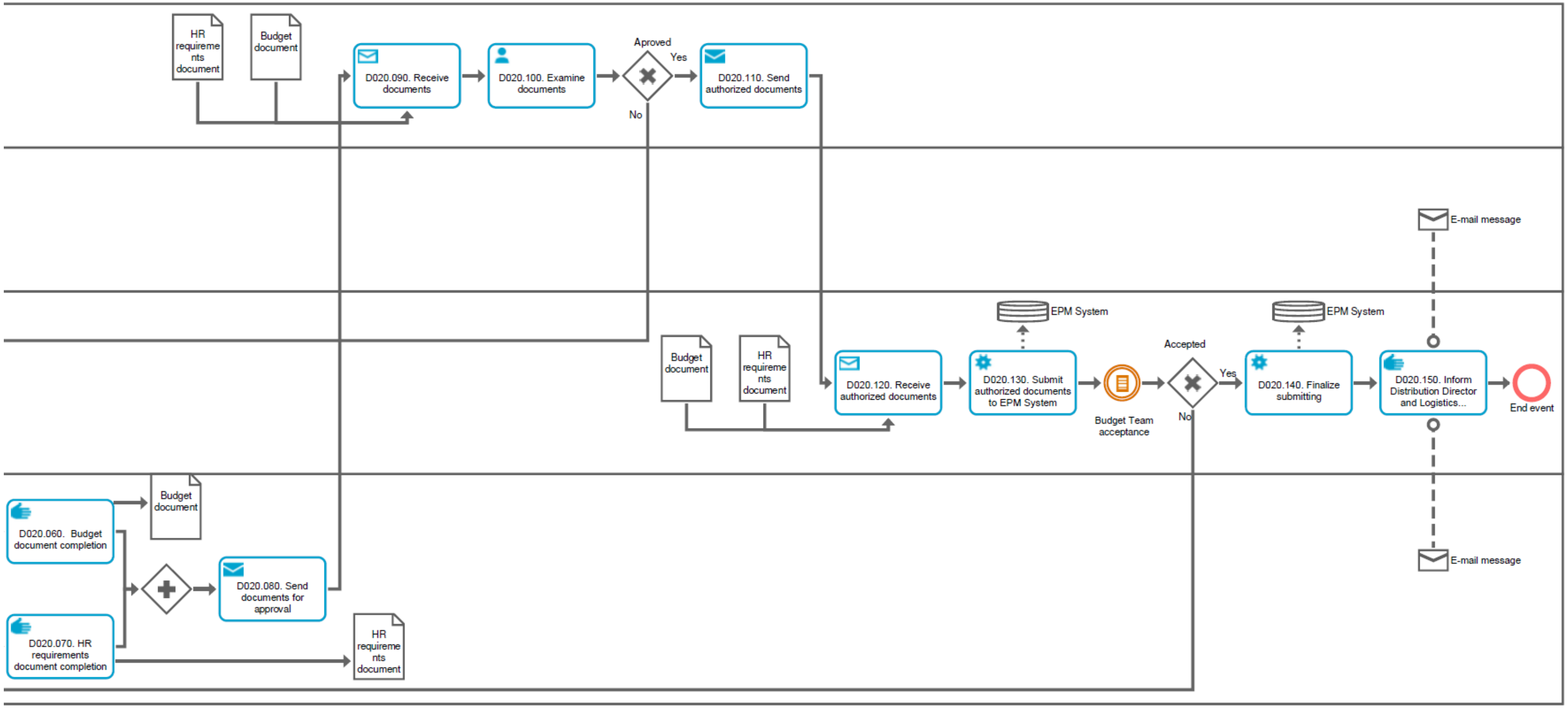
Process Description

Every day, the Controller extracts a general briefing report for the previous days distributions. The DMS generates the analytical cost report for the transportations and for the third-party companies. The Controller examines the completeness and correctness of the report and includes in the reports the changes if needed. Then, the KPIs' report is generated. The Controller sends all reports to the Planning Manager who resolves the discrepancies, makes the appropriate changes in the DMS and reports the reason of the discrepancies. After, the finalizing the DMS generates the pro-forma invoices for each third-party logistics company and send them. The companies reply by sending the official invoice and in case of disagreement it is resolved with the Controller. The invoice is sent to the Planning Manager and the accounting, and the Planning Manager uploads the invoice on the DMS. Once, the invoice is uploaded the smart contract is completed and automatically the payment is executed.

4.2.5.18. D020. Budgeting




Distribution Department
Strategic Dialogue Committee
Logistics Manager
Logistics Budget Coordinator
Distribution Director
Start event
D020.010. Company's strategic goals establishment
D020.020. Logistics' strategic goals establishment
HR requirements document
Budget document
D020.030. Budget and HR requirements documents receival
D020.040. Forward Budget and HR requirements documents
D020.050. Performing analysis and forecasting
D020.060. Budget document completion
D020.070. HR requirements document completion
D020.080. Send documents for approval
D020.090. Receive documents
D020.100. Examine documents
Aproved
Yes
No


HR requirements document
Budget document
D020.090. Receive documents
D020.100. Examine documents
Aproved
Yes
No
D020.110. Send authorized documents
E-mail message
EPM System
Budget document
HR requirements document
D020.120. Receive authorized documents
D020.130. Submit authorized documents to EPM System
Budget Team acceptance
Accepted
Yes
No
D020.140. Finalize submitting
D020.150. Inform Distribution Director and Logistics...
End event
D020.060. Budget document completion
D020.070. HR requirements document completion
D020.080. Send documents for approval
E-mail message

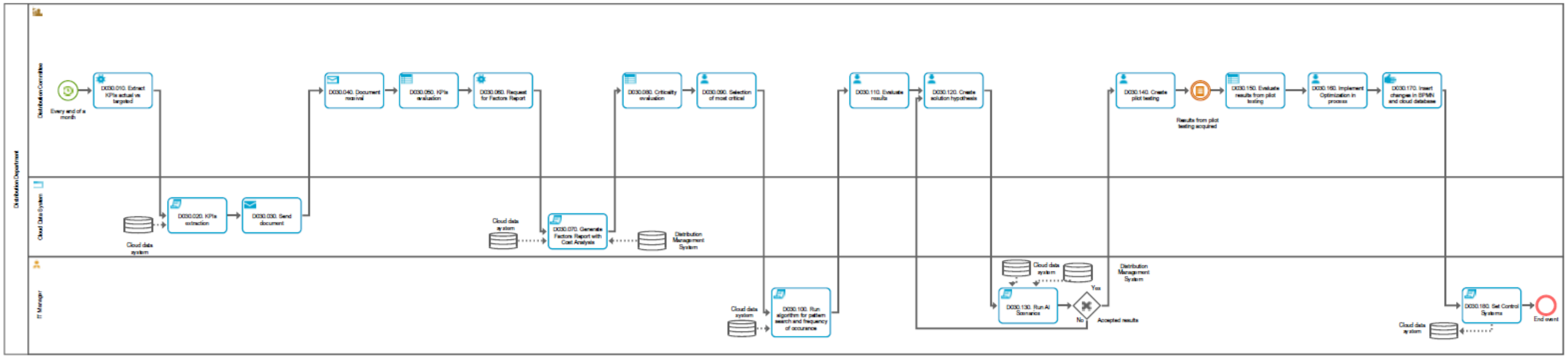
Main Changes

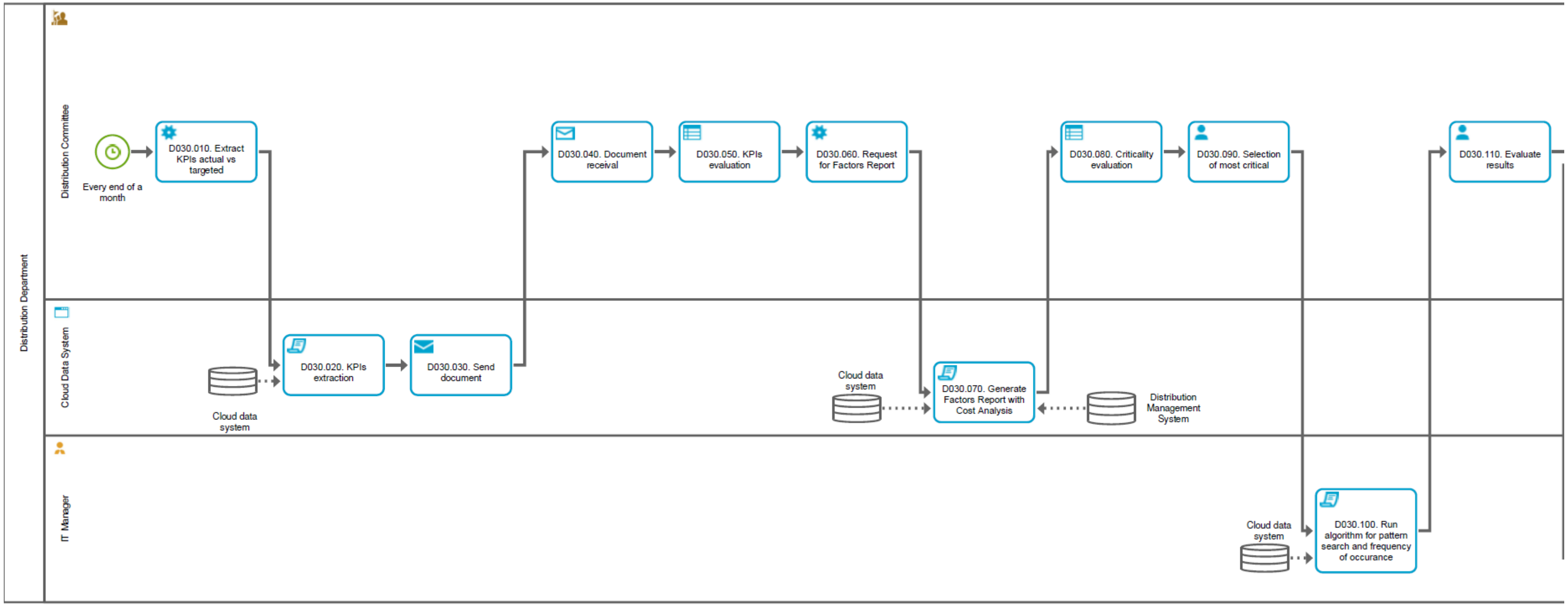
The Budgeting process remains the same regarding the activities. The only change is the way the analysis and forecasting are performed.

