NOVA IMS Information Management School

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Mestrado em Gestão de Informação
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Execution Management System implementation in international retail company

Kirill Trifonov

Project Work presented as partial requirement for obtaining the Master's degree in Information Management

NOVA Information Management School
Instituto Superior de Estatística e Gestão de Informação
Universidade Nova de Lisboa

BOOK SPINE


2021
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Advisor / Co Advisor: *Pedro Manuel Carqueijeiro Espiga Da Maia Malta*

Co Advisor*:*

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ABSTRACT

In nowadays the penetration of new technologies and changing business environment are pushing companies to compete and focus on efficiency of its processes. One of company's competitive advantage is its operational processes and its efficiency. In order to save money and increase competitive advantage a company should continuously improve its processes and today the company could use not only dedicated business improvement frameworks and technics, but also specific software which can explore existing processes of the company by searching and analysing program logs and process trails in the company's systems. Process mining software could help companies to understand different variants of existing processes, compare them to reference models, see actual efficiency and automation rate, understand the root cause of the inefficiency and take necessary actions to improve the existing processes. But Process mining software is not yet so popular in CIS retail market and many companies are looking sceptically towards using this type of software. So far not every retail business in CIS countries is using Process Mining software to understand its processes and even more rare is implementation of RPA software to substitute human work with robots and AI. The aim of planned work is to design and implement EMS system and present case study of the implementation.

KEYWORDS

Process mining; Project implementation methodology; Process optimization; Retail; Process simulation; Robotic Process Automation; Machine Learning

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LIST OF ABBREVIATIONS AND ACRONYMS

IT	Information Technologies
EMS	Execution Management System
BI	Business Intelligence
CIO	Chief Information Officer
ROI	Return of Investments
BPM	Business Process Management
CRISP-DM	The Cross Industry Standard Process for Data Mining
PM2	Project Management Methodology
RPA	Robotic Process Automation
ML	Machine Learning
P2P	Purchase to Pay
KPI	Key Performance Indicator
DC	Distribution Centre
BPMN	Business Process Model and Notation
WMS	Warehouse Management System
SRM	Supplier Relationship Management
EDI	Electronic Data Interchange
SaaS	Software as a Service
VPN	Virtual Private Network
RFC	Remote Functional Call
API	Application Programming Interface
AI	Artificial Intelligence
ABAP	Advanced Business Application Programming
CR	Change request
CIS	Commonwealth of Independent States

1. INTRODUCTION

In nowadays the penetration of new technologies and changing business environment are pushing companies to compete and focus on efficiency of its processes. One of company's competitive advantage is its operational processes and its efficiency. IT industry has a lot of tools to fulfil the demand of the business to evolve in this direction. Companies have opportunities to implement specific systems to automate some steps in the process, they can substitute humans with AI for some tasks, but if the process itself is not efficient this will just add complexity to implementation projects and additional costs to the company.

In order to save money and increase competitive advantage companies should continuously improve its processes and today company could use not only dedicated business improvement frameworks and technics for this purpose, but also specific software which can explore existing processes of the company by searching and analysing program logs and process trails in the company's systems. This type of software becomes more common and frequency of usage this type of software is dramatically increasing last years. This type of software called Process mining software but in nowadays it also evolving in new class – Execution Management Software (EMS).

"Modern process-aware information systems store detailed information about processes as they are being executed. This kind of information can be used for very different purposes. The term process mining refers to the techniques and tools to extract knowledge (e.g., in the form of models) from this. Several key players in this area have developed sophisticated process mining tools." (Boudewijn F. van Dongen, Wil Van der Aalst, 2005)

Process mining software could help companies to understand all variants of existing processes, compare them to reference models, see actual efficiency and automation rate, understand the root cause of the inefficiency and take necessary actions to improve existing processes and set appropriate controls. New type of software – EMS, has functionality in one step forward, it can help companies to establish proactive monitoring of the process, alert for possible nonconformities and help companies to modulate the processes and execute different what-if scenarios to improve the processes. This "allow managers and analysts to get an aggregate picture of the health of a process, process mining techniques allow them to dig deeper." (Dumas, 2018)

"Process mining refers to a broad collection of techniques to extract insights from event logs generated during the execution of a business process. Some of these techniques are focused on discovering a model of the process, while others allow us to analyze the process from different perspectives (conformance, performance, variants)." (Dumas, 2018)

The importance of business efficiency can be seen comparing different business process KPIs to market leaders (Celonis, 2021). Here are some examples. "Here's how the average and top-quartile companies are performing across Procurement's three most actively tracked KPI's" (Celonis, 2021):

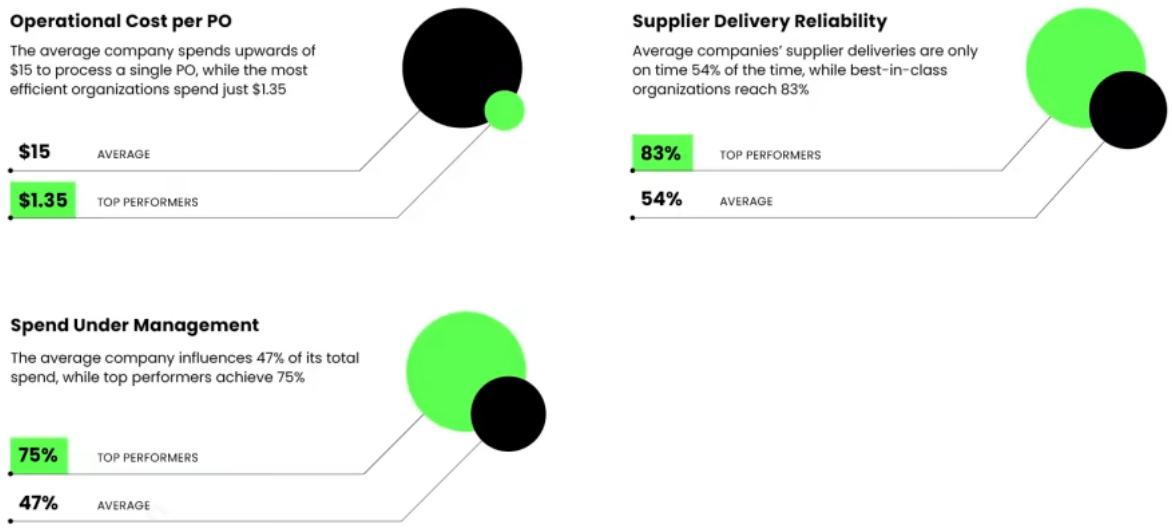

Figure 1 Three most actively tracked KPI's (Celonis, 2021)

International market leaders who already started to use Process mining software getting benefits from it: "Vodafone increased their 'Perfect PO' rate from 73% to 96% in a year and reduced the cost of each PO by 11%. And Chart Industries saved $6M in material purchase prices, while Zalando reduced maverick buying by 75%." (Celonis, 2021)

But Process mining software is not yet so popular in CIS retail market and many companies are looking sceptically towards using it. The aim of planned work is to see how implementation of Process mining software could lead to success and achievement of business goals for International retail company which operates its business in CIS market. To do this, I plan to find an answer to the following main research questions:

- **How EMS can contribute to the company to achieve target goals?**
- **How planned business cases to be met through EMS implementation?**
- **Does RPA really work and help business?**
- **Can business results to be achieved without EMS implementation?**
- **What are the main success factors for such kind of projects?**

For each company the question of efficiency is one of the important and relevant for competitive advantage specially in covid time and overall economy stagnation in Russia.

The answers for the questions I would like to find is quite relevant and will help both for consulting market and clients who would like to benefit from process mining software implementation:

- Companies will receive insight on what and how value can be achieved using process mining software.
- Business case of implementation will be tested.
- Approach for selecting KPIs and results will be published.
- Lessons learned and success factors will be shared.

- All this will give more confidence to the market and could influence other companies to start their journey in optimizing their processes.

As it was mentioned before just a few companies in CIS retail market implemented process mining software. Based on my interview of five CIOs the main doubts their companies have about process mining implementation are:

- Unclear benefits company will receive.
- No precise cost and timelines of implementation.
- New and not well-known software

The study that planed to perform will help them to find answers on these questions and give additional information about this type of software and information about how it can be used.

2. LITERATURE REVIEW

2.1. PROCESS MINING

"Any company would ideally like to make its processes faster, cheaper, and better. This simple observation leads us already to identifying three process performance dimensions: time, cost, and quality." (Dumas. 2018) The fourth dimension is related to external circumstances in which the process executed - flexibility. (Dumas, 2018) There are different technics and approaches described in the literature to assess process performance and evaluation the process. So the company could take some actions to improve it.

In classic approach of BPM studying business process starts from examination of business of the company, building the models of the process and trying to find some patterns to evaluate the maturity and its efficiency. The Process Mining approach starts from the bottom: if the company use software to account its process activities we can use the logs from this systems to build and analyse existing process flows. (Santos, 2017) "Process mining is a family of techniques to analyze the performance and conformance of business processes based on event logs produced during their execution." (Dumas, 2018)

Process Mining could be considering relatively young discipline and emergingly developing in nowadays. The year of birth of it considered to be 2012 – the year when Process Mining Manifesto was published. (van der Aalst et al., 2012) It highlights key demand factors of the Process Mining and defines key guidelines and principles of the new discipline.

However, implementation of Process Mining software could be quite challenging and not every project management methodology could suit for such task. In his work van Eck give insights of existing Process Mining project Methodologies and gives overview and steps required to achieve success. (van Eck et al., 2015) The paper gives quite a good description of using PM2 methodology for Process Mining project implementation with the description of key steps and activities. In this key study as a lessons learned author gives some insights which could be valuable to consider for the fix price project implementations:

- the process of implementation has iterative steps with unclear result
- the question of the quality of data is crucial for the project

Marcelo Luiz Monteiro Marinho (2015) in his work gives excessive overview of different approaches how to deal with uncertainty in software implementation projects. This work confirms that high number of projects fail due to poor control of uncertainties and projects with high degree of uncertainty has to pay a lot of attention to this subject in order to succeed. As a key outcome of this work which should be used for the Process Mining project management is creation of strong risk control to react proactively for future challenges in the project.

For any data mining project quite crucial to have good quality data in CRISP-DM methodology there is two steps specially dedicated to understand and to filter input data: Data understanding and Data

preparation. (Larose & Larose, 2015) These steps were missed in PM2 methodology which is mainly focused on the processes.

“Process mining has a history of over two decades of published research papers and case studies started to appear a bit over a decade ago.”(Emamjome et al., 2019). Based on existing publications the two aspects during Process Mining software implementations should be taken into consideration:

- Managerial aspects of implementation, planned usage and expectations (Grisold et al., 2021.). Clear business case and tasks for the project should be defined at the beginning of the project. All involved parties should clearly understand expected results and outcomes as well as usage scenarios.
- Quality of data is crucial for implementation. (Andrews et al., 2020). Process Mining software like any Data Mining software is quite sensitive to the quality of input data (Larose & Larose, 2015) and specific actions should be planned in the project.

2.2. Robotic Process Automation (RPA).

New generation of Process Mining software not focused only on methods and technics of exploring processes, but evolve it and make robust. Adding new technologies like Machine Learning algorithms (Bozorgi et al., 2020) to serve new business demands for automatic reactions to certain findings in the process flows and nonconformities.

Some Process Mining software vendors are making step forward to give clients create automation scenarios based on specific patterns in process flow. This functionality lies in another class of software – Robotic Process Automation (RPA), “a rapidly emerging technological tool” (Ma et al., 2019).

RPA is a new class of software which is use AI to substitute human labour in routine tasks (Aguirre & Rodriguez, 2017). “Nowadays, RPA robots are increasingly used in daily office tasks such as finance and human resources. They play an increasingly important role in realizing office automation, which can improve work efficiency and reduce labour costs.” (Luo & Luo, 2021). More and more business starting to use this tool in their work, case studies with analysis of positive and negative effects of implementation are published (Zhang & Liu, 2018).

However, it is quite important carefully chose the right task for automation (Viehhauser & Doerr, 2021). It doesn’t make sense to automate waste tasks. Also, too complicated tasks cannot bring expected economy effects. (Wewerka & Reichert, 2020)

2.3. Process mining benchmarking

“Gartner sizes the market at about 40 vendors, which offer most of the process mining capabilities.” (Marc Kerremans, Tushar Srivastava, Farhan Choudhary, 2021). It also highlights five main use cases for process mining:

1. Discovery and analysis
2. Auditing and compliance.

3. Automation
4. Digital transformation
5. IT Processes

First two use cases are quite common, and all process mining tools has capabilities to fulfill business requirements for these tasks. Automation and Digital transformation require more robust system capabilities, with near on-line integration to operational systems and RPA. IT Processes is relatively new use case not yet so popular, but could bring benefits to the companies.