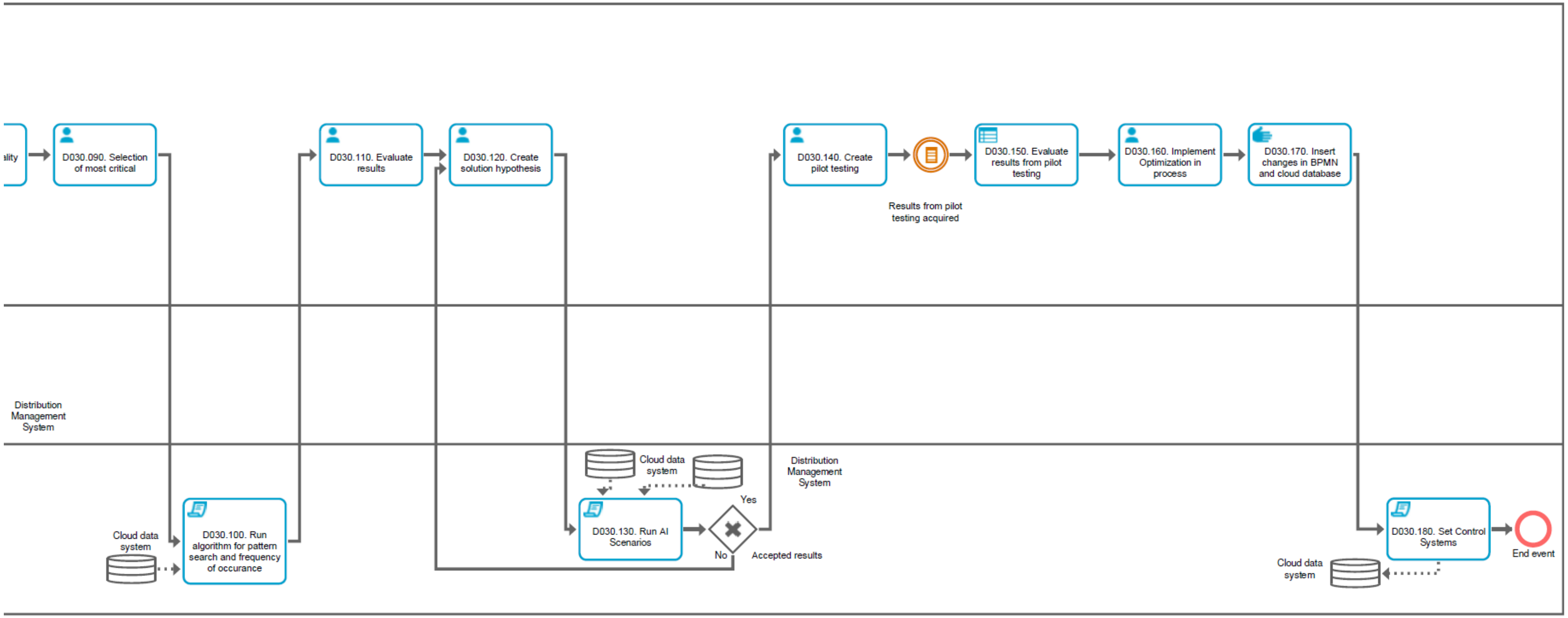
Currently, he Distribution Director performs analysis of the historic data available, macro and micro analysis, new trends and estimates the future needs of the Distribution Department using conventional forecasting and brainstorming. The new model provides more data for analysis and the trends estimation and future needs can be estimated using predictive analytics, analyzing information from social media, customers' profiling, stores' location data etc.

In general, all forecasting activities in the company will turn to predictive analytics and Machine Learning techniques.

4.2.5.19. D030. Monthly Process Monitoring




Distribution Department
Distribution Committee
Cloud Data System
IT Manager
Every end of a month
D030.010. Extract KPIs actual vs targeted
D030.020. KPIs extraction
D030.030. Send document
D030.040. Document receival
D030.050. KPIs evaluation
D030.060. Request for Factors Report
D030.070. Generate Factors Report with Cost Analysis
D030.080. Criticality evaluation
D030.090. Selection of most critical
D030.100. Run algorithm for pattern search and frequency of occurance
D030.110. Evaluate results
Cloud data system
Cloud data system
Distribution Management System
Cloud data system



ality
D030.090. Selection of most critical
D030.110. Evaluate results
D030.120. Create solution hypothesis
D030.140. Create pilot testing
Results from pilot testing acquired
D030.150. Evaluate results from pilot testing
D030.160. Implement Optimization in process
D030.170. Insert changes in BPMN and cloud database
Distribution Management System
Cloud data system
D030.100. Run algorithm for pattern search and frequency of occurance
Cloud data system
D030.130. Run AI Scenarios
Yes
No
Accepted results
Distribution Management System
D030.180. Set Control Systems
End event
Cloud data system

Main Changes

The current Distribution Processes Model does not involve a monitoring process. In the suggested Distribution Processes Model a Monthly Distribution Processes Monitoring process is included aiming to promote the constant improvement mindset, increase the optimization projects and provide a clearer overview and systematic monitoring of the processes.

The new process combines LSS tools and technological advancements such as AI scenarios to discover and apply solutions and optimization actions.

- ✓ A Distribution Committee is created with employees of different background and positions
- ✓ The IT Manager participates in the process to apply the investigative algorithms, to run the scenarios, to make the system changes and to set the control systems
- ✓ The saved data in the cloud database are used in the algorithms and to support the decision making
- ✓ Cloud ECP systems are used for the statistical analysis and the control systems

Table 4-21: Process Comparison D030

	As-Is Model	To-Be Model
Process Participants	N/A	• Distribution Management System • Distribution Committee • IT Manager
#Automated activities	N/A	3/18

Process Description

Every month, the Distribution Committee extracts from the DMS the KPIs' report (targeted vs actual) which they evaluate. For those KPIs' they select they extract a Factor Report with Cost Analysis. The Factors Report is a report which includes the specific process points with the worst performance and the Cost Analysis for the KPI. For example, for the loading cycle time, one of the KPIs the Factors Report will include those loadings which their duration was more than the targeted with the corresponding information for those loadings and the translation of the difference between targeted duration and actual duration in cost if applicable. Then, the Committee selects the most critical issue, and the IT Manager runs a pattern search and occurrence frequency algorithm. In the loading cycle time for example, the algorithm is going to search if there is a pattern in the loaded products, employees working in the loadings, error reported in the loading process etc. The Committee evaluates the results to decide the most critical causes and create a solution hypothesis. In the loading cycle time the results of the algorithm could be a specific Loading Coordinator and the number of pallet merges and splits. In this case, the Committee would evaluate the results and might decide that the cause is not the Loading Coordinator but the fact that too many pallet merges and splits are time consuming and if they exceed a specific number instead of beneficial, they create cost. After that they have to brainstorm and create a solution hypothesis.

If applicable, the IT Manager runs AI scenarios with the suggested changes and if the results are optimistic the Distribution Committee implements a pilot test of the solution in the process and using the DMS, the sensors, the Cloud Data System collect data to examine the results of the pilot test. If the wanted results are provided, the optimization is implemented in the process. The next step is to make the appropriate changes in the BPMN diagram and create and save the optimization project report in the Cloud Database which will be shared among the employees. Finally, the IT Manager sets the control systems to monitor the optimization and ensure that it is used and that the outcomes are the wanted ones.

4.2.6. Verify Phase

In the verify phase the New Distribution Processes Model was presented to the Stakeholders, Distribution Director and SVP of Logistics and it was accepted. Currently, the verified improved metrics are the automation rate which is increased from 4% to 64% and the number of exchanged emails which are decreased from 56 to 20 and only 11 out of 20 are manual, the rest are automated e-mails from the systems.