Gartner predicts that usage of process mining software in first two use cases will descent but for last three will grow (2021):

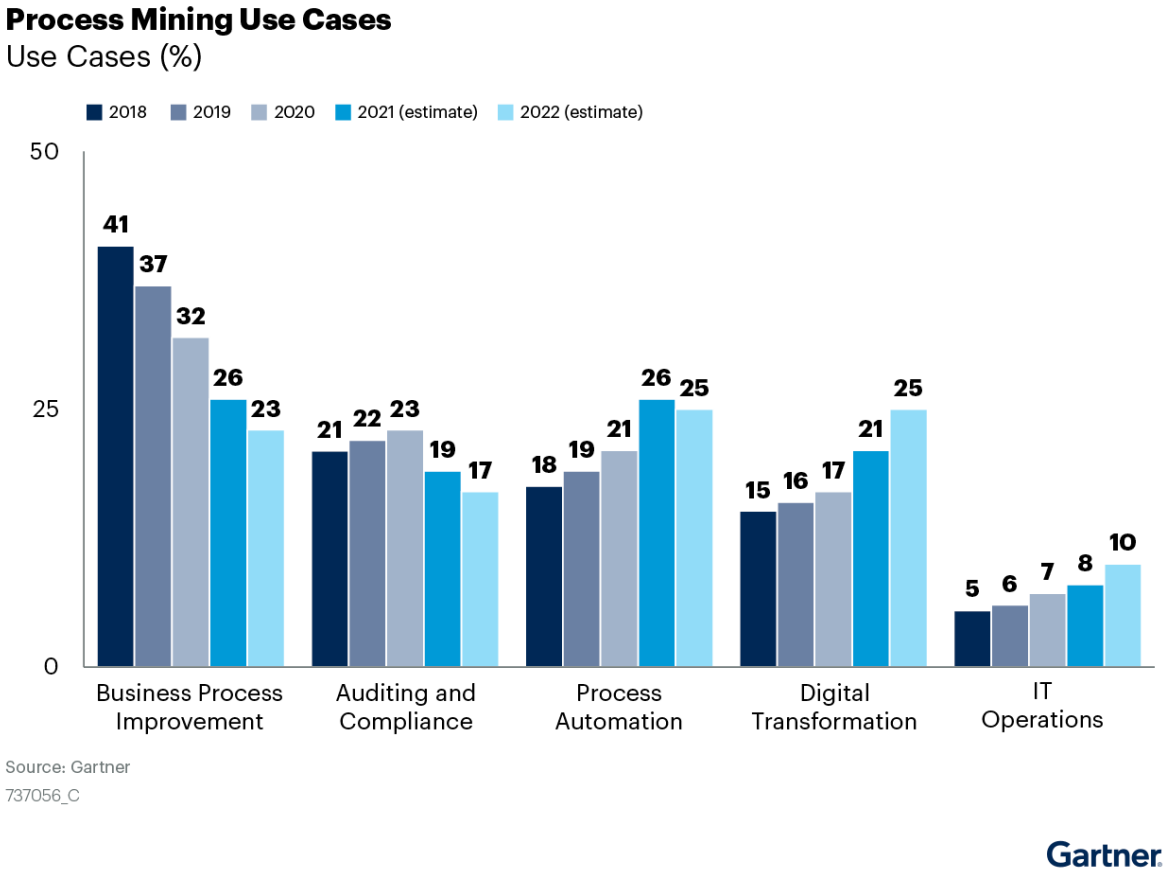

Figure 2 Process Mining Use Cases (Marc Kerremans, Tushar Srivastava, Farhan Choudhary, 2021)

Gartner (2021) recommends "explore use cases that go beyond traditional, internally focused process discovery, process validation and model enhancement by targeting business operations and interactions with external parties, such as customers."

Bailey Kong (2021) in his report also highlights that "process discovery & mining market is still driven by process visibility needs but future needs focus around planning and accelerating process changes, where deep actionable and impactful insights derived from business and desktop data is critical."

Bailey Kong (2021) in his report provides magic quadrant to benchmark current process mining vendors and identifies Celonis as a leading player in Process mining software market:

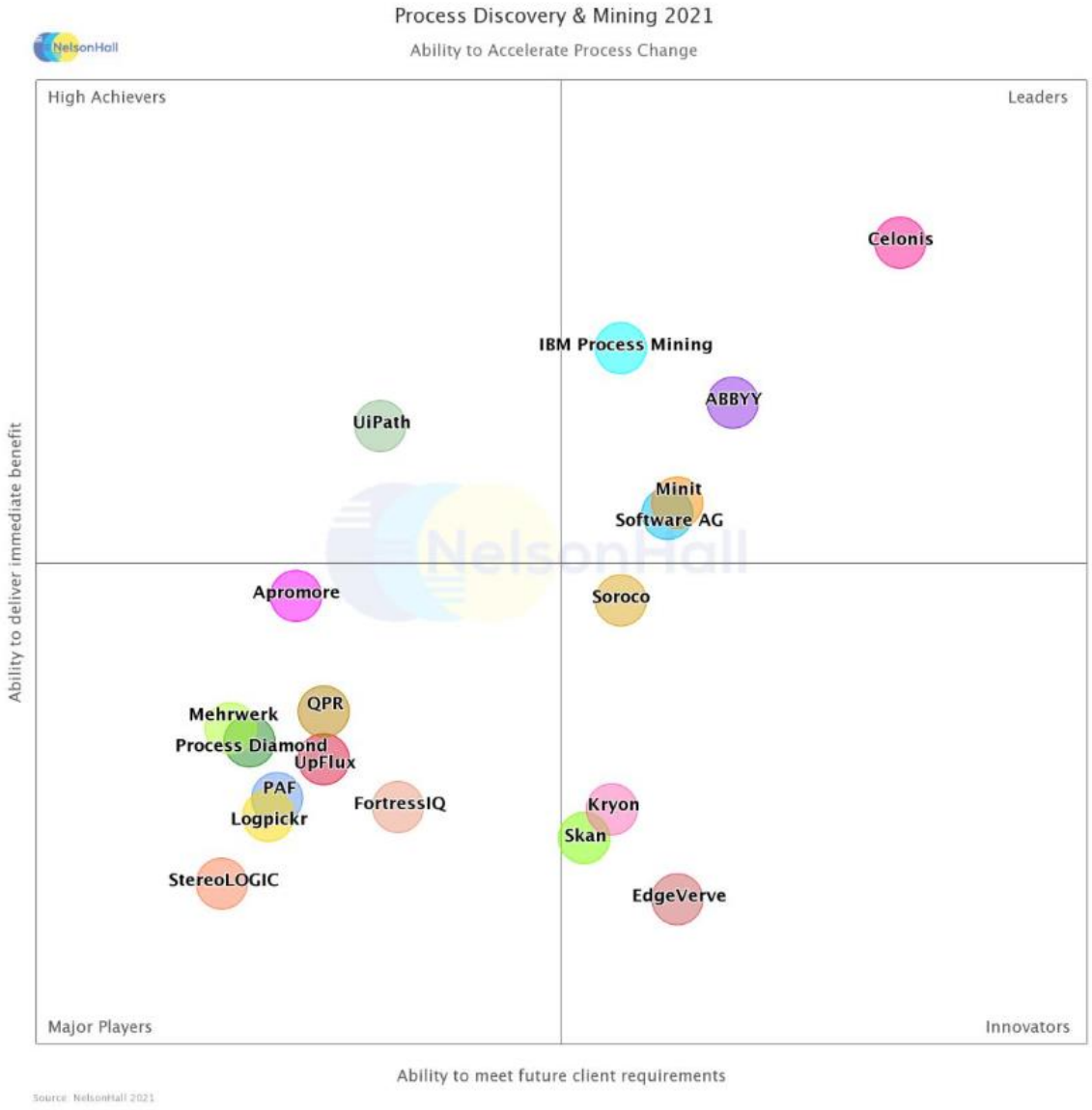

Figure 3 NEAT Evaluation: Process Discovery & Mining (Bailey Kong, 2021)

3. BACKGROUND

3.1. CONTEXT

Despite of active growth of Process mining software implementation worldwide this type of software still is not so widely used by companies comparing to BI systems, which are used to analyse and interpret company's data to take managerial decisions for company's processes optimization.

So, for most of the companies (and CIOs) it is an open question: should they invest their money in process mining software? Could the same results be achieved using BI solutions? How quickly the company will achieve ROI if process mining will be implemented?

Specially these questions are very actual for retail companies as they work in highly competitive environment with low margin where any investment should be justified and ROI needs to be proved. Management of the retail companies should have fully confidence of the efficiency of the tools company would like to buy.

And more rare fact is implementation of another class of software – RPA (Robotic Process Automation), especially when the question is related to main process like Order to Cash or any other process in logistic chain.

Recently company Celonis introduced its new software – EMS (Execution Management System). This system evolved from the company's Process Mining software, but it has additional feature of automation of the processes. The new system declared to be able not only analyse existing variants of the process but also predict and react in case if it's machine learning algorithm will notice any possible nonconformities in the process – it could be e-mail to responsible person or block of the transaction in the system.

3.2. BUSINESS CASE

In 2020 a consulting company for which I'm working for realized a small pilot project of Celonis's Process mining software for its client - big International retailer. Based on this pilot project and internal research the business case was created of using EMS for Purchase to Pay process (P2P). According to this business case the company will receive savings and additional income of more than 2 million euros yearly from the following cases:

1. *Improving quality of deliveries*.
2. *Improve payment process*.
3. *On time delivery*.
4. *Price discrepancies*.
5. *Decreased paperwork*.
6. *Automation of the processes*.

3.3. PROJECT PLANNING

Based on this business case the management of the company took decision to implement EMS for P2P process. The project was started in August 2021 and planned to be finished in April 2022. Key project timelines are presented in the following table:

Phase	Start date	End date
Conceptual design	September 2021	November 2021
Realization	November 2021	March 2022
Preparation and Go-Live	March 2022	April 2022

Table 1 Project timetable

3.4. STUDY OBJECTIVES

In this study we plan to run the project of EMS implementation in the retail company, working on the side of implementation company, and answer the following questions:

- How can EMS contribute to the company to achieve target goals?
- How designed KPIs can be transformed through the project?
- How planned business cases to be met through EMS implementation?
- Does RPA really work and help business?
- Can business results to be achieved without EMS implementation?
- What are the main success factors for such kind of projects?

In order to answer these questions, we plan to execute the following activities:

- Plan and design architecture of the system.
- Interview key business users to understand process flow and build reference model of the process.
- Design data model.
- Implement data model.
- Create automation scripts.
- Prepare case study based on implementation.

In order to answer the first question, we would like to interview key stakeholders at the begging of the project to understand main pain points, build list of KPIs connected to the project goals that can be measured and put as a logic into the system. So, the people and ML algorithms can track them and perform actions based on its interpretation. At the end of the project number of findings and triggered events will be assessed and included into the case study.

We assume that during the project some KPIs will be transformed and adopted based on findings in the process variants and some additional inputs from stakeholders based on their understanding of the process flows. These changes will be documented in the paper to understand the evolution of KPIs and see if Process Mining software can bring insights and better understanding of the process comparing to how involved parties understand it.

As the result of the project, we would like to compare its outcomes to planned benefits and see how accurate were the prediction and if there any other additional benefits will contribute to ROI. At this point we would like to understand what will be the nature of these changes so it can be used for future projects and business cases preparations.

And one of the important questions which we would like to explore is to stress the idea of using Process Mining and RPA software to improve the business. Does it really necessary to implement such kind of software in order to achieve business goals and improvements? To do so we will conduct post implementation interview of the key stakeholders to understand their feedback of the project. The results will be included into case study.

And the last but not least, based on lessons learned we would like to assess the project and see which success factors are the most relevant and important for EMS implementation projects. How they contribute to improve efficiency of the project realization and give more value to involved parties.

3.5. METHODOLOGY

The nature of the planned research lies in Design Science Research paradigm. In this study described the project of implementation of the EMS system from the design phase to post implementation review. At the end of the project, will be done assessment of the results to evaluate to evaluate the accuracy of the model and newly created artefact will stress the initially prepared design.

For this, the following actions were planned::

1. Build system design based on business case.
2. Deliver the project based on created design.
3. Evaluate the results.
4. Prepare report with lessons learned and conclusions.

As the first step interview of key stakeholders of the project and project sponsors will be conducted to create design of the system which expect to deliver the required benefits to the company. This design will include specific KPIs to be put into the system, base process flows and systems to be monitored for process execution, system architecture of the planned solution and as well the description of data to be extracted from selected systems.

During project execution all deviations and issues will be documented and closely examined to understand the cause root of any changes and discrepancies from business case.

The results of the project will be evaluated using both quantitative and qualitative methods to better understand and asses the results.

Based on the assessment the report will be prepared with explanation and comparison of the results and things to consider for future implementations and studies.

4. PROJECT EXECUTION

4.1. CONCEPTUAL DESIGN

4.1.1. Scope planning

For better understanding of the current system landscape and process flow a series of interview with key stakeholders were conducted. The interview has been aimed to get answers to the following questions:

- What is the current process flow?
- What systems are involved and how they integrate?
- What are the main pain points in the process? What metrics could be used to measure process efficiency?
- What automation scenarios could be used to improve the process?

The series of interview were split in two sections. First series were done with business staff. And after understanding the business process flow second series of interview were conducted with IT architects responsible for development and maintenance of the corresponding systems.

From business key stakeholders are:

- Head of procurement department
- Head of commerce department
- Head of marketing department
- Store managers
- Head of logistic distribution center (DC)
- Deputy chief accountant

From IT key stakeholders are:

- Head of business process optimization team
- SAP FI architect
- SAP Retail architect
- SAP ERP architect
- SAP EWM architect
- Head of development team
- Head of SAP basis
- Head of information security

As a result of these interviews the following documents were created:

1. BPMN scheme of the process flow.
2. List of KPIs to be setup in the system.
3. System architecture.
4. Concept for future automation.
5. Dataset to be transferred into EMS for analysis

All these documents were combined in one single document – conceptual design of the system for review and approval by the client to narrow the scope of the project and plan further activities.

In the following sections details of the design are presented.

4.1.2. Process overview

Based on the interview the schemes in BPMN format of the base process were created and agreed with key stakeholders. The schemes represent base process flow scenario to visualize and get high level picture of the process. Later these schemes will be used to compare actual process flows based on process mining interpretation of the data to select reference model of the process.

All schemes were done using Bizagi Modeler software. Bizagi Modeler was a tool selected by the client and used in the company for processes modelling and documenting purposes before the start of the project. Celonis has it's own BPMN tool, but as per license agreement start of usage of it was planned for later stages and it was unavailable for us at Design phase. However this option maybe considered by the company to implement and use Celonis to describe and model its processes. Especially taking into account that Celonis has advanced functionality integrated with PM and specific Process Repository to track evolvement of the processes. (Peyman Badakhshan, 2020)

The high level BPML schemes are presented below.

Process itself could be split in 3 main subprocesses:

- Order creation
- Order execution
- Order payment

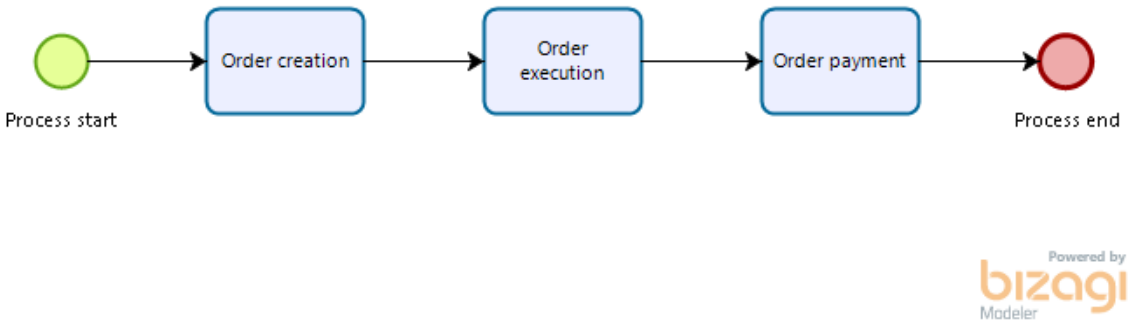

Figure 4 High level process scheme.

The first subprocess – Order creation has 5 variants of flows depending of what is needed to be ordered and for what purposes. Depending of that the process has different steps and executed in different systems.

First variant is order for common goods, which doesn't has any specific handling and legal requirements. All steps executed in one system and process seems well automated.

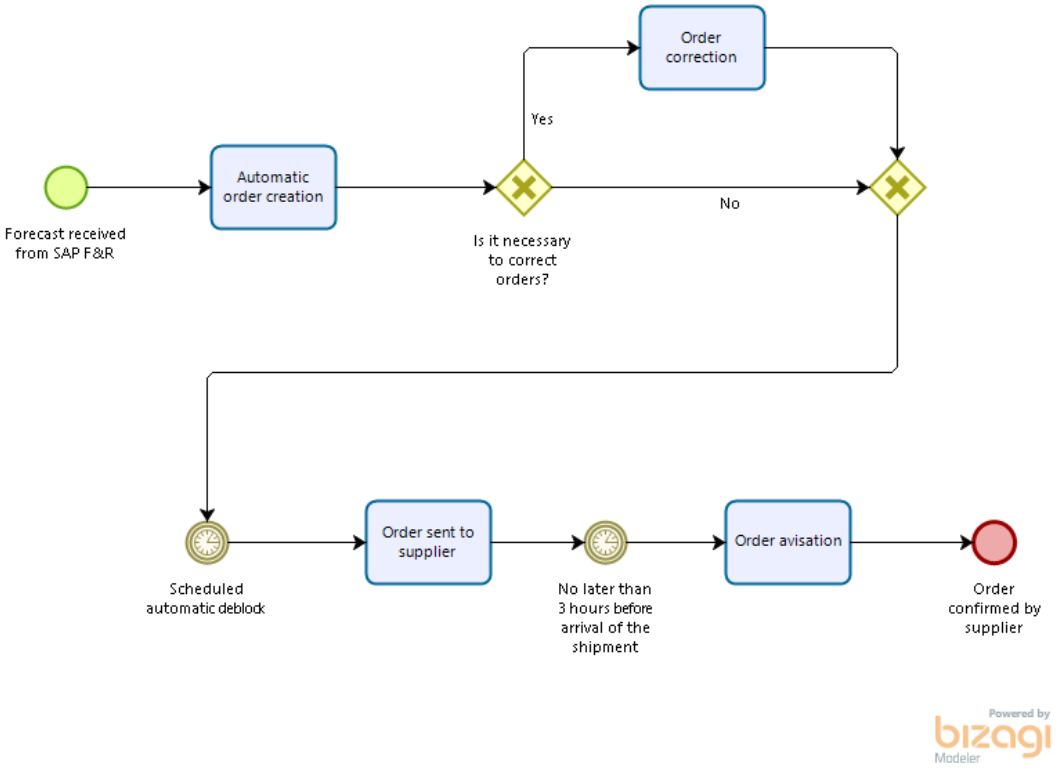

Figure 5 Standard orders

For fruits and vegetables there are another process steps because of the short shelf life and special handling. The main difference here is quite a lot steps right from the beginning of the process are done manually.

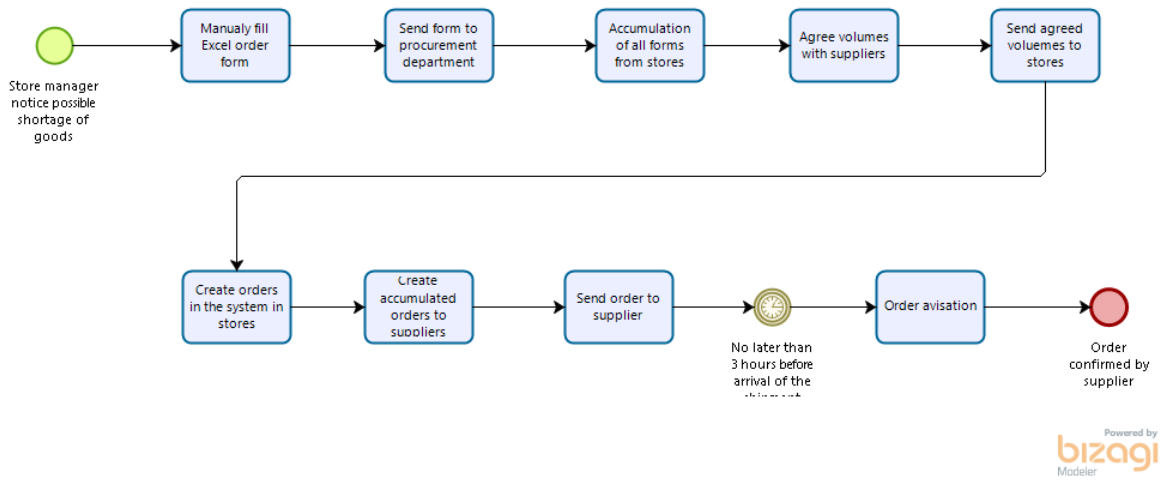

Figure 6 Orders for vegetables and fruits

Orders creation for frozen food is quite similar to the standard but could have some restrictions for order editing in the system.

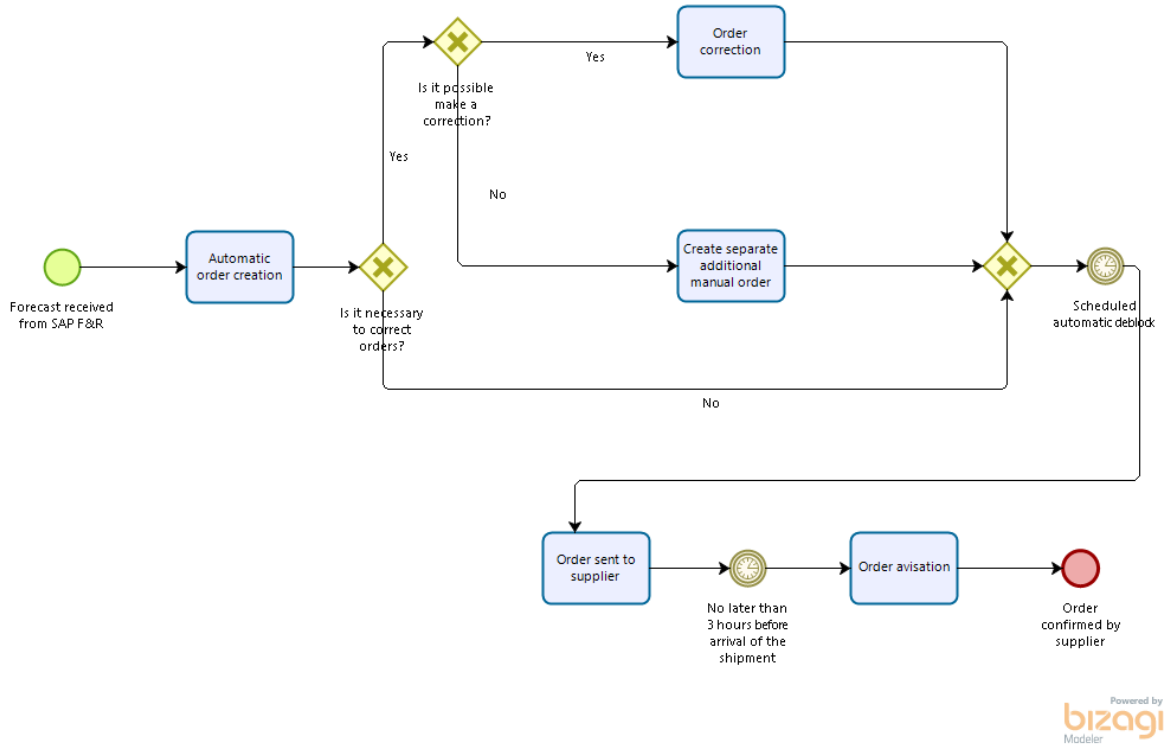

Figure 7 Orders for frozen food

Orders for marketing campaigns are created slightly different because of the PUSH approach for calculating and planning demand.

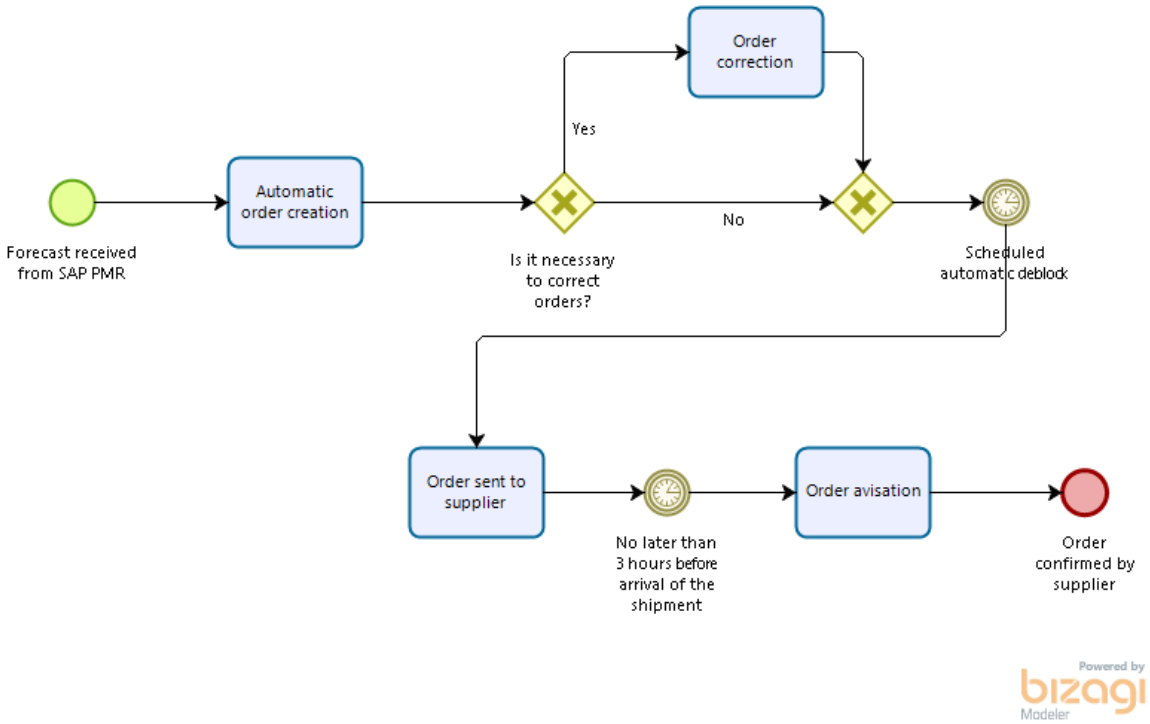

Figure 8 Orders for marketing campaigns

All previous scenarios are executed in SAP Retail system, the last variant is done in separate system – SAP ERP, which is used for manufacturing and in store restaurants.