The objective is for the team to implement gradually in the near future the changes and measure the metrics to determine the success rate of the project. The new model provides the ability to easily monitor the desired metrics in a systematic way and aid in controlling the improvements. The stored data and information in the Cloud database system can be easily extracted and used in various real-time SPC software existing in the market to automatically create control charts, X-bars, Pareto charts etc. to monitor, control and verify the improvements of the proposed model.

The Distribution Processes model described succeeds in lowering the administrative cost. Although it is not easy to measure it, it is clear that by including more automated activities in the Distribution Processes, reducing the excessive documentation and changing the way the employers used to communicate, inform and authorize processes administrative cost is reduced. This model achieves to streamline, digitalize, and reduce several wastes in the Distribution Processes of the company. The increased digitalization of the processes changes several policies and procedures regarding suppliers, partners, third-party companies, and payments minimizing those expenses, and establishing better deals with them, thus minimizing also these costs. The new processes as mentioned also accomplish to reduce several wastes, such as the excessive documentation by introducing BCT, Smart Contracts, e-loading documents, e-consignment notes which are automatically created, shared, stored and updated and contain the need for multiple document creations, prints, copies and exchanges. With these technologies and the usage of smartphone application for intercommunication motion waste is also reduced, as the need for the employees to pass document from hand to hand is eliminated and e-mail communication is reduced, and several notifications are now automated. Reduction of transportation waste and cost is also succeded by using the suggested model. Thanks to the dynamic planning capabilities and the advanced fleet management capabilities, better truck utilization, decrease in order delays, increase in on-time deliveries, and better distribution combinations i.e., merging emergency deliveries with other small quantity deliveries are accomplished. Concurrently, the advanced forecasting capabilities of such systems offer better order accuracy, demand estimation, abnormalities detection, and workload management thus reducing emergency orders, DCs' schedule changes and offering better HR utilization. Better HR utilization is not only succeeded by minimizing their idle time and allocating employees to DCs according to the workload but also by using the smartphone application for better training and directions offering during the activities execution to meet the employees' fullest potential. Moreover, wait waste is also reduced not only from minimizing order's delay but also from better maintenance scheduling resulting to less unexpected machine, truck's breakdown and also to having a constant overview of available trucks and not wasting time to find which trucks are available.

Apart from these direct improvements in the Distribution Processes, the new Distribution Processes Model with the increased digitalization and utilization of new technologies successfully establishes Critical Success Factors (CSFs) for LSS projects, overcomes various LSS barriers and improves the Distribution Processes' leanness. This way the model supports the increase of number of LSS Projects and ensures the success of the future LSS Projects in the whole supply chain of the company and especially in the Distribution Processes. Finally, the new Model supports the future LSS Projects by supporting the different phases of the methods used in such projects i.e., DMAIC and DMAEV. The new technologies used in the model provide the necessary means for each phase and more sophisticated ways to implement the LSS tools as discussed in the literature review extensively.

Regarding the CSFs established, the previously described technologies used in the new model give unlimited access to quality data and information both internal and external. Also, more accurate results are drawn by the sophisticated and advance analytic methods and continuous and accurate KPIs' measurement is attained. Constant control and overview of past, on-going and future LSS projects is offered not only from the monitoring and control systems but also from the existence of monitoring processes and the establishment of a Distribution Committee in charge for these. The development of an Enterprise BPMN collaboration diagram, the exploitation of Blockchain Technologies and the utilization of a smartphone application provides better documentation of the business processes and procedures establishing another CSF for the LSS Projects. Furthermore, the Distribution Committee and the new processes for damaged products handling and monthly KPIs' monitoring boost the CI and innovative mindset of the organization and create a more quality based organizational structure. The involvement of the IT Manager in these new processes and the support of the IT systems in all processes create a supportive internal infrastructure for the LSS Projects and all these are few other CSF as mentioned in the literature review. Last but not least, the systems, software and applications used in the processes are interconnective and collaborative establishing another factor for the successful implementation of LSS Projects.

The increased digitalization and new technologies involvement also aid in overcoming multiple LSS barriers and this hypothesis is confirmed in this model. The implementation of the model instantly overcomes the lack of IT implementation and insufficient existence of new technologies and initiatives. The development of an Enterprise BPMN collaboration diagram instantly provides details for the processes' ownership and a clear picture for responsibilities and roles. Thus, easily helping the organization to overcome four serious LSS barriers. The automation in many activities improves the standardization in processes another crucial barrier. The real time SPC software offers process control, effective statistical and visual control systems and constant feedback for the processes. The sustainability of the optimizations is achieved not only from the SPC software but also from the detailed reporting of the changes which is saved in the Cloud Platform and shared among the organization for all level employees to know the issues the company faced, and the changes made, once again promoting the CI mindset. Finally, the BCT, e-loading documents, smartphone application, DMS, WMS and ERP are helping overcome the lack of transparency, traceability in the processes, the lack of effective communication between employees, partners etc., the lack of visibility and monitoring of the marketing activities and the insufficient monitoring of process times such as delivery time, loading time etc. The smartphone application improves the effectiveness of the communication by making it easier to send notifications, track the communication and have automatic communication options. The combination of the smartphone application and the e-loading documents offer high transparency and traceability in the processes and make easier to monitor each step of the process with the status confirmation feature. The Cloud ERP and the connectivity with the other systems also increase the traceability of the processes and the visibility of the marketing activities as the Warehouses have real-time data regarding the stock level of each store and so on and so forth.

Improving the leanness of the Distribution Processes is another goal of the new model in order to prepare a suitable environment for LSS Projects. As Haddud and Khare in their research paper confirmed the positive impact of digitalization of SC with the improved leanness of the SC by positively affecting JIT, VM, TPM, CI, and automation and Poke-Yoke also the proposed Distribution Processes model due to the increased digitalization of the processes improves the leanness of the Distribution Processes. Visual Management is improved as the systems used in the proposed model make activities and processes visible and abnormalities, performance gaps and errors are easily and timely identified. Just-In-Time strategy is also improved with increased accuracy of forecasting and the dynamic planning. The new processes and sub-processes improve the Continuous Improvements by every time wastes, errors or abnormalities are identified they include all level employees and try to find quick solutions to eliminate them. Automation and Poke-Yoke is positively influenced by the tremendous increase of process automation rate and the monitoring technologies uses in the processes.

All these derive from the description of the activities and the new model. The next step is for the company to include these proposals and back all the described results with data and numbers.

5. CONCLUSION

In this thesis an improved Distribution Processes Model is developed for a leading Greek Supermarket company by utilizing the DMAEV designed for LSS methodology and includes new technological advancements and an increase in SC digitalization. This model proposes a way by using the DMAEV approach to follow when trying to improve their processes by including new technologies and digital transformation. It gives guidelines on how the LSS methodology can be used to gradually digitalize the supply chain. It also outlines that the outcomes of using new technologies in the Supply Chain and of digitalizing it, are establishing numerous Critical Success Factors for the LSS projects and help to overcome many barriers of the LSS. Hence, LSS projects and mindset can benefit from them, and companies can create a fertile environment for future LSS Projects for process optimization. Instead of just starting a new investment for innovation in the SC, this model proposes a step-by-step methodology on how to effectively introduce innovations, how to select the area of the optimization, the project and on which technologies to invest.

Through the literature review and the case study the two-way positive influence of new technologies and LSS are established. It would be interesting for future research to examine this correlation between these notions both qualitatively with surveys in different sectors and quantitively in companies which include new technologies and perform LSS projects. Unfortunately, in the supermarket sector, which is examined in this thesis, companies are not familiar with the LSS methodology, and such optimization projects have not taken place. Furthermore, limited technologies are used in the Supermarket Supply Chain in Greece currently. So, this model based on the LSS principles is the first attempt to examine possible LSS projects in the Supermarket Supply Chain and involvement of state-of-art technologies in it.

This Distribution Processes model help the Supermarket Company to streamline their Distribution Processes, find potential areas for improvement, and proposes advanced technologies used by other retail companies in the Supply Chain not only to improve the current performance but also to create an LSS mindset, understand the LSS methodology and give them the required means to implement such projects in the future. Processes included in this model are also achieving to evolve the CI mindset of the company and help in including employees in more projects.

Also, the proposed technologies are indeed successful in increasing the automation and digitalization of the Distribution Processes, while improving the documentation of the processes and reducing administrative and distribution costs and various wastes.

It would be of interest for future research in order to see the condition of all the Greek Supermarkets regarding LSS initiatives and new technologies involvement to perform a qualitative research with the questionnaire used for this case study to extract safer results for their needs. Additionally, it would be beneficial to extend this model to the whole supply chain of the supermarkets and create a Reference Model for their business processes based on the LSS principles. A next step for this thesis it could also be to implement the proposed changes and extract more data to prove the described outcomes.

What is also realized by this case study is the importance of mapping and documenting the business processes prior trying to implement improvements. My understanding is that although LSS applications can be beneficial for process improvement, cannot be applied without first mapping the processes, understanding all the involved parties, and creating ways to constantly gather process data. In Greece, most supermarkets use ad-hoc solutions and very few have created Business Process Models. Empirically, they know the duration of the processes, but they do not have systematic ways to capture these data. To implement successful LSS projects having available data and mapped processes are the two very important factors.