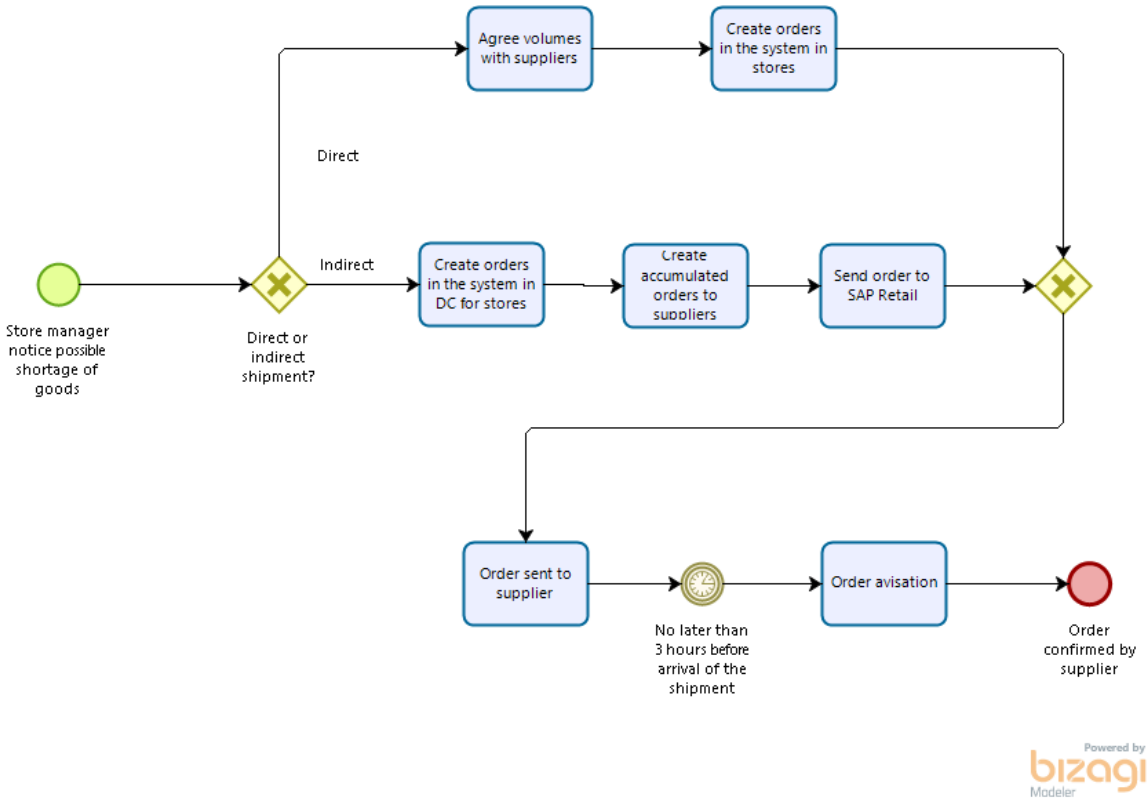

Figure 9 Orders for manufacturing

Despite different steps, involved parties and systems all these scenarios are ended with the same result – order received by supplier and confirmed. After that next block of steps within order execution is performed. Order execution has two variants depending on where the goods should be received in store or DC.

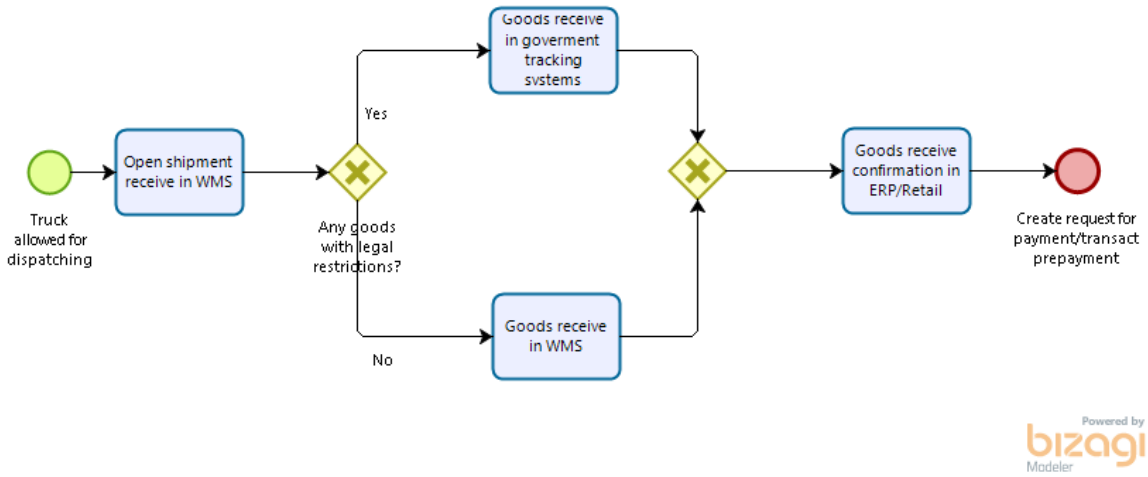

Figure 10 Goods receive in DC

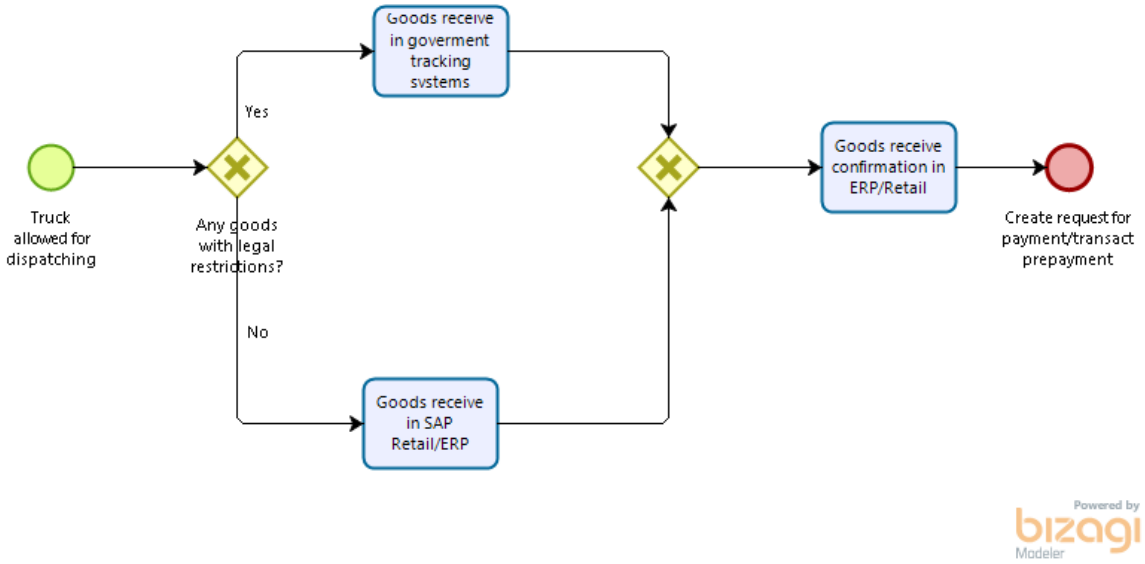

Figure 11 Goods receive in store

The last subprocess – payment has just one base variant, but executed in separate system.

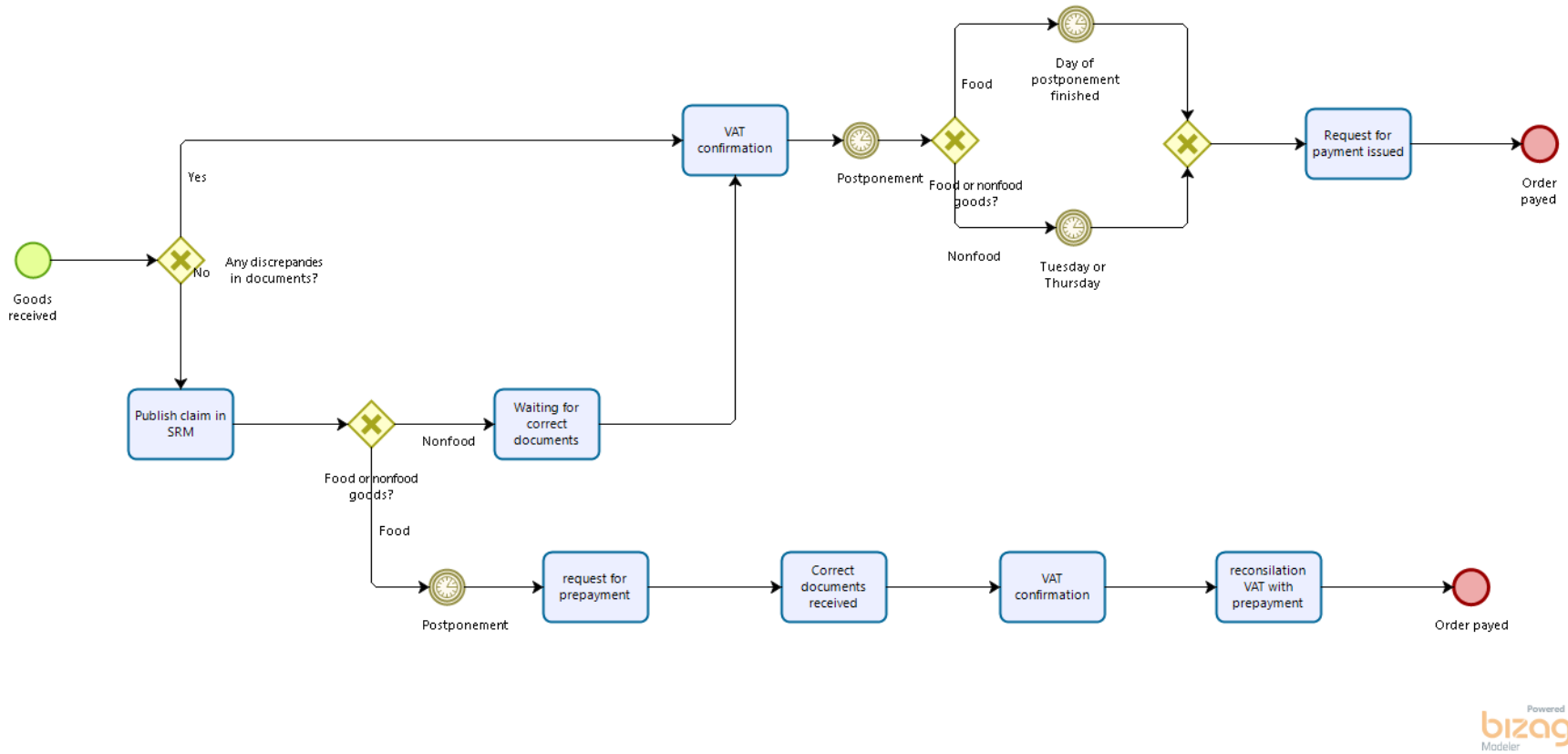

Figure 12 Payment

Later we will compare how these schemes differentiate from what was collected directly from the system logs.

4.1.3. Selected KPIs

Based on the conducted interviews the following KPIs were selected by key stakeholders to be monitored and analyse in the EMS, they are split by defined subprocesses:

Order creation

KPI	Short description
% of not executed orders	Because not every order is executed its necessary to track the amount of such orders to see if there is no overproduction in the process.
% of manual advised	Sometimes suppliers do not send advise for the orders or doing this in the wrong way. According standard contract terms this could lead to certain penalties and potentially this is a point for automation.
% of confirmed quantity	Usually, supplier should be committed to fulfil the orders by not less than 95%. Thus, this KPI should be closely monitored.
% of automatization	This KPI could give insight on how many steps in the process are performed automatically.
% of orders sent to suppliers on time	Company's staff should also meet agreed rules and create all orders on time. Violating these rules could lead to shortage of the products.

Table 2 Order creation KPIs

Order execution

KPI	Short description
Average time for shipment receiving	Normal KPI should be no more than 2 hours. This KPI is monitored by supplier and company should comply with it.
% of confirmed orders on time	All orders should be confirmed no later than 3 hours before shipment arrival.
% of errors in EDI	Errors in EDI with suppliers can lead to increased time and manual operations in the system. Thus, the number of errors should be monitored and examined.
Interrupted shipment receiving	Case when shipment receiving process is interrupted may lead to the loses to the company. Currently there is no statistic in the

KPI	Short description
	company for such cases. But it was confirmed that sometimes it happens.
% of errors in government tracking systems	Such errors are leading to unavailability of the goods as without proper confirmation from government some goods can't be sold in the market (alcohol, meat, milk and cigarettes).
Average order execution time	Depending of the type of goods orders should be executed by suppliers within from 1 to 14 days.
% of confirmed but not delivered orders	This type of nonconformity is leading to product shortage and should be carefully monitored.
% of delivered amount of goods	Usually, supplier should be committed to fulfil the orders by not less than 95%. Thus, this KPI should be closely monitored. This KPI is correlated with one in Order Creation subprocess.
% of orders with correct documents	As it seen from the payment process scheme incorrect documents are leading to longer and more complicated process execution.
% of correction in the documents	This KPI represent redoing waste.
% of automatization	This KPI could give insight on how many steps in the process are performed automatically.
Discrepancies between SAP and government tracking systems	Such type of discrepancies could lead to fines to the company.

Table 3 Order execution KPIs

Order payment

KPI	Short description
Time from receiving to payment	Payment is always should be done on time according to the contract, so this KPI will show if there any nonconformities in the process.
% of prepaid orders	Normally all orders should be paid after receiving goods with correct documents. But in some cases, with food suppliers prepayment is strictly necessary according to the law even if supplier didn't provide company with correct documents and without documents this type of payment is considered as prepayment.