Finally, by including new technologies in processes, the way employees execute their activities is affected. As it is known it is difficult to change the way that employees have get used to work, especially in lower levels. Reluctance in changes is a very important factor in process optimization and reengineering. So, before implementing any changes it is imperative for the company's management team to have a well-structured plan of how to motivate and include employees in these changes and later on train them without reducing productivity and disrupting the normal flow of the daily operations. To do so, I would suggest that companies who want to implement LSS projects and/or include new technologies in processes should have a department work on such projects always including at least one Green Belt in the team. Process optimization is not a one-time project but rather a continuous process.

In conclusion, Lean Six Sigma methodology can be used in changing the Supply Chain Processes and including new technologies effectively and at the same time these new technologies can further enable the Lean Six Sigma projects for process optimization and the company's CI mentality.

6. APPENDIXES

6.1 APPENDIX I: Questionnaire

Ερωτηματολόγιο

1. Γενικά Στοιχεία εταιρείας

1.1. Όνομα Εταιρείας:

1.2. Αριθμός εργαζομένων

- 0-250
- 250-500
- 501-1000
- 1001-3000
- 3001-5000
- >5001

1.3. Αριθμός Καταστημάτων

- 0-50
- 51-100
- 101-150
- 151-200
- 201-250
- 251-300
- >301

1.4. Τίτλος Θέσης ερωτώμενου

2. Γενικές Ερωτήσεις για την Εφοδιαστική Αλυσίδα

2.1. Είναι σημαντική η εύρυθμη λειτουργία της Εφοδιαστικής Αλυσίδας για την Εταιρεία σας;

- Καθόλου
- Λίγο
- Αρκετά

- Πολύ
- Πάρα Πολύ

2.2. Είναι σημαντική η σωστή οργάνωση της Εφοδιαστικής Αλυσίδας για την Εταιρείας σας;

- Καθόλου
- Λίγο
- Αρκετά
- Πολύ
- Πάρα Πολύ

2.3. Πιστεύετε ότι η σωστή οργάνωση της Εφοδιαστικής Αλυσίδας προσφέρει συγκριτικό πλεονέκτημα σε σχέση με τον ανταγωνισμό;

- Καθόλου
- Λίγο
- Αρκετά
- Πολύ
- Πάρα Πολύ

2.4. Ποιο είναι το μοντέλο οργάνωσης της Εφοδιαστικής Αλυσίδας της Εταιρείας σας;

- Μία κεντρική αποθήκη για διανομή σε όλη την Ελλάδα
- Περισσότερες από μία αποθήκες σε διαφορετικές τοποθεσίες για διανομή σε όλη την Ελλάδα
- Μία κεντρική αποθήκη με ενδιάμεσα σημεία διανομής
- Παραπάνω από μία κεντρικές αποθήκες με ενδιάμεσα σημεία διανομής

2.5. Ποιες τεχνολογικές μεθόδους χρησιμοποιείται για την λειτουργία και την οργάνωση της Εφοδιαστικής σας Αλυσίδας;

- Πληροφοριακά Συστήματα
- Εφαρμογές Τεχνητής Νοημοσύνης
- Συστήματα Παρακολούθησης Προϊόντων
- Ηλεκτρονικό Σύστημα Παραγγελιών

2.6. Ποια τα οφέλη από τη χρήση των συγκεκριμένων τεχνολογιών;

- Μείωση κόστους
- Εξοικονόμηση χρόνου
- Διευκόλυνση εργαζομένων
- Αποδοτικότερη λειτουργία εφοδιαστικής αλυσίδας

2.7. Γνωρίζετε για την τάση υιοθέτησης τεχνολογιών Industry 4.0 και Internet of Things στην Εφοδιαστική Αλυσίδα των Supermarkets;

- Ναι
- Όχι

2.8. Πιστεύετε ότι θα βοηθούσε η εισαγωγή των συγκεκριμένων τεχνολογιών την Εφοδιαστική Αλυσίδα της Εταιρείας σας;

- Καθόλου
- Λίγο
- Αρκετά
- Πολύ
- Πάρα Πολύ

2.9. Ποια πιστεύετε ότι θα ήταν τα οφέλη από την υιοθέτηση των συγκεκριμένων τεχνολογιών;

- Μείωση κόστους
- Εξοικονόμηση χρόνου
- Διευκόλυνση εργαζομένων
- Καλύτερη οργάνωση της εφοδιαστικής αλυσίδας
- Καλύτερη εξυπηρέτηση των πελατών

2.10. Έχει η Εταιρεία καταγεγραμμένες διαδικασίες οργάνωσης και λειτουργίας της Εφοδιαστικής Αλυσίδας;

- Ναι
- Όχι

3. Ερωτήσεις για Έργα Βελτίωσης Εφοδιαστικής Αλυσίδας

3.1. Έχουν πραγματοποιηθεί έργα Βελτίωσης της Εφοδιαστικής Αλυσίδας;

- Ναι
- Όχι

3.2. Αν ναι, πόσα;

3.3. Με ποιόν τρόπο βελτιώθηκε η οργάνωση και η λειτουργία της Εφοδιαστικής Αλυσίδας;

- Εισαγωγή Πληροφοριακών Συστημάτων
- Ανασχεδιασμός Διαδικασιών
- Εισαγωγή προηγμένων τεχνολογιών
- Αλλαγές οργάνωσης

3.4. Σε ποια κομμάτια της Εφοδιαστικής Αλυσίδας χρειάστηκε να πραγματοποιηθούν έργα Βελτίωσης;

- Παραλαβή εμπορευμάτων από προμηθευτή
- Αποθήκευση
- Διανομή στα καταστήματα
- Επιστροφή μη πωληθέντων προϊόντων

3.5. Βοήθησαν τα έργα στη Βελτίωση της λειτουργίας της Εφοδιαστικής Αλυσίδας;

- Καθόλου
- Λίγο
- Αρκετά
- Πολύ
- Πάρα Πολύ

3.6. Με ποιόν τρόπο τα έργα Βελτίωσης επηρέασαν θετικά τη λειτουργία της Εφοδιαστικής Αλυσίδας;

- Καλύτερη οργάνωση
- Αύξηση δεικτών απόδοσης
- Μείωση κόστους
- Αύξηση Εσόδων
- Υψηλότερη αποδοτικότητα εργαζομένων
- Αύξηση ικανοποίησης πελατών

3.7. Ήταν οι βελτιώσεις της Εφοδιαστικής Αλυσίδας σημαντικές για την πιο εύρυθμη λειτουργία της εταιρείας;

- Καθόλου
- Λίγο
- Αρκετά
- Πολύ
- Πάρα Πολύ

4. Ερωτήσεις σχετικά με την έννοια της Συνεχούς Βελτίωσης;

4.1. Γνωρίζετε την έννοια της Συνεχούς Βελτίωσης και πως αυτή εφαρμόζεται στις Επιχειρησιακές Διαδικασίες;

- Ναι
- Όχι

4.2. Πιστεύετε ότι είναι χρήσιμο να πραγματοποιούνται έργα Συνεχούς Βελτίωσης στην Εφοδιαστική Αλυσίδα της Εταιρείας σας;

- Καθόλου
- Λίγο
- Αρκετά
- Πολύ
- Πάρα Πολύ

4.3. Υπάρχει η νοοτροπία της Συνεχούς Βελτίωσης στην οργάνωση και τη λειτουργία της Εφοδιαστικής Αλυσίδας;

- Καθόλου
- Λίγο
- Αρκετά
- Πολύ
- Πάρα Πολύ

4.4. Αν ναι, με ποιους τρόπους διαχέεται αυτή η νοοτροπία ανάμεσα στους εργαζόμενους;

- Εκπαίδευση Εργαζομένων

- Είναι στη στρατηγική και την κουλτούρας της Εταιρείας
- Από τους προϊστάμενους ή τους παλαιότερους εργαζόμενους προς τους νεότερους
- Μέσω προτροπής προς τους εργαζόμενους για νέες ιδέες

4.5. Πραγματοποιούνται Έργα Συνεχούς Βελτίωσης της Εφοδιαστικής Αλυσίδας στην Εταιρείας σας;

- Ναι
- Όχι

4.6. Αν ναι, πόσα έργα Συνεχούς Βελτίωσης πραγματοποιούνται περίπου το χρόνο;

4.7. Αν ναι, ποιο είναι το ύψος του budget που δαπανάται σε τέτοιου είδους έργα;

4.8. Ποια είναι τα οφέλη από τα έργα Συνεχούς Βελτίωσης της Εφοδιαστικής Αλυσίδας;

- Μείωση Κόστους
- Αύξηση αποδοτικότητας
- Αύξηση Εσόδων
- Καλύτερη Διαχείριση μεταφοράς και διανομής προϊόντων
- Μεγαλύτερη ικανοποίηση πελατών
- Διευκόλυνση της εργασίας των εργαζομένων
- Καλύτερη οργάνωση

4.9. Ποιοι πιστεύετε ότι είναι οι Κρίσιμοι Παράγοντες που επηρεάζουν την υιοθέτηση της νοοτροπίας Συνεχούς Βελτίωσης στην Εφοδιαστική Αλυσίδα της Εταιρείας σας;

- Ύπαρξη νοοτροπίας Συνεχούς Βελτίωσης σε όλα τα ιεραρχικά κλιμάκια
- Εκπαίδευση Εργαζομένων
- Αλλαγή κουλτούρας στην Εταιρεία
- Εναρμόνιση στρατηγικών στόχων με τη λογική της Συνεχούς Βελτίωσης
- Συμμετοχή της διοίκησης στις πρωτοβουλίες Συνεχούς Βελτίωσης

4.10. Ποιοι παράγοντες πιστεύετε ότι δρουν ανασταλτικά στην υιοθέτηση της νοοτροπίας της Συνεχούς Βελτίωσης;

- Μη εμπλοκή της ανώτατης διοίκησης στη διάχυση της
- Έλλειψη Εκπαίδευσης
- Λάθος επιλογή έργων προς Βελτίωση
- Έλλειψη επικοινωνίας
- Αντίσταση στην υιοθέτησή της
- Υψηλό κόστος έργων
- Χρονοβόρα έργα
- Έλλειψη γνώσης

5. *Ερωτήσεις σχετικά με το Lean Six Sigma*

5.1. Γνωρίζετε το Lean Six Sigma ως μεθοδολογία Συνεχούς Βελτίωσης;

- Ναι
- Όχι

5.2. Έχουν πραγματοποιηθεί έργα Συνεχούς Βελτίωσης για Βελτίωση των Διαδικασιών της Εφοδιαστικής Αλυσίδας νε βάση τις αρχές του Lean Six Sigma;

- Ναι
- Όχι

5.3. Αν όχι, πιστεύετε ότι θα ήταν χρήσιμο;

- Ναι
- Όχι

5.4. Αν ναι, σε ποια κομμάτια της Εφοδιαστικής Αλυσίδας; Αν όχι, σε ποια κομμάτια της Εφοδιαστικής Αλυσίδας της Εταιρείας σας θα πιστεύατε ότι θα μπορούσε να χρησιμοποιηθεί το Lean Six Sigma;

- Παραλαβή εμπορευμάτων από προμηθευτή
- Αποθήκευση
- Διανομή στα καταστήματα
- Επιστροφή μη πωληθέντων προϊόντων

5.5. Πόσα έργα Lean Six Sigma έχουν πραγματοποιηθεί στην Εφοδιαστική Αλυσίδα της Εταιρείας;

5.6. Υπάρχουν πιστοποιημένοι εργαζόμενοι (belts) που να αναλαμβάνουν έργα Lean Six Sigma για την Εφοδιαστική Αλυσίδα της Εταιρείας;

- Αριθμός Yellow belts
- Αριθμός Green Belts
- Αριθμός Black Belts
- Δεν υπάρχουν

5.7. Τι είδους εργαλεία χρησιμοποιήθηκαν για την εφαρμογή του Lean Six Sigma;

- Ποιοτικά
- Ποσοτικά

5.8. Αν έχουν πραγματοποιηθεί έργα Lean Six Sigma στην Εφοδιαστική Αλυσίδα ποια είναι τα οφέλη;

- Μείωση Κόστους
- Αύξηση αποδοτικότητας
- Αύξηση Εσόδων
- Καλύτερη Διαχείριση μεταφοράς και διανομής προϊόντων
- Μεγαλύτερη ικανοποίηση πελατών
- Διευκόλυνση της εργασίας των εργαζομένων
- Καλύτερη οργάνωση
- Πιο απλές διαδικασίες

5.9. Αν δεν έχουν πραγματοποιηθεί έργα Lean Six Sigma στην Εφοδιαστική αλυσίδα ποια πιστεύατε ότι θα ήταν τα οφέλη;

- Μείωση Κόστους
- Αύξηση αποδοτικότητας
- Αύξηση Εσόδων
- Καλύτερη Διαχείριση μεταφοράς και διανομής προϊόντων
- Μεγαλύτερη ικανοποίηση πελατών
- Διευκόλυνση της εργασίας των εργαζομένων

- Καλύτερη οργάνωση
- Πιο απλές διαδικασίες

5.10. Ποιοι πιστεύετε ότι είναι οι Κρίσιμοι Παράγοντες που επηρεάζουν την υιοθέτηση του Lean Six Sigma στην Εφοδιαστική Αλυσίδα της Εταιρείας σας;

- Γνώση των αρχών του Lean Six Sigma σε όλα τα ιεραρχικά κλιμάκια
- Εκπαίδευση Εργαζομένων
- Αλλαγή κουλτούρας στην Εταιρεία
- Εναρμόνιση στρατηγικών στόχων με τη λογική του Lean Six Sigma
- Συμμετοχή της διοίκησης στις πρωτοβουλίες Lean Six Sigma

5.11. Ποιοι παράγοντες πιστεύετε ότι δρουν ανασταλτικά στην υιοθέτηση της νοοτροπίας του Lean Six Sigma;

- Μη εμπλοκή της ανώτατης διοίκησης στη διάχυση της
- Έλλειψη Εκπαίδευσης
- Λάθος επιλογή έργων Lean Six Sigma
- Έλλειψη επικοινωνίας
- Αντίσταση στην υιοθέτησή του
- Υψηλό κόστος έργων
- Χρονοβόρα έργα
- Έλλειψη γνώσης

6. Ερωτήσεις σχετικά με τη λειτουργία της εφοδιαστικής αλυσίδας

6.1. Σε ποιό σημείο της εφοδιαστικής αλυσίδας παρατηρείτε τα πιο υψηλά κόστη;

- Διαδικασία Εύρεσης Προμηθευτών
- Διαδικασία Παραγγελίας Προμηθειών
- Διαδικασία Αποθήκευσης
- Διαδικασία Διανομής από αποθήκες σε καταστήματα
- Διαδικασία πρόγνωσης ζήτησης
- Διαδικασία φόρτωσης

- Διαδικασία κοστολόγησης
- Υποστηρικτικές διαδικασίες διανομής
- Διαδικασία reverse logistics
- Άλλο

6.2. Ποιό σημείο της εφοδιαστικής αλυσίδας θεωρείτε χρειάζεται βελτίωση;

- Διαδικασία Εύρεσης Προμηθευτών
- Διαδικασία Παραγγελίας Προμηθειών
- Διαδικασία Αποθήκευσης
- Διαδικασία Διανομής από αποθήκες σε καταστήματα
- Διαδικασία πρόγνωσης ζήτησης
- Διαδικασία φόρτωσης
- Διαδικασία κοστολόγησης
- Υποστηρικτικές διαδικασίες διανομής
- Διαδικασία reverse logistics
- Άλλο

6.3. Υπάρχουν καταγεγραμμένα όλα τα βήματα των διαδικασιών;

- Ναί
- Όχι

6.4. Χρησιμοποιείται δελτία ελέγχου για συλλογή πληροφοριών στα διάφορα στάδια;

- Ναί
- Όχι

6.5. Παρατηρείτε προβλήματα με παραπάνω απόθεμα από όσο χρειάζεστε;

- Ναί
- Όχι

6.6. Χρησιμοποιείτε συστήματα:

- Παρουσίασης όλων των διαδικασιών της εφοδιαστικής αλυσίδας
- Καταγραφής χρόνων διαδικασιών

- Καταγραφής δεδομένων για διαδικασίες λήψης αποφάσεων
- Διαδικασιών λήψεων αποφάσεων
- Καταγραφής κόστους κάθε διαδικασίας
- Καταγραφής προϊόντων που δεν φτάνουν τον τελικό προορισμό
- Καταγραφής καθυστερήσεων σε κάθε στάδιο της εφοδιαστικής

7. BIBLIOGRAPHY

Akbulut-Bailey, A.Y., Motwani, J. and Smedley, E.M. (2012), "When Lean and Six Sigma converge: A case study of a successful implementation of Lean Six Sigma at an aerospace company", *International Journal of Technology Management*, Vol. 57 No. 1–3, pp. 18–32.

Albliwi, S., Antony, J., Lim, S.A.H. and van der Wiele, T. (2014), "Critical failure factors of lean Six Sigma: A systematic literature review", *International Journal of Quality and Reliability Management*, Vol. 31 No. 9, pp. 1012–1030.

Alblooshi, M., Shamsuzzaman, M., Khoo, M.B.C., Rahim, A. and Haridy, S. (2020), "Requirements, challenges and impacts of Lean Six Sigma applications – a narrative synthesis of qualitative research", *International Journal of Lean Six Sigma*, available at:https://doi.org/10.1108/IJLSS-06-2019-0067.

Antony, J. (2015), "An assessment of the critical success factors for Six Sigma implementation in Indian industries International Journal of Productivity and Performance Management Article information ":, No. November, available at:https://doi.org/10.1108/17410401211212670.

Arnheiter, E. and Maleyeff, J. (2005), "The integration of lean management and Six Sigma", *The TQM Magazine*, Vol. 17, pp. 5–18.

"Artificial Intelligence and Machine Learning to Accelerate Translational Research". (2018), *Artificial Intelligence and Machine Learning to Accelerate Translational Research*, available at:https://doi.org/10.17226/25197.

Aull, B., Kuijpers, D., Sawaya, A. and Vallöf, R. (2020), "What food retailers should do during the coronavirus crisis", *McKinsey & Company*, No. March.