KPI	Short description
% of automatization	This KPI could give insight on how many steps in the process are performed automatically.
% orders with claims	Number of orders where the claim is issued to the supplier.
% of orders with discrepancies in price in the documents	Payment is always executed based on the price in the document and sometimes this price differs from the price in the system. This is leading to additional steps in the process and increasing time for the process.
% of correction in the documents	This KPI represent redoing waste.
Amount of fines to suppliers	This metric will be interested to analyse comparing to nonconformities in the process related to particular supplier.

Table 4 Order payment KPIs

4.1.4. System architecture

Based on the interview we selected information systems were the steps of the process are executed:

- SAP ERP
- SAP Retail
- SAP EWM
- SAP FI
- 5 self-developed systems used to work with government tracking systems
- SAP SRM

Potentially 2 more self-developed systems could be included into the scope. These systems are used for yard management in DC and stores. They can give us more information about the process and answer the questions what is happening before truck arrival and shipment receiving starts. But currently these systems are not integrated to SAP ERP/Retail so it is impossible to match activities in these systems to the particular shipment.

High level EMS architecture of the solution is shown on the following picture:

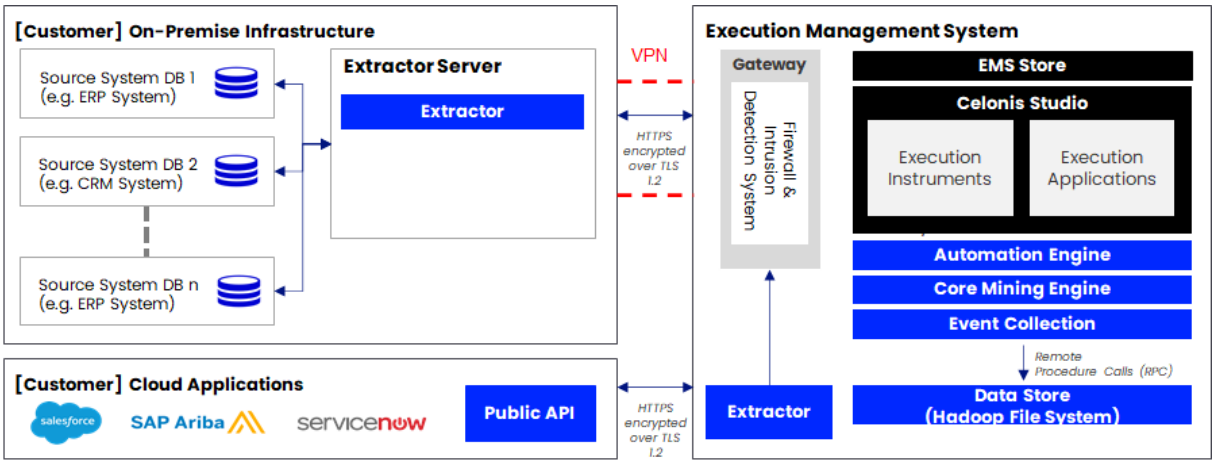

Figure 13 High level technical architecture

Proposed solution is consisting from the following 3 main components:

- EMS – core system is a cloud system and delivered based on SaaS model
- Source systems – in our case there will be 10 systems mentioned above
- Extractor server – this component is installed on-premisses on company's infrastructure and will be used to harvest data from source systems and deliver it to EMS for further analysis.

Between company's infrastructure and cloud VPN tunnel is setup to comply with information security policy requirements.

Celonis supports different mechanics to collect data from source systems. For the current project two methods will be used:

- For all SAP systems RFC native module integration will be used developed by vendor – Celonis
- For other systems PUSH API will be created on Celonis Extractor Server so systems will push data into Celonis using integration bus SAP PI.

4.1.5. Automation

At the moment of design creation there was not many requirements related to automation for the processes. Based on interview there were two main reasons for that:

- 65% of the stakeholders didn't hear anything about this kind of software and didn't have any idea how this could help in their work.
- 20% of stakeholders do not have confidence in ML algorithms that will be used to automate their processes and would prefer to receive any recommendations and see analytics to take actions by humans rather than machines.

Nevertheless, the following list of possible scenarios for automation was created with agreement to review it based on the results of process analysis:

Automation task	Short description
Violation of delivery quota by suppliers	In case of violation or potential violation of delivery quota by supplier the system should inform all involved parties.
Errors in EDI	All discrepancies in EDI should be monitored by the system and automation scenario should be triggered in these cases.
Inform suppliers in case of violation of the contract terms	E-mail or short text message should be sent to supplier in case of any violation of the contract.
Inform managers in case of any nonconformities	Inform stakeholders in case of any errors and nonconformities in the process.
Create claim in SRM	For some violations of the contract system should automatically create claim in SRM.

Table 5 Automation tasks

As it can be seen from the list most of the tasks except the last one are related to some actions performed outside of transaction systems, but we will test ML on them to see how good system can predict possible negative scenarios. The last action is purely lies in RPA paradigm.

Later in case study will be described how these tasks will transform during the project realization and assess benefits of using automation.

4.1.6. Selected dataset and data model

As it previously described in section 4.1.4 System architecture to extract data from SAP systems we will use standard RFC connectors from Celonis. This allows to use native data extraction and all standard data objects can be extracted without significant time-consuming efforts.

Based on process workflows and review with SAP consultants the following data tables will be extracted from SAP systems:

- Order header
- Order line item
- Order history
- Order delivery confirmation
- Delivery header
- Delivery line item
- Material Management invoice header
- Material Management invoice line item
- Suppliers
- Materials

For SAP FI and government tracking system PUSH API will be created on Extractor server to receive the following information from source system:

- Material Management invoice header
- Material Management invoice line item
- Finance invoice header
- Finance invoice line item
- Universal payment document header
- Universal payment document line item
- Incoming delivery header
- Incoming delivery line item

For SAP FI this type of connection was chosen due to security requirements – control of extracted data should be on SAP FI side. For self-developed systems we will use PUSH API as there is no standard connectors from Celonis and data base structure is not fixed, so any changes will impact on the ability to extract the data.

Corresponded data model is created in Celonis to store all this information. Each table connected through external keys.

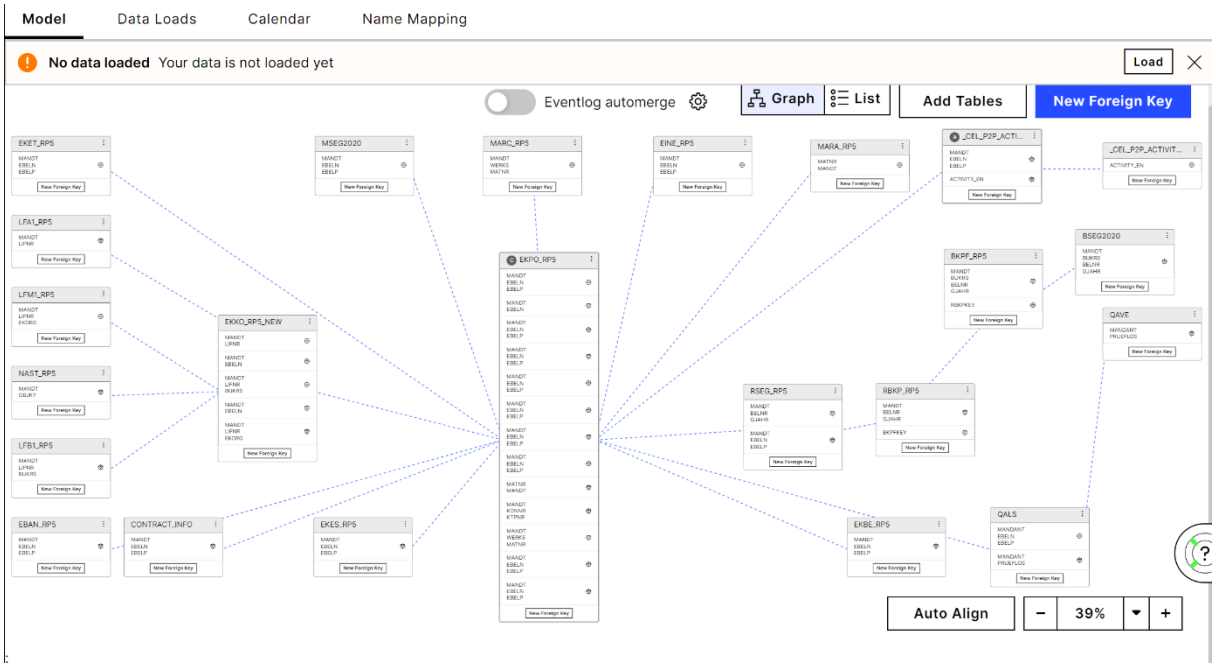

Figure 14 Celonis data model

Data model was created using SQL Vertica script which is a standard for Celonis EMS. The key table in the model is activity table. It has sequence of all activities related to the selected process in agreed with the customer notation. Primary key in this table is ID of the marker – one particular exemplar of the process, in our project we used aggregation of order ID and ID of line item related to it, as in process suppliers can execute orders by line items so it is needed to track all activities on line-item level.

Second important table in the model is order header. It contains all information related to the order so the customer can not only see the process steps itself but to see all business relevant information about the order like supplier, manager, date of creation, contract and etc.

Other tables are connected through order header table containing master data information (like supplier information) and transactional data (line items).

As data space in the Celonis cloud is limited we didn't include all information related to the orders and the process at this stage, just strictly necessary. Later when the analytical reports and KPIs will be built we will check with the business if any additional information will be required to be added to the model. This will be described in the future chapters.

4.2. REALIZATION

Based on the created design we start realization of the project. The following activities were executed in this stage:

1. Build connections and interfaces
2. Upload test data
3. Build dashboards with agreed KPIs
4. Evaluate results with stakeholders
5. Adjust data model
6. Build automation

This chapter describes in more details these main steps of the realization phase.

4.2.1. Building connectors and interfaces

For building data model in design phase, we used already prepared downloaded data from source systems. In order to monitor the processes near on-line we have to build specific extractors and integration interfaces with source systems in order to upload the data in our database in EMS.

For SAP systems we agreed to use native Celonis extractors – specially developed ABAP programmes installed in the source systems, which establish RFC connection with extractor server and send requested information.

One of the advantages of using standard Celonis extractors is that they can be used to execute different ABAP programs in the source systems by request from EMS. This can be used in the future to program automation algorithms for automation of the processes.

To setup extractors there is no need to have any specific programming knowledge so we spent less than a week to setup all extractors with 3 SAP systems which were in scope of the project.

Setup of the extractor consists from the following steps:

1. Installation of the extractor to the source system – this step was executed by SAP administrators using installation manual, provided by Celonis.
2. Establish connection – in this step we setup connection parameters to the source system.
3. Wright extraction script – Based on the interview and studying source system data structure in Design phase we created the list of tables in source system which needs to be extracted to EMS. For the first prototype we extracted all fields from selected tables. However, to optimize the space utilisation as further step we plan to extract only the fields which are required for data model. Another reason to extract all data from the selected tables for the first prototype is that based on the future review with the stakeholders we might require to add some additional fields to our data model and represent them in the dashboards.

For non-SAP system we built 5 interfaces which use PUSH API to receive data EMS require to fulfil our data model. The disadvantage of using this type of integration with EMS is that in case of rebuilding the model this information can't be requested by Celonis users, in our case this information can be

uploaded only with the technical help by SAP PI administrators. This adds complexity for the testing process.

Building PUSH API interfaces has the following steps:

1. Agree XML structure – here were involved 3 parties: our team as a receiver of the information, source system development team and PI team. On this step we have to agree XML structure and naming of the tegs.
2. Setup interfaces – based on agreed XML format for each interface we created a table, where received information will be transferred. For each type of XML format, we created the rules for extracting information from received XML file ant to put this information to the specific field in the table.
3. Agree and setup exception rules – one of the important steps in building interfaces is to agree with the sender of information what could be exceptions in data transfer and how they must be treated. On this step we agreed with PI team typical error codes and rules to be applied for each of them to maintain data integrity.

For 5 interfaces we spent about 3 weeks as this process is far more time-consuming comparing to using Celonis extractors.

4.2.2. Upload test data

Uploading data into our data model consists of the following steps:

1. Extract data to extraction tables – extracted data is not uploaded directly to the data model. Extracted or received by API data stored in interim tables. At this step we are checking how are working our extraction or XML parsing rules. Based on the results of this step we did some corrections and developments to make extraction process work better.
2. Examine extracted data – before uploading data into data model we have to examine and study received data. The main purpose of this step is to check if we selected the right format type for the fields of our data model and correct it based on the findings if needed.
3. Wright transformation scripts – transfer of extracted data into data model is done using transformation scripts. Using SQL Vertica, we wrote scripts to upload all the necessary data into data model.

```
    ,CASE WHEN CDPOS.VALUE_OLD IS NOt NULL THEN 'Change requested delivery date'
     --     ELSE 'Set requested delivery date'
    END AS "ACTIVITY_EN"
    ,CAST(CDHDR.UDATE AS DATE) + CAST(CDHDR.UTIME AS TIME) AS "EVENTTIME"
       ,CASE WHEN VALUE_OLD IS NOT NULL THEN 1520
        --   ELSE 1510
    END AS "_SORTING"
    ,CDHDR.USERNAME AS "USER_NAME"
    ,USR02.USTYP AS "USER_TYPE"
    ,CDHDR.TCODE AS "TRANSACTION_CODE"
    ,'<%=SOURCE_TYPE%>' AS "SOURCE_TYPE"
FROM
    CDPOS AS CDPOS
    inner JOIN EKET AS EKET on 1=1
        AND CDPOS.TABKEY = EKET.MANDT || EKET.EBELN || EKET.EBELP || EKET.ETENR
    inner JOIN ekpo AS E ON 1=1
        AND EKET.MANDT = E.MANDT
        AND EKET.EBELN = E.EBELN
```

Figure 15 Example of transformation SQL script.

4.2.3. Build dashboards with agreed KPIs

When all sample data were uploaded into data model, we started building dashboards. Based on the previously agreed KPIs we setup 7 dashboards in order to monitor and analyse process:

1. Process flow.
2. Overall information.
3. Percentage of completed tasks.
4. On-time delivery.
5. Payment conditions
6. Automation level
7. Conformance

4.2.3.1. Process flow

First dashboard contains information about all variants of process flow and steps performed in the systems for each occurrence of the process.

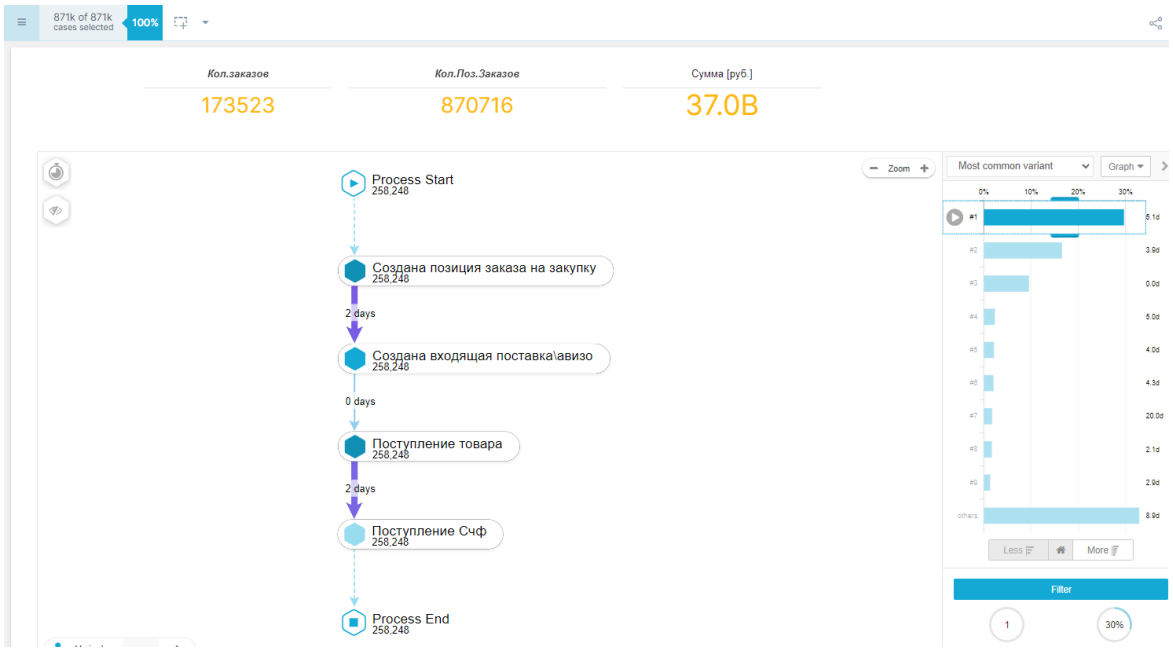

Figure 16 Process flow dashboard.

It also has basic KPIs of the process:

1. Number of orders.
2. Number of order items.
3. Total value of orders.

4.2.3.2. Overall information.

This dashboard contains more information about the process statistics and type of orders.

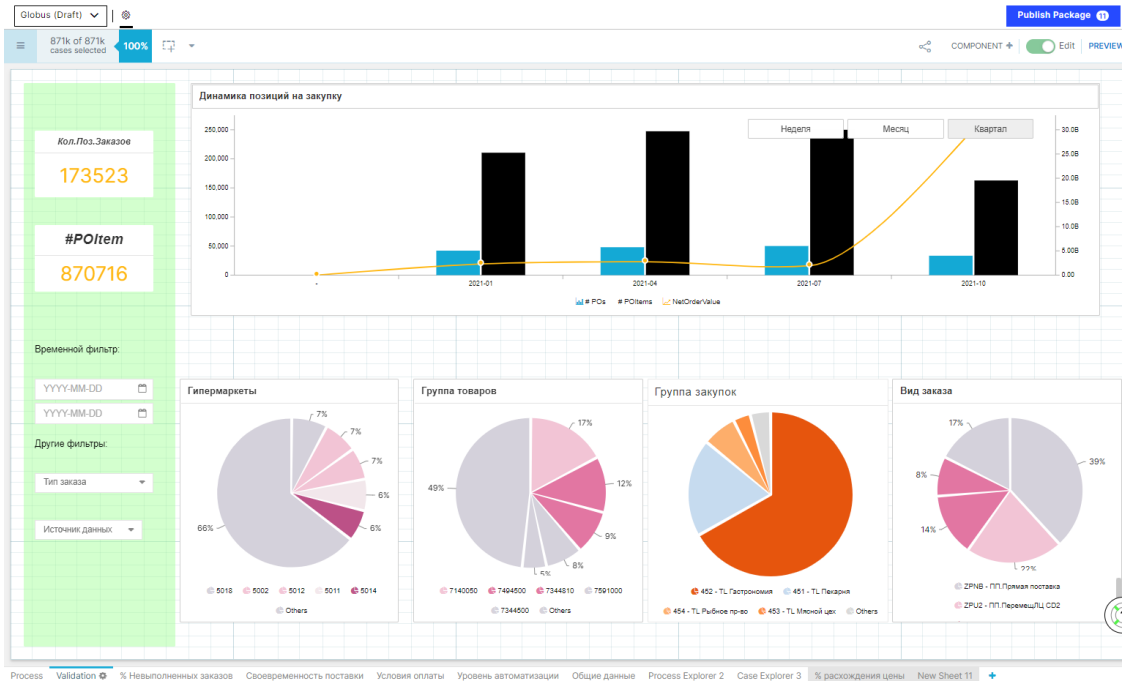

Figure 17 Overall information

The following KPIs displayed on this dashboard:

1. Dynamic of order's items.
2. Procurement group.
3. Type of order filtering.
4. Type of order statistics.

4.2.3.3. Percentage of completed tasks.

This dashboard contains information about quality of the deliveries comparing orders and shipments quantities.

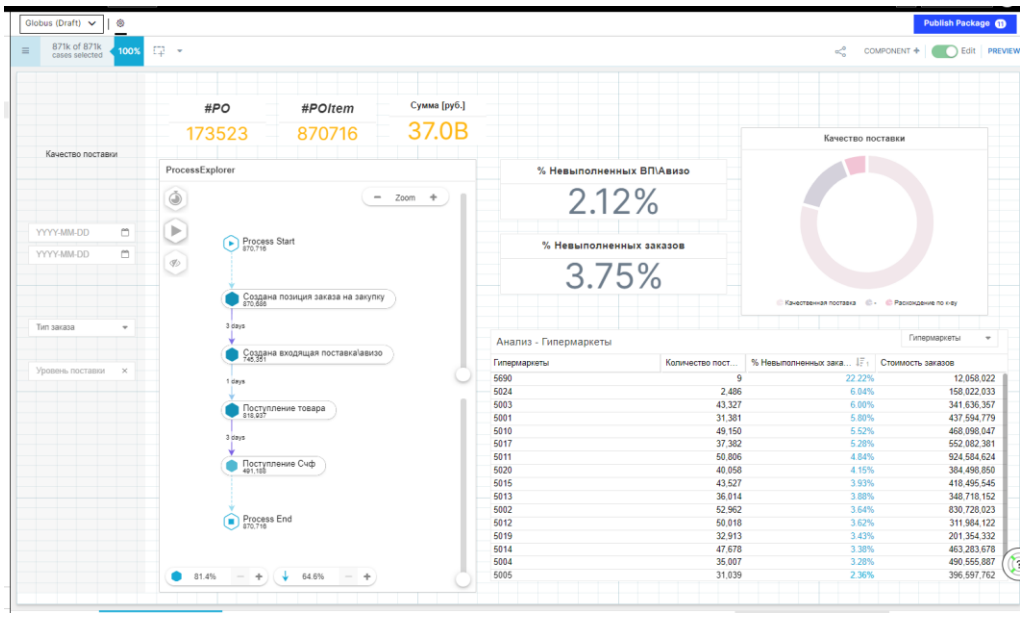

Figure 18 Percentage of completed tasks.

The main KPIs presented on this dashboard are the following:

1. Percentage of incomplete orders.
2. Percentage of orders without confirmation from the suppliers.
3. Percentage of not delivered orders.
4. Quality of deliveries.

All these KPIs can be calculated in regard to stores, suppliers, groups of procurement/delivery, SKUs and timeframe.

4.2.3.4. On-time delivery.

The main purpose of this dashboard is to calculate on time delivery KPI and to explore any patterns in late deliveries.

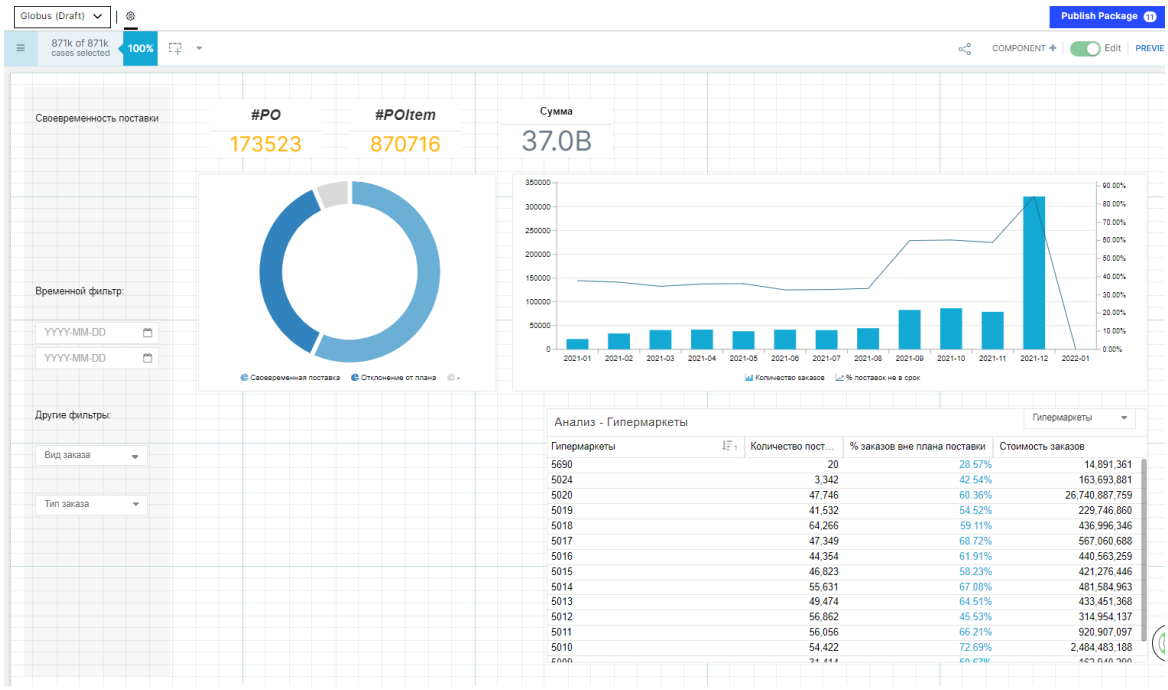

Figure 19 On-time delivery

4.2.3.5. Payment conditions

This dashboard gives information about payment conditions and checks whether the payment was done on-time, delayed or was performed too earlier.

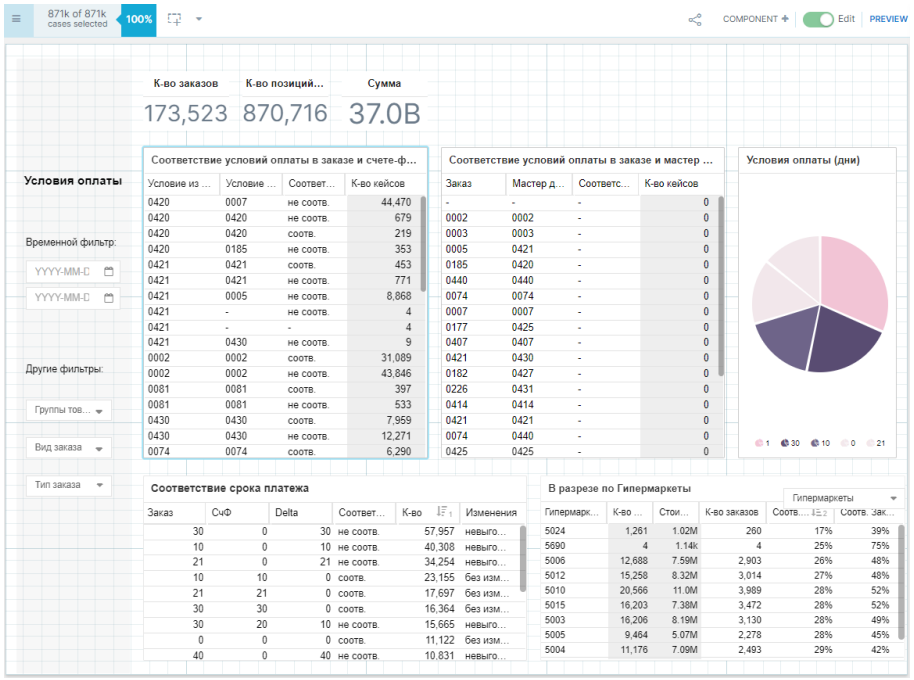

Figure 20 Payment conditions

The following KPIs are presented on this dashboard:

1. Payment conditions.
2. Time of payment conformance.
3. Changes in payment conditions.
4. Percentage of payment conditions conformance.