Ayers, J.B. and Odegaard, M.A. (2007), "Retail Supply Chain Management", *Retail Supply Chain Management*, available at:https://doi.org/10.1201/9781420013757.

Bag, S., Telukdarie, A., Pretorius, J.H.C. and Gupta, S. (2018), "Industry 4.0 and supply chain sustainability: framework and future research directions", *Benchmarking*, available at:https://doi.org/10.1108/BIJ-03-2018-0056.

Banerjee, A. and Mukhopadhyay, S.K. (2016), "A contemporary TOC innovative thinking process in the backdrop of leagile supply chain", *Journal of Enterprise Information Management*, Vol. 29 No. 3, pp. 400–431.

Bardaki, C., Kourouthanassis, P. and Pramatari, K. (2012), "Deploying RFID-Enabled

Services in the Retail Supply Chain: Lessons Learned toward the Internet of Things", *Information Systems Management*, Vol. 29 No. 3, pp. 233–245.

Baxter, P. and Jack, S. (2015), "Qualitative Case Study Methodology: Study Design and Implementation for Novice Researchers", *The Qualitative Report*, No. January, available at:https://doi.org/10.46743/2160-3715/2008.1573.

Begley, S., Fox, R., Lunawat, G. and MacKenzie, I. (2018), "How analytics and digital will drive next-generation retail merchandising", *McKinsey & Company*, No. August, available at: https://www.mckinsey.com/industries/retail/our-insights/how-analytics-and-digital-will-drive-next-generation-retail-merchandising.

Begley, S., Marohn, E., Mikha, S. and Rettaliata, A. (2020), "Digital disruption at the grocery store", *McKinsey & Company*, No. February, p. 8.

Bendell, T. (2006), "A review and comparison of six sigma and the lean organisations", *TQM Magazine*, Vol. 18 No. 3, pp. 255–262.

Blackburn, S., Laberge, L., Toole, C.O. and Schneider, J. (2020), "Digital strategy in a time of crisis Now is the time for bold learning at scale .", No. April.

Borchert, K. and Pratap Mukharji, P. (2016), "Modern Retail Supply Chains : Backbone for Omnichannel", *Bain & Company*, available at: http://www.bain.com/publications/articles/modern-retail-supply-chains-backbone-for-omnichannel.aspx.

Boyer, K.K., Hult, G.T. and Frohlich, M. (2003), "An exploratory analysis of extended grocery supply chain operations and home delivery", *Integrated Manufacturing Systems*, Vol. 14 No. 8, pp. 652–663.

Buck, R., Francis, T., Little, E., Moulton, J. and Phillips, S. (2020), "How consumer-goods companies can prepare for the next normal", No. April.

Cain, S. and Paratore, M. (2019), "Omnichannel Grocery Is Open for Business — and Ready to Grow", pp. 1–16.

Campus, F. (2015), "Submitted for the Qualification of MSc in International Management The dissertation title: Role of Innovation in Retail Supermarket in the", No. January, pp. 1–93.

Chelariu, C., Asare, A.K. and Brashear-Alejandro, T. (2014), "'A ROSE, by any other name'...: Relationship typology and performance measurement in supply chains", *Journal of Business and Industrial Marketing*, Vol. 29 No. 4, pp. 332–343.

Cheung, M. and Hidders, J. (2011), “Round-trip iterative business process modelling between BPA and BPMS tools”, *Business Process Management Journal*, Vol. 17 No. 3, pp. 461–494.

Communications, B. (2020), “Τερκενλής : Στέλνει τα τσουρέκια του σε όλη την Ελλάδα μέσω ACS Μαρία Ηρωίδη : Marketing Director στην Ολυμπιακή Ζυθοποιία Καθήκοντα marketing director στην SPAR Hellas : Νέο κατάστημα στην Πάτρα”, pp. 1–9.

Cox, A. and Chicksand, D. (2005), “The limits of lean management thinking: Multiple retailers and food and farming supply chains”, *European Management Journal*, Vol. 23 No. 6, pp. 648–662.

Das, P. (2005), “Reduction in delay in procurement of materials using six sigma philosophy”, *Total Quality Management and Business Excellence*, Vol. 16 No. 5, pp. 645–656.

Dasgupta, T. (2003), “Using the six-sigma metric to measure and improve the performance of a supply chain”, *Total Quality Management and Business Excellence*, Vol. 14 No. 3, pp. 355–366.

Ding, Y., Jin, M., Li, S. and Feng, D. (2020), “Smart logistics based on the internet of things technology : an overview”, *International Journal of Logistics: Research and Applications*, Taylor & Francis, Vol. 0 No. 0, pp. 1–23.

Forcellini, F., Pereira, M., Ferenhof, H.A. and Boeing Ribeiro, A. (2018), “A Lean Six Sigma implementation model based on Critical Success Factors”, No. August 2018, available at:https://doi.org/10.26678/abcm.cobem2017.cob17-2095.

Franck, A. and Nemes, I. (2018), *Supermarket Supply Chains ENDING THE HUMAN*, available at:https://doi.org/10.21201/2017.1626.

Fullerton, R.R. and Wempe, W.F. (2009), “Lean manufacturing, non-financial performance measures, and financial performance”, *International Journal of Operations and Production Management*, Vol. 29 No. 3, pp. 214–240.

Furterer, S.L. (2014), *Lean Six Sigma Case Studies in the Healthcare Enterprise*, *Lean Six Sigma Case Studies in the Healthcare Enterprise*, Vol. 9781447155, available at:https://doi.org/10.1007/978-1-4471-5583-6.

Gamal Aboelmaged, M. (2010), “Six Sigma quality: a structured review and implications for future research”, *International Journal of Quality & Reliability Management*, Vol. 27 No. 3, pp. 268–317.

Garay-Rondero, C.L., Martinez-Flores, J.L., Smith, N.R., Caballero Morales, S.O. and Aldrette-Malacara, A. (2019), "Digital supply chain model in Industry 4.0", *Journal of Manufacturing Technology Management*, available at:https://doi.org/10.1108/JMTM-08-2018-0280.

Gawankar, S., Kamble, S. and Raut, R. (2016), "Development, measurement and validation of supply chain performance measurement (SCPM) scale in Indian retail sector", *Benchmarking*, Vol. 23 No. 1, pp. 25–60.

Ghobakhloo, M. and Fathi, M. (2020), "Corporate survival in Industry 4.0 era: the enabling role of lean-digitized manufacturing", *Journal of Manufacturing Technology Management*, Vol. 31 No. 1, pp. 1–30.

Glatzel, C., Hopkins, M., Lange, T. and Weiss, U. (2016), "The secret to smarter fresh-food replenishment? Machine learning", *McKinsey & Company*.

Gupta, S., Modgil, S. and Gunasekaran, A. (2019), "Big data in lean six sigma : a review and further research directions", Taylor & Francis, Vol. 7543, available at:https://doi.org/10.1080/00207543.2019.1598599.

Gutierrez-Gutierrez, L., de Leeuw, S. and Dubbers, R. (2016), "Logistics services and Lean Six Sigma implementation: a case study", *International Journal of Lean Six Sigma*, Vol. 7 No. 3, pp. 324–342.

Haddud, A. and Khare, A. (2018), "The Impact of Digitizing Supply Chains on Lean Operations", *Marktorientiertes Produkt- Und Produktionsmanagement in Digitalen Umwelten*, pp. 27–46.

Haddud, A. and Khare, A. (2020), "Digitalizing supply chains potential benefits and impact on lean operations", *International Journal of Lean Six Sigma*, Vol. 11 No. 4, pp. 731–765.

Hambleton, L. (2008), *Treasure Chest of Six Sigma Growth Methods , Tools , and Best A Desk Reference Book For*.

Hasan, M.R., Shiming, D., Islam, M.A. and Hossain, M.Z. (2020), "Operational efficiency effects of blockchain technology implementation in firms: Evidence from China", *Review of International Business and Strategy*, Vol. 30 No. 2, pp. 163–181.

Hong, P.C., Dobrzykowski, D.D. and Vonderembse, M.A. (2010), "Integration of supply chain IT and lean practices for mass customization: Benchmarking of product and service focused manufacturers", *Benchmarking*, Vol. 17 No. 4, pp. 561–592.

Hübner, A. and Schaal, K. (2017), "Effect of replenishment and backroom on retail shelf-space planning", *Business Research*, Vol. 10 No. 1, pp. 123–156.

Huxley, C. (2015), "Three Decades of Lean Production: Practice, Ideology, and Resistance", *International Journal of Sociology*, Vol. 45 No. 2, pp. 133–151.

Irfan, M. and Wang, M. (2019), "Data-driven capabilities, supply chain integration and competitive performance: Evidence from the food and beverages industry in Pakistan", *British Food Journal*, Vol. 121 No. 11, pp. 2708–2729.

Jain, G., Singh, H., Chaturvedi, K.R. and Rakesh, S. (2020), "Blockchain in logistics industry: in fizz customer trust or not", *Journal of Enterprise Information Management*, Vol. 33 No. 3, pp. 541–558.

James W. Martin. (2013), *Lean Six Sigma for Suuply Chain Management*, *Journal of Chemical Information and Modeling*, Vol. 53, available at:https://doi.org/10.1017/CBO9781107415324.004.

Knowles, G., Whicker, L., Femat, J.H. and Canales, F.D.C. (2005), "A conceptual model for the application of Six Sigma methodologies to supply chain improvement", *International Journal of Logistics Research and Applications*, Vol. 8 No. 1, pp. 51–65.

Kuijpers, D., Simmons, V. and van Wamelen, J. (2018), "Reviving grocery retail: Six imperatives", *McKinsey Report*, pp. 1–12.

Kumar, S. (2008), "A study of the supermarket industry and its growing logistics capabilities", *International Journal of Retail and Distribution Management*, Vol. 36 No. 3, pp. 192–211.

Kumar, S., Choe, D. and Venkataramani, S. (2013), "Achieving customer service excellence using Lean Pull Replenishment", *International Journal of Productivity and Performance Management*, Vol. 62 No. 1, pp. 85–109.

Kumar, S., Kumar, N. and Haleem, A. (2015), "Conceptualisation of Sustainable Green Lean Six Sigma: An empirical analysis", *International Journal of Business Excellence*, Vol. 8 No. 2, pp. 210–250.

Kumar, S., Strandlund, E. and Thomas, D. (2008), "Improved service system design using Six Sigma DMAIC for a major US consumer electronics and appliance retailer", *International Journal of Retail & Distribution Management*, Vol. 36 No. 12, pp. 970–994.

Kurpjuweit, S., Reinerth, D., Schmidt, C.G. and Wagner, S.M. (2019), "Implementing visual management for continuous improvement: barriers, success factors and best practices", *International Journal of Production Research*, Taylor & Francis, Vol. 57 No. 17, pp. 5574–5588.

Lande, M., Shrivastava, R.L. and Seth, D. (2016), "Critical success factors for Lean Six Sigma in SMEs (small and medium enterprises)", *TQM Journal*, Vol. 28 No. 4, pp. 613–635.

Laureani, A. and Antony, J. (2015), "Leadership characteristics for Lean Six Sigma", *Total Quality Management & Business Excellence*, pp. 1–22.

Lee, K. liang, Tai, C.T. and Sheen, G.J. (2013), "Using LSS to improve the efficiency and quality of a refund process in a logistics center", *International Journal of Lean Six Sigma*, Vol. 4 No. 4, pp. 409–424.

Lopez-Campos, M., Cannella, S., Miranda, P.A. and Stegmaier, R. (2019), "Modeling the operation of synchronized supply chains under a collaborative structure", *Academia Revista Latinoamericana de Administracion*, Vol. 32 No. 2, pp. 203–224.

Manzouri, M., Nizam Ab Rahman, M., Saibani, N. and Rosmawati Che Mohd Zain, C. (2013), "Lean supply chain practices in the Halal food", *International Journal of Lean Six Sigma*, Vol. 4 No. 4, pp. 389–408.

Martinez, F. (2019), "Process excellence the key for digitalisation", *Business Process Management Journal*, Vol. 25 No. 7, pp. 1716–1733.

Mazzola, M., Gentili, E. and Aggogeri, F. (2007), "SCOR, Lean and Six Sigma integration for a complete industrial improvement", *International Journal of Manufacturing Research*, Vol. 2 No. 2, pp. 188–197.

McAdam, R. and Lafferty, B. (2004), "A multilevel case study critique of six sigma: Statistical control or strategic change?", *International Journal of Operations and Production Management*, Vol. 24 No. 5–6, pp. 530–549.

McLean, R. and Antony, J. (2014), "Why continuous improvement initiatives fail in manufacturing environments? A systematic review of the evidence", *International Journal of Productivity and Performance Management*, Vol. 63 No. 3, pp. 370–376.

Mehrjerdi, Y.Z. (2013), "A framework for Six-Sigma driven RFID-enabled supply chain systems", *International Journal of Quality and Reliability Management*, Vol. 30 No. 2, pp. 142–160.

Milton, S.K. and Johnson, L.W. (2012), "Service blueprinting and BPMN: A comparison", *Managing Service Quality*, Vol. 22 No. 6, pp. 606–621.

Mishra, P. and Sharma, R.K. (2014), "A hybrid framework based on SIPOC and Six Sigma DMAIC for improving process dimensions in supply chain network", *International Journal of Quality and Reliability Management*, Vol. 31 No. 5, pp. 522–546.

Mishra, P. and Sharma, R.K. (2015), "Integration of Six Sigma and ISM to improve Supply Chain Coordination – A conceptual framework", *International Journal of Production Management and Engineering*, Vol. 3 No. 1, p. 75.

Moazzam, M., Akhtar, P., Garnevska, E. and Marr, N.E. (2018), "Measuring agri-food supply chain performance and risk through a new analytical framework: a case study of New Zealand dairy", *Production Planning and Control*, Taylor & Francis, Vol. 29 No. 15, pp. 1258–1274.

Nabhani, F. and Shokri, A. (2009), "Reducing the delivery lead time in a food distribution SME through the implementation of six sigma methodology", *Journal of Manufacturing Technology Management*, Vol. 20 No. 7, pp. 957–974.

Nicoletti, B. (2013), "Lean six sigma and digitize procurement", *International Journal of Lean Six Sigma*, Vol. 4 No. 2, pp. 184–203.

Nikoličić, S., Kilibarda, M., Atanasković, P., Duđak, L. and Ivanišević, A. (2015), "Impact of RFID Technology on Logistic Process Efficiency in Retail Supply Chains", *PROMET - Traffic&Transportation*, Vol. 27 No. 2, pp. 137–146.

Niu, H., Bhowmick, C. and Jagannathan, S. (2019), "Chapter 9 - Attack Detection and Estimation for Cyber-Physical Systems by Using Learning Methodology", in Alanis, A.Y., Arana-Daniel, N. and López-Franco, C.B.T.-A.N.N. for E.A. (Eds.), , Academic Press, pp. 107–126.

Packaged, C. and Practice, G. (2020), "Rapidly forecasting demand and adapting commercial plans in a pandemic", No. April.

Panayiotou, N.A. and Stergiou, K.E. (2020), "A systematic literature review of lean six sigma adoption in European organizations", *International Journal of Lean Six Sigma*, No. 2010, available at:https://doi.org/10.1108/IJLSS-07-2019-0084.

Pepper, M.P.J. and Spedding, T.A. (2010), "The evolution of lean Six Sigma", *International Journal of Quality and Reliability Management*, Vol. 27 No. 2, pp. 138–155.

Perez, C., de Castro, R., Simons, D. and Gimenez, G. (2010), “Development of lean supply chains: A case study of the Catalan pork sector”, *Supply Chain Management*, Vol. 15 No. 1, pp. 55–68.

Pramatari, K. and Miliotis, P. (2008), “The impact of collaborative store ordering on shelf availability”, *Supply Chain Management*, Vol. 13 No. 1, pp. 49–61.

Psychogios, A.G., Atanasovski, J. and Tsironis, L.K. (2012), “Lean Six Sigma in a service context: A multi-factor application approach in the telecommunications industry”, *International Journal of Quality and Reliability Management*, Vol. 29 No. 1, pp. 122–139.

Rana, S.M.S., Osman, A. and Ab Halim, M.S. (2014), “A Revisited Retail Supply Chain Management (SCM) Practices : A Conceptual Framework”, *International Journal of Business and Technopreneurship*, Vol. 4 No. 2, pp. 307–317.

Rane, S.B. and Thakker, S.V. (2019a), “Green procurement process model based on blockchain–IoT integrated architecture for a sustainable business”, *Management of Environmental Quality: An International Journal*, available at:https://doi.org/10.1108/MEQ-06-2019-0136.

Rane, S.B. and Thakker, S.V. (2019b), “Green procurement process model based on blockchain–IoT integrated architecture for a sustainable business”, *Management of Environmental Quality: An International Journal*, Vol. 31 No. 3, pp. 741–763.

Rashid, Y., Rashid, A., Warraich, M.A., Sabir, S.S. and Waseem, A. (2019), “Case Study Method: A Step-by-Step Guide for Business Researchers”, *International Journal of Qualitative Methods*, Vol. 18, pp. 1–13.

Raval, S.J., Kant, R. and Shankar, R. (2018), “Revealing research trends and themes in Lean Six Sigma: from 2000 to 2016”, *International Journal of Lean Six Sigma*, Vol. 9 No. 3, pp. 399–443.

Raval, S.J., Kant, R. and Shankar, R. (2020), “Analyzing the Lean Six Sigma enabled organizational performance to enhance operational efficiency”, *Benchmarking*, Vol. 27 No. 8, pp. 2401–2434.

Rese, A., Baier, D., Geyer-Schulz, A. and Schreiber, S. (2017), “How augmented reality apps are accepted by consumers: A comparative analysis using scales and opinions”, *Technological Forecasting and Social Change*, Elsevier Inc., Vol. 124, pp. 306–319.

Sabry, A. (2014), “Factors critical to the success of Six-Sigma quality program and their influence on performance indicators in some of Lebanese hospitals”, *Arab Economic and Business Journal*, Korea Institute of Oriental Medicine, Vol. 9 No. 2, pp. 93–114.