4.2.3.6. Automation level

The purpose of this dashboard is to analyse and calculate of automation level of the process – how many steps in the system performed automatically without any intervention from the users. In this dashboard automation level KPI is calculated with regards to the steps of the business process.

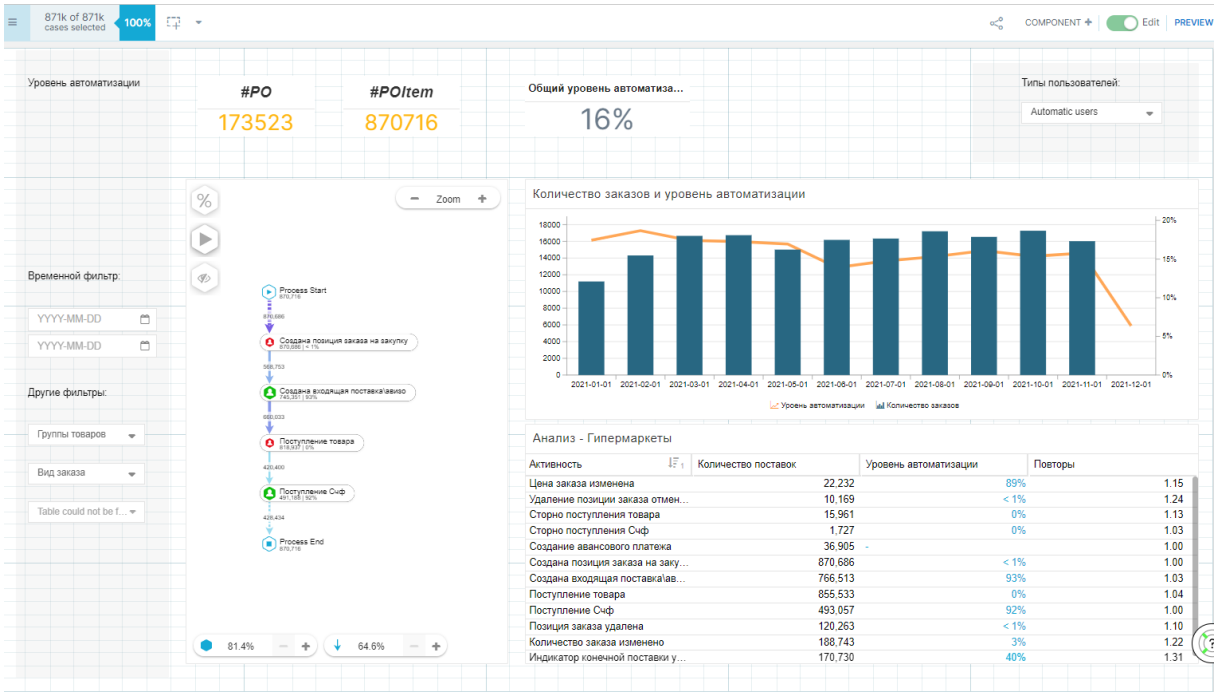

Figure 21 Automation level

4.2.3.7. Conformance

The last dashboard aims to find nonconformities in the process based on the comparison with reference business process flow. Based on the analysis of existing variants of the business flows with the one we created at the beginning of the project and described in chapter 4.1.2.Process overview there is just less than 10% of all variants comply with it. So, for the first prototype we decided to choose for the reference process flow model with which 30% of the variants comply and it doesn't contain any redo and garbage steps.

As the next step, we will discuss this model with the key stakeholders and make adjustments based on their feedback.

We suggest each half a year check and evaluate the chosen reference model as the process can evolve in time. Celonis EMS has its own ML algorithms to check and analyse the existing process flows, based on this analysis and findings existing variants of the process can be researched and some of them can be used for new reference model.

4.2.4. Evaluating results and adjusting the model.

To ensure good quality of the model we executed several steps to evaluate the model and make proper adjustments to satisfy the business requirements and alignment with the business goals of the project.

This process can be displayed on the following scheme:

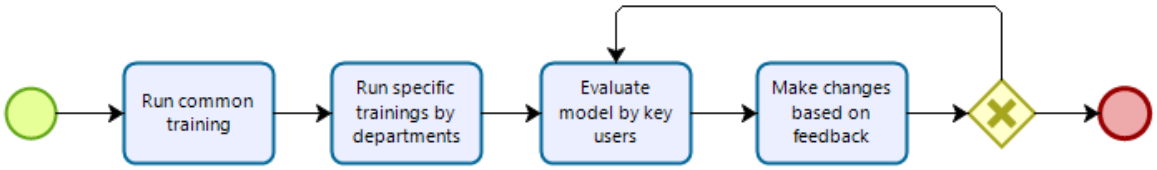

Figure 22 Evaluation process

As shown on the scheme, first of all we conducted a common training for all key users where we trained them how to use dashboards, create queries and filter results. This step contains basic training of main capabilities of the Celonis to navigate and understand results of the filtering.

After that we organized specific trainings for each involved in the project department where we explained to business users:

- how KPIs calculated;
- how create specific filters;
- how assess the results of the filtering;
- how calculate specific KPIs using the existing ones;
- how explore process flows with the regards to existing filters.

At the same time, we received feedback from the business users about usability of the created dashboards and interpretation of some steps and sequence of the steps in the process flow.

To ensure better understanding of the system and involve key users in process exploring we created questionary. To answer questions, users have to explore deeply the process and understand analytical tools of EMS.

Within next two weeks we answered the questions from business users, receiving feedbacks regarding system functionality and data model. Based on it we did some changes in data model, KPIs calculations and dashboards design.

By the end of this phase, we ensured system readiness for production usage and agreed to connect it to the production data.

4.2.5. Automation in the process.

EMS has ML capabilities to react proactively in case if some nonconformities will be forecasted. Based on the discussion with keyholders we decided to use them but without direct involvement into the process (create automatic process steps and postings in the system). This decision was directed by the following reasons:

1. Key stakeholders do not have confidence in the system and its algorithms.
2. Direct access for changes in some of the systems was not allowed by global security policy.
3. The business rules itself for reacting to some of the predicted issues in the process were not in place and pilot was requested before they can be applied.

As a result the following automation actions were setup in the system:

1. Inform manager in case of delivery delayed.
2. Inform manager if KPI of the order delivery below agreed threshold.
3. Inform manager if payment conditions were violated.
4. Inform manager if ML algorithms will find any patterns that shipment could be delayed or not delivered.

Thus, no direct actions in the system were setup in EMS, the business agreed to monitor the alerts and in case if in the future the algorithms prove efficient and accurate the business might consider to use them to setup some automated actions in the target systems like:

- Stop the payment for supplier.
- Cancel the order.
- Create invoice to supplier with fines.

The most interesting for us in pilot will be exploring how accurate ML algorithms will predict any nonconformities in the process as this could proactively alert business and make corrective actions before the problem will appear.

4.3. GO-LIVE AND PROJECT RESULTS

Business process optimisation is iterative process and it takes some time to make some changes and evaluate the results. During the preparation of this document the company has been working with the software less than half a year. So, at the moment there is no any confirmed and proved benefits the company received. So far, based on our findings and exploration of the process the business has implemented some corrections to the process that are scheduled to be evaluated by the end of this year.

In this chapter the key findings will be presented as an outcome of the project, corrective actions the business decided to implement based on them and lessons learned from the project.

4.3.1. Key findings and improvements in the process

By exploring different variants of the process, we noticed that just less than 30% of all occurrences has good KPIs and doesn't contain any garbage steps. Other 70% contains different deviations from lean process variants and their improvement could bring value to the business.

Based on our findings we classified most common of them and proposed actions to be taken to improve the situation.

Findings	Root cause	Possible solution
11% of all orders not met agreed quality conditions of the shipments. Most of the low-quality deliveries came from orders for a large amount and with a small number of items of goods. In case of exceeding tolerance framework, the company has the right to impose fines on suppliers.	With a tolerance (recommendation to suppliers on the quality of deliveries) of the agreed percentage, there are suppliers with an annual number of orders up to 88, who brought orders with underdelivery in 100% of cases. By the number of orders with discrepancies, the most frequent underdeliveries fall on the purchase groups: Butcher shop (2%), Household chemicals and cosmetics (1%), Drinks Beer (1%).	• Intelligent notification from EMS to an employee that an order has been fully delivered and the shipment has arrived with a quantity discrepancy allowing the supplier to be penalized. • Automating postal fines to a supplier with EMS. • Real-time notifications if there is an underdelivery with the ability to take action directly from EMS and avoid losses for hypermarkets.
Inconsistency of the conditions of deferral in a disadvantageous direction ● 668.637 orders with incorrect invoices / 2378 suppliers ● 3.502 orders with incorrect master data / 53 suppliers For such cases, a new payment date is set (manual changes and subsequent approval steps)	Irrelevant master data of terms of payment to suppliers. Suppliers change payment terms when sending invoices.	• Comparison and highlighting of cases when the conditions in the invoice are worse than those entered in the order - the ability to automatically update the conditions. • Notifications to the managers about early payment or change of conditions after the order is created. • Notifications when an order is entered with a divergence of conditions from the supplier's master data. • Automation of the approval process when changing the terms of payment.
The level of on-time delivery to the company is 91%, for internal movements - 46%. 42,511 orders were delivered late by suppliers,	Delay of the shipments by suppliers.	• Inform manager about delays in shipments. • Automation of the process of deleting an order when the shipment is late (did not arrive on the

Findings	Root cause	Possible solution
resulting in a duplicate of the entire order with a new delivery date. 22,729 orders were delivered too early, which in part leads to additional storage costs.		appointed day) by EMS. • Copying the deleted order after agreeing a new delivery date from EMS.
The number of orders with price discrepancy is 218.984. Of these, about 10% are processed manually, and not by automatic EDI claims. A tolerance limit of no more than 5% of the total order amount is taken into account. Promotional orders excluded. Processing orders with price discrepancies require additional labour from multiple departments.	Incorrect maintenance of the purchase price in the order / late price updates in the order. The supplier does not provide the current price on time. In 102.165 cases, the invoiced price exceeds the acceptance amount by more than 50%.	• Automatic price updates from the supplier in the data master and workflow.
9,699 invoices were delayed by more than 45 days. Delays in receipt of invoices lead to delays in VAT refunds in a given quarter and a negative effect on working capital.	Suppliers are delaying in creation and sending of invoices.	• Communication through EMS with suppliers to control the process of timely provision of invoices.
The overall level of procurement process automation is 70.72%. Some highly repetitive activities have good level of automation, indicating that automation is technically feasible, but not always used.	For certain types of orders, additional automation through Celonis is possible: - Create order item - 490k manual changes - additional savings of 0.74 FTE - Delete order item - 20k manual changes - additional savings of 0.27 FTE - Change of delivery completed indicator - 236k	• Workflow for automatic updating of data from EMS in the retail system based on relevant and consistent business logic • Smart notifications with EMS identifying systematic manual adjustments • Automation of the process of deleting order positions with EMS

Findings	Root cause	Possible solution
	manual changes - additional savings 0.21 FTE - Delivery date change - 25K manual changes - Additional savings of 0.16 FTE	
Last year there were more then 800 000 payments made, of which 34% were made too late and <1% too early. Too early payments have a negative impact on working capital. Paid too late can hypothetically lead to fines from supervisory authorities.	Errors in data master on deferral.	• Intelligent notifications of early payment in accordance with the terms of the contract. • Intelligent offer for payment when the moment of payment comes in accordance with the terms of the contract or with the terms of the law.

Table 6 Classification of findings

Based on the finding and agreed with the business actions we setup in the EMS rules to inform relevant managers about incidents. The business decided not to implement automatic actions at this stage as it has some concerns regarding logic behind and decided to pilot and check accuracy of the system to be hundred percent sure that the algorithms were setup in the right way.
Also, we noticed that quite a big number of nonconformities in the process comes from errors in master data governance. The company decided to audit current process and probably consider using EMS to dive dipper into it and explore actual process flows in the systems.

To increase current automation level business decided to raise 4 CRs to existing systems in order to automate some steps of the processes which doesn't require manual checks. EMS gave to the business insight about what value this could bring to the company and justify investments.

4.3.2. Lessons learned.

By the end of the project, we met with key users and stakeholders to assess the results and examine mistakes and difficulties we had met during the project. As a result, we prepared a table with key issues and lessons learned.

Issue	Lessons learned
At the beginning of the project, we spent a lot of time on integration architecture of the system. There was a request form Information Security not to use any addons to SAP, which allows to obtain the data from outside of SAP systems (sending the data should be initiated from SAP system).	As we learned from the project this approach will lead to the increase of efforts and costs of the project as new interfaces need to be developed, tested and maintained in the future. So, for the systems where we built interfaces from scratch, we spent much more time to setup them and to force them running comparing to using out of the box Celonis's connectors. In the future these interfaces will require more effort to support and keep them running as it will require involvement of 3 specialists (Celonis, SAP PI and source system) in case of any changes.
Business users thinks that they know the business process well but sometimes it is not the case. Especially when the process goes not on happy flow scenario the number of steps and systems involved in the process can be increased. This leads to the changes in the initial design	In our project we had separate sessions with key business and IT users. As it came out it is better to organise common sessions with IT and business where IT could verify and prove the business steps and confirm overall approach to the architecture and data we plan to use for our model.