Salah, S., Rahim, A. and Carretero, J.A. (2010), “The integration of Six Sigma and lean management”, *International Journal of Lean Six Sigma*, Vol. 1 No. 3, pp. 249–274.

Salah, S., Rahim, A. and Carretero, J.A. (2011), “Implementation of Lean Six Sigma (LSS) in supply chain management (SCM): an integrated management philosophy”, *International Journal of Transitions and Innovation Systems*, Vol. 1 No. 2, p. 138.

Salim, M. and Yadav, R. (2012), “Capital Structure and Firm Performance: Evidence from Malaysian Listed Companies”, *Procedia - Social and Behavioral Sciences*, available at:https://doi.org/10.1016/j.sbspro.2012.11.105.

Schrauf, S. and Berttram, P. (2016), “Industry 4.0: How digitization makes the supply chain more efficient, agile, and customer-focused”, *Strategy &Technology*, p. pg. 1-32.

Senthilkumar, T., Karthi, S., Devadasan, S.R., Sivaram, N.M., Sreenivasa, C.G. and Murugesh, R. (2012), “Implementation of DMAIC methodology in supply chains to reduce customer end-rejections: A case study in an Indian SME”, *International Journal of Productivity and Quality Management*, Vol. 10 No. 3, pp. 388–409.

Sheel, A. and Nath, V. (2019), “Effect of blockchain technology adoption on supply chain adaptability, agility, alignment and performance”, *Management Research Review*, Vol. 42 No. 12, pp. 1353–1374.

Shokri, A. (2017), “Quantitative analysis of Six Sigma, Lean and Lean Six Sigma research publications in last two decades”, *International Journal of Quality and Reliability Management*, Vol. 34 No. 5, pp. 598–625.

Shokri, A., Oglethorpe, D. and Nabhani, F. (2014), “Evaluating Six Sigma methodology to improve logistical measures of food distribution SMEs”, *Journal of Manufacturing Technology Management*, Vol. 25 No. 7, pp. 998–1027.

Singh, M. and Rathi, R. (2019), *A Structured Review of Lean Six Sigma in Various Industrial Sectors*, *International Journal of Lean Six Sigma*, Vol. 10, available at:https://doi.org/10.1108/IJLSS-03-2018-0018.

Singh, S.K. and Jenamani, M. (2020), “Cassandra-based data repository design for food supply chain traceability", *VINE Journal of Information and Knowledge Management Systems*, No. 5, available at:https://doi.org/10.1108/VJIKMS-08-2019-0119.

Sundarakani, B., Kamran, R., Maheshwari, P. and Jain, V. (2019), "Designing a hybrid cloud for a supply chain network of Industry 4.0: a theoretical framework", *Benchmarking*, available at:https://doi.org/10.1108/BIJ-04-2018-0109.

Sunder M, V., Mahalingam, S. and M, S. (2019), "Improving patients' satisfaction in a mobile hospital using Lean Six Sigma – a design-thinking intervention", *Production Planning & Control*, pp. 1–15.

T. Stock, G.S. (2016), "Opportunities_and_Challenges_for_Constru.pdf", *ScienceDirect*, pp. 536–541.

Takeda Berger, S.L., Tortorella, G.L. and Frazzon, E.M. (2018), "Simulation-based analysis of inventory strategies in lean supply chains", *IFAC-PapersOnLine*, Elsevier B.V., Vol. 51 No. 11, pp. 1453–1458.

Timans, W., Antony, J., Ahaus, K. and Van Solingen, R. (2012), "Implementation of Lean Six Sigma in small- and medium-sized manufacturing enterprises in the Netherlands", *Journal of the Operational Research Society*, Vol. 63 No. 3, pp. 339–353.

Tompkins, J. (n.d.). "Reinventing your supply chain".

Tsironis, L.K. and Psychogios, A.G. (2016), *Road towards Lean Six Sigma in Service Industry: A Multi-Factor Integrated Framework*, *Business Process Management Journal*, Vol. 22, available at:https://doi.org/10.1108/BPMJ-08-2015-0118.

Vallandingham, L.R., Yu, Q., Sharma, N., Strandhagen, J.W. and Strandhagen, J.O. (2018), "Grocery retail supply chain planning and control: Impact of consumer trends and enabling technologies", *IFAC-PapersOnLine*, Elsevier B.V., Vol. 51 No. 11, pp. 612–617.

Vasseur, J.-P. and Dunkels, A. (2010), "Chapter 1 - What Are Smart Objects?", in Vasseur, J.-P. and Dunkels, A.B.T.-I.S.O. with I.P. (Eds.), , Morgan Kaufmann, Boston, pp. 3–20.

Wang, Y., Han, J.H. and Beynon-Davies, P. (2019), "Understanding blockchain technology for future supply chains: a systematic literature review and research agenda", *Supply Chain Management*, Vol. 24 No. 1, pp. 62–84.

Weber, F.D. and Schütte, R. (2019), "State-of-the-art and adoption of artificial intelligence in retailing", *Digital Policy, Regulation and Governance* , Vol. 21 No. 3, pp. 264–279.

Wei, C.C., Sheen, G.J., Tai, C.T. and Lee, K.L. (2010), "Using Six Sigma to improve replenishment process in a direct selling company", *Supply Chain Management: An International Journal*, Vol. 15 No. 1, pp. 3–9.

Yang, H.M., Choi, B.S., Park, H.J., Suh, M.S. and Chae, B. (2007), "Supply chain management six sigma: A management innovation methodology at the Samsung Group", *Supply Chain Management*, Vol. 12 No. 2, pp. 88–95.

Zailani, S. (2015), "기사 (Article) 와 안내문 (Information) [", *The Eletronic Library*, Vol. 34 No. 1, pp. 1–5.

Zarour, K., Benmerzoug, D., Guermouche, N. and Drira, K. (2020), "A systematic literature review on BPMN extensions", *Business Process Management Journal*, Vol. 26 No. 6, pp. 1473–1503.

Zhang, A., Luo, W., Shi, Y., Chia, S.T. and Sim, Z.H.X. (2016), "Lean and Six Sigma in logistics: a pilot survey study in Singapore", *International Journal of Operations and Production Management*, Vol. 36 No. 11, pp. 1625–1643.

Zhu, S., Song, J., Hazen, B.T., Lee, K. and Cegielski, C. (2018), "How supply chain analytics enables operational supply chain transparency: An organizational information processing theory perspective", *International Journal of Physical Distribution and Logistics Management*, Vol. 48 No. 1, pp. 47–68.

Zwetsloot, I.M., Kuiper, A., Akkerhuis, T.S. and de Koning, H. (2018), "Lean Six Sigma meets data science: Integrating two approaches based on three case studies", *Quality Engineering*, Taylor & Francis, Vol. 30 No. 3, pp. 419–431.

"ΕΝΔΙΑΜΕΣΗ ΕΚΘΕΣΗ Κλαδική έρευνα στον κλάδο παραγωγής , διανομής και εμπορίας βασικών καταναλωτικών ειδών και ιδίως ειδών διατροφής , καθώς και ειδών". (n.d.). .

Further reading

iSixSigma. 2020. What Is Six Sigma?. [online] Available at: <https://www.isixsigma.com/new-to-six-sigma/what-six-sigma/> [Accessed 30 March 2020].

ASK LEX PH ACADEMY. 2020. Thinking Outside The Box…….Plot!. [online] Available at: <https://asklexph.com/2019/06/10/thinking-outside-the-box-plot/> [Accessed 3 April 2020].

Improving patients' satisfaction in a mobile hospital using Lean Six Sigma – a design-thinking intervention - Scientific Figure on ResearchGate. Available from: https://www.researchgate.net/figure/Quality-function-deployment-output-house-of-quality_fig4_335348192 [accessed 14 Apr, 2020]

Six Sigma Camp. 2020. Six Sigma Belts - Six Sigma Belt Levels - Lean Six Sigma Belts. [online] Available at: <https://www.sixsigmacamp.com/six-sigma-belt-levels/> [Accessed 14 April 2020].

George, M.L., Rowlands, D., & Kastle, B. (2004). What is Lean Six Sigma? New York: McGraw-Hill

article, N., 2020. Vertical Integration In The Grocery Industry. [online] Supplychainanalysis.igd.com. Available at: <https://supplychainanalysis.igd.com/news/news-article/t/vertical-integration-in-the-grocery-industry/i/22955> [Accessed 27 April 2020].

Ibm.com. 2020. Big Data Analytics. [online] Available at: <https://www.ibm.com/analytics/hadoop/big-data-analytics> [Accessed 1 May 2020].

https://www.retail-insight-network.com/features/food-retail-innovation/

APICS, 2021. APICS Webinar: SCOR 101—APICS For Business. [video] Available at: <https://www.youtube.com/watch?app=desktop&v=58SJY2P42PE> [Accessed 23 January 2021].

Lean Six Sigma Business Excellence Institute (2021), Lean Six Sigma Overview. Available at: https://lssbei.com/lean-six-sigma-overview/ [Accessed 23 June 2021]

IVEPE(2021), Professional Certifications Available at: https://www.ivepe.gr/en/professional-certification/421-lean-six-sigma [Acessed 23 June 2021]