Issue	Lessons learned
and architecture.	
The quality of data not always allows us to use initially planned data model. Based on the examination of data we had to change our data model several times.	It is always better at the beginning of the design phase examine data in the systems. For some dictionary tables it make sense to run cleansing process in order to use it for reports and analysis. Also it make sense to revie and examine current data flows between the systems to choose the right master system for data source. And it is very important to do it with the reference to the business process we are trying to mine.
In the project we use a mix of waterfall and agile methodology to run the project. For realization we choose agile as the requirements and scope were not 100% fixed. As it turned out, it was right approach to changing several times KPIs we want to measure and systems we want to include into the scope.	For projects where the scope and final results have some uncertainties it makes sense to use agile project methodology to be more flexible and get the result which is desired by the customer. At the same time to manage the budget and time it is better to agree at the beginning some rules how the changes need to be managed within the project and final deliveries.
Examining the process, we noticed that there were some changes in the steps of the process variants with the time. Based on our interview with the key users, we concluded that the process evolves and changes in response to new business challenges.	When building reports and assessing KPIs it always makes sense to evaluate factor of time and check relevance of KPIs to current state of process. In some cases, it doesn't make sense to include into sample data obtained for long period of time because it will not represent the present situation.

Table 7 Lessons learned

4.3.3. Final recommendation

By summarising results of the project and lessons learned the following list of recommendations could be taken into account for future projects:

- Use vendor recommended approach for the project. Every vendor already has portfolio of delivered projects and based on them created list of recommendations and even methodology of implementation which can be used for particular project. This will help save time and efforts for implementation.

- Interview with the key business users could help understand business process in general, but detailed workshops won't brig much value. The efforts and time spent for detailed discussions of the process doesn't make sense for PM software implementation.
- Data quality always will be an issue and specific steps for data cleansing and research needs to be planned and taking into account.
- During design phase extended set of attributes needs to be planned for model building (e.g. article master data, suppliers master data, contract details etc.). This will help in future analyses. It will be easier to collect as much data as possible in the beginning and delete redundant in the future rather than trying to analyse the process only by looking at different variants without context.
- PM software implementation is an iterative process and classic waterfall methodology probably not the best option for it. This should be taken into account for planning and contracting.
- Analysing results the factor of time and evolution of the processes should be taken into consideration. In some cases analyse of last year's process variants won't bring any value as the process may already changed and some new policies were applied in the company.
- To evaluate the process the reference model should be selected. This could be a limited number of variants which businesses consider as normal.
- To find nonconformities business agreed KPIs could be used. By applying these KPIs as a filters for the process abnormal variants could be easily spotted.
- For better analysis of the nonconformities repeatable patterns should be found, as it doesn't make sense to analyze each specific case. Additional process attributes could help find it easier. Also interview with key business users could help in this task.

For future research topics please refer to the chapter 6 TO CONSIDER IN FUTURE RESEARCH.

5. CONCLUSION

At the beginning of this project, I planned to find answers to the following questions:

- How EMS can contribute to the company to achieve target goals?
- How designed KPIs can be transformed through the project?
- How planned business cases to be met through EMS implementation?
- Does RPA really work and help business?
- Can business results to be achieved without EMS implementation?
- What are the main success factors for such kind of projects?

According to the results of the project the company met the target goals and finally received planned business benefits. Process mining software gave to the business insights on how the processes really looks like in the company and what are the main bottle necks for them.

BPMN schemes created by the Celonis EMS visualise actual real process flows and simplify the task for company's departments to find garbage actions in it. With the links between different actions in the process and business metrics (time and money) different variants of the process can be easily evaluated and future improvements in the processes can be justified.

As it can be seen from the chapter "4.3.1 Key findings and improvements in the process", we created a list of actions and evaluated the business impact. The results were assessed by the business users and management of the company. The plan for implementation of these changes was created and execution started by responsible departments of the company.

The list of KPIs we chosed in the beginning of the project had remained the same. However, during the project for some KPIs we agreed with the business to change the method of calculation. Mainly this was done due to the scope restrictions of the project. As for some KPIs, additional information was required from other process or data which had not been in scope.

Based on the interview of the key stakeholders and assessing the results of the project, I would like to highlight the following points:

1. Based on the data analysis using existing BI system, business can find gaps where the process should be explored and some correction may be required. But using BI system for future exploration of the process would require much more efforts to explore the process comparing to the Process mining software.
2. Process mining software has specific tools which helps business visualize and understand the process flows. This functionality is missing in classical BI.
3. EMS functionality which allows business users to receive in real time alerts and notifications if any nonconformities in the business process were spotted. It is essential and allows proactively react before receiving unwanted results.

Thus, the usage of classic BI system can't substitute Process mining software in this kind of tasks but definitely can give initial clues for further investigation and exploration of the processes.

In chapter “4.3.2 Lessons learned.” the main issues which need to be considered in future projects were already described. Here in conclusion, I would highlight key success factors for Process mining software implementation:

1. Using standard solutions recommended by the vendor save time and money. It is always better to start with the implementation of standard functionality (connectors/architecture) and evolve it and develop in the future by the results of the piloting.
2. Business users and IT specialists need to be involved into the project at early stages. They have to participate actively and have a good motivation.
3. Provided data should have a good quality. If it’s not the case would (or will) be better to run data cleansing project prior to start Process mining software implementation.
4. Agile project management methodology should be used for this kind of projects whenever it is possible.
5. The data sample should always be up to date. Using old data and too big periods of time for analysis could mislead.

Unfortunately, in the current project we were unable to fully test RPA functionality and explore its capabilities. But we managed to create a basement for further exploration and were able to setup the rules for alerts which can be used in the future to build automation logic in target systems.

Important to mention that present work has some limitations which need to be considered for future analysis and usage:

1. The work is based on implementation of the specific vendor’s software – Celonis EMS.
2. The client company is an international retailer.
3. This project was delivered for Russian branch of the company.
4. We analyzed just one process – P2P.
5. Core data were obtained mostly from SAP systems for which vendor provides out of the box connectors.

6. TO CONSIDER IN FUTURE RESEARCH

In this chapter I would like to highlight some topics which might be considered for future research:

1. As Process mining software has analytical capabilities of classic BI systems, could it be used as classical BI in the companies? To what extent it can substitute classical BI systems?
2. How accurate are ML algorithms or EMS? Can a company fully rely on them and when is it necessary to implement human control?
3. ERP versus RPA. As in ERP some control can be implemented (for example using ABAP programming in SAP), does it really make sense to use external RPA or some automation rules can be developed in ERP?

7. BIBLIOGRAPHY REFERENCES

TURNER, Rodney J. (2009): *The Handbook of Project-Based Management: Leading Strategic Change in Organizations*. Mc-Graw-Hill. Berkshire

Dumas, M., Rosa, M. L., Mendling, J., & Reijers, H. A. (2018). *Fundamentals of Business Process Management 2nd Edition*. Springer Berlin Heidelberg

vom Brocke, J., & Mending, J. (Ed.) (2018). *Business Process Management Cases: Digital Innovation and Business Transformation in Practice.* Springer Berlin Heidelberg

Cheah, S., Ho, Y. P., & Li, S. (2018). *Business model innovation for sustainable performance in retail and hospitality industries. Sustainability* (Switzerland).

Cho, M., Song, M., Comuzzi, M., & Yoo, S. (2017). *Evaluating the effect of best practices for business process redesign: An evidence-based approach based on process mining techniques. Decision Support Systems*.

Wang, Jianmin, Wong, Raymond K., Ding, Jianwei (2013). *Efficient selection of process mining algorithms. IEEE Transactions on Services Computing*

Horn, Richard, Zschech, Patrick (2019) *Application of Process Mining Techniques to Support Maintenance-Related Objectives. Wirtschaftsinformatik.*

Marciniak, Piotr, Stanisławski, Robert (2021) *Internal Determinants in the Field of RPA Technology Implementation on the Example of Selected Companies in the Context of Industry 4.0 Assumptions. Information*.

Celonis (2021) *The 2021 State of Business Execution Benchmarks Report. https://www.celonis.com/blog/supply-chain-nightmares-its-time-to-optimize-your-procurement-processes*

Celonis (2021) *Supply Chain Nightmares? It's Time to Optimize your Procurement Processes.*

Marc Kerremans, Tushar Srivastava, Farhan Choudhary (2021) *Market Guide for Process Mining. Gartner.*

W. van der Aalst (2016) *Process Mining: Data Science in Action. Springer Verlag*

Bailey Kong (2021) *Process Discovery & Mining Technology Evaluation 2021. NelsonHall.*

B.F. van Dongen and W.M.P. van der Aalst (2005) *A Meta Model for Process Mining Data. Conference: EMOI - INTEROP'05, Enterprise Modelling and Ontologies for Interoperability, Proceedings of the Open Interop Workshop on Enterprise Modelling and Ontologies for Interoperability, Co-located with CAiSE'05 Conference, Porto (Portugal), 13th-14th June 2005*

Peyman Badakhshan, Jerome Geyer-Klingeberg, Muhammad El-Halaby, Thomas Lutzeyer, Gabriela Vianna Lembo Affonseca (2020) *Celonis Process Repository: A Bridge between Business Process Management and Process Mining, Conference paper Celonis SE*

Aguirre, S., & Rodriguez, A. (2017). Automation of a Business Process Using Robotic Process Automation (RPA): A Case Study. *Communications in Computer and Information Science*, *742*, 65–71. https://doi.org/10.1007/978-3-319-66963-2_7

Andrews, R., Emamjome, F., ter Hofstede, A. H. M., & Reijers, H. A. (2020). An expert lens on data quality in process mining. *Proceedings - 2020 2nd International Conference on Process Mining, ICPM 2020*, 49–56. https://doi.org/10.1109/ICPM49681.2020.00018

Bozorgi, Z. D., Teinemaa, I., Dumas, M., la Rosa, M., & Polyvyanyy, A. (2020). Process mining meets causal machine learning: Discovering causal rules from event logs. *Proceedings - 2020 2nd International Conference on Process Mining, ICPM 2020*, 129–136. https://doi.org/10.1109/ICPM49681.2020.00028

Emamjome, F., Andrews, R., & ter Hofstede, A. H. M. (2019). A Case Study Lens on Process Mining in Practice. *Lecture Notes in Computer Science (Including Subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)*, *11877 LNCS*, 127–145. https://doi.org/10.1007/978-3-030-33246-4_8

Grisold, T., Mendling, J., Otto, M., & vom Brocke, J. (2020). *Adoption, use and management of process mining in practice*. https://doi.org/10.1108/BPMJ-03-2020-0112

Larose, D. T., & Larose, C. D. (2015). *Data mining and predictive analytics*.

Luo, H., & Luo, H. (2021). *Research Article RPA and Artificial Intelligence in Budget Management Based on Multiperspective Recognition Based on Network Communication Integration*. https://doi.org/10.1155/2021/9723379

Ma, Y. W., Lin, D. P., Chen, S. J., Chu, H. Y., & Chen, J. L. (2019). System Design and Development for Robotic Process Automation. *Proceedings - 4th IEEE International Conference on Smart Cloud, SmartCloud 2019 and 3rd International Symposium on Reinforcement Learning, ISRL 2019*, 187–189. https://doi.org/10.1109/SMARTCLOUD.2019.00038

Marcelo Luiz Monteiro Marinho. (2015). *UNCERTAINTY MANAGEMENT IN SOFTWARE PROJECTS*. www.cin.ufpe.br/~posgraduacaoRECIFE2015

Santos, L. P. (2017). Process mining: A recent framework for extracting a model from event logs. *Atas Da Conferencia Da Associacao Portuguesa de Sistemas de Informacao*, *17*, 174–184. https://doi.org/10.18803/CAPSI.V17.174-184

van der Aalst, W., Adriansyah, A., de Medeiros, A. K. A., Arcieri, F., Baier, T., Blickle, T., Bose, J. C., van den Brand, P., Brandtjen, R., Buijs, J., Burattin, A., Carmona, J., Castellanos, M., Claes, J., Cook, J., Costantini, N., Curbera, F., Damiani, E., de Leoni, M., … Wynn, M. (2012). Process mining manifesto. *Lecture Notes in Business Information Processing*, *99 LNBIP*(PART 1), 169–194. https://doi.org/10.1007/978-3-642-28108-2_19

van Eck, M. L., Lu, X., Leemans, S. J. J., & van der Aalst, W. M. P. (2015). PM2: A process mining project methodology. *Lecture Notes in Computer Science (Including Subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)*, *9097*, 297–313. https://doi.org/10.1007/978-3-319-19069-3_19

Viehhauser, J., & Doerr, M. (2021). Digging for Gold in RPA Projects – A Quantifiable Method to Identify and Prioritize Suitable RPA Process Candidates. *Lecture Notes in Computer Science (Including Subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)*, *12751 LNCS*, 313–327. https://doi.org/10.1007/978-3-030-79382-1_19

Wewerka, J., & Reichert, M. (2020). Towards Quantifying the Effects of Robotic Process Automation. *Proceedings - IEEE International Enterprise Distributed Object Computing Workshop, EDOCW*, *2020-October*, 11–19. https://doi.org/10.1109/EDOCW49879.2020.00015

Zhang, N., & Liu, B. (2018). *The Key Factors Affecting RPA-business Alignment*. 978–979. https://doi.org/10.1145/3265689.3265699