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**EXPLORING THE POTENTIAL OF BPMN AND ROBOTIC PROCESS
AUTOMATION INTEGRATION IN END-TO-END BUSINESS
PROCESSES**

Master Thesis

of

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**EXPLORING THE POTENTIAL OF BPMN AND ROBOTIC PROCESS
AUTOMATION INTEGRATION IN END-TO-END BUSINESS
PROCESSES**

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Abstract

Nowadays organizations are in charge of implement many different and complex processes. Business processes are the most valuable asset of an organization. They have direct impact on the effectiveness of the services, the delivery of a product, the fulfillment of all third- party's requirements, and ultimately revenue in case of corporations. The orchestration of the business processes is the challenging part since all the external and internal demands and requirements must be operated efficiently and sufficiently. In a world where the innovation and technology are constantly evolving, organizations with low active demand for technology and innovation services cannot prosper. In demand side organizations must develop a long-term strategy with the key consideration to sustain flexibility, agility and productivity in real time. In this regard, digital transformation is the solution. Business process and business process decision modeling and automation are the core part to achieve digital transformation. However, there is a plethora of available orchestration technologies and each of these technologies have different functionalities, notation languages and APIs and therefore the difficulty to choose and implement the proper one is getting increased gradually.

The ultimate aim of this thesis is to analyze the business process modeling and the workflow automation by providing a real example of a business process. In order to accomplish that there is the need to use a standard notation language which will be Business Process Model and Notation (BPMN) and Decision Model and Notation (DMN). The end-to-end process will be implemented using Camunda Platform and Camunda's tools. Furthermore, this thesis aims to explore the full value and potentials of Robotic Process Automation (RPA) combined with the BPMN capabilities and propose a methodology which can optimize the full automation of business processes. While RPA is a field which lacks academic research on theoretical and practical analysis, after detailed research, not only the possible areas and ways of RPA application will be analyzed, but also the benefits and the potential risks of bot use. Lastly, this research will indicate various methods of smoothing the process execution and analyze the benefits of digital initiative.

Keywords:

BPMN, DMN, RPA, bots, BPA, UiPath Studio, UiPath Orchestrator, Slack, MySQL Workbench, Camunda Platform 8, Camunda Modeler, workflow, workflow engine, workflow automation, decision automation, Account Payables, Mitos.gov

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Abbreviations

AP - Account Payables

API - Application Programming Interface

BDM – Business Decision Management

BPMN - Business Process Model and Notation

CRM - Customer Relationship Management

DB - Database

DI - Dependency Injection

DMN - Decision Model and Notation

DPT - Department

DRD - Decision Requirements Diagram

ERP - Enterprise Resource Planning

IoC - Inversion of Control

IT - Information Technology

OMG - Object Management Group

PO - Purchase Order

ROI - Return on Investment

RPA - Robotic Process Automation

WH - Warehouse

CHAPTER 1: Introduction

Nowadays organizations are facing the challenge of implement many complex and various processes. Since business processes are the most valuable asset of an organization, they have a huge impact on the different layers of an organization and on the different ways and methods of how these layers and the departments are managed. The core part of the business processes is the orchestration of them which is challenging due to the fact that the innovation and technology are constantly evolving and for this reason businesses with low active demand for technology and innovation services cannot prosper. Based on this approach, digital transformation is the ultimate solution and in order to achieve that business process modeling and automation are the key.

However, there is a plethora of available orchestration technologies and each of these technologies have different functionalities, notation languages and APIs and therefore the decision to choose and implement the proper one is not that easy. Generally, the way of how to measure the quality of a business process model and the overall digital transformation is multi-faceted. [39] In this sense, the Business Process Model and Notation (BPMN) language has been identified as one of the most prevalent for modeling business operations in a graphical, but executable way. Additionally, business process modeling is helpful due to the fact that it can provide an in-depth overview of the business processes and therefore the practitioners can understand the end-to-end process easily. A variety of companies and organizations use BPMN (Business Process Modelling and Notation) to illustrate and present different kind of processes either complex or not.

In parallel, nowadays more and more organizations are taking advantage of Business Process Automation (BPA). The new era of BPA has transformed not only the daily processes into a digital form but also the business processes due to the fact that there is an undeniable link between them. The daily processes leave a strong imprint on the business processes and vice versa. This is the reason why organizations and companies to an increasing extend are tending to automate their business processes and to recognize the new opportunities which are arising from the digital transformation and the automation. Thus, the benefits that ensue from

the capitalization on the BPA are countless, but at the same time there are risks that should be taken into consideration. In conclusion, the reinventing of the traditional BP into BPA is highly and vitally important. One of the extensions of BPA is Robotic Process Automation (RPA). RPA is a tool that allows businesses to replace manual low-value single tasks by automating a high variety of manual and recurring tasks. By accomplishing that companies have the opportunity to gain the advantages from the automation which are a lot. For instance, the businesses can decrease their costs, they can save time, they can respond and act in-real time in order to succeed a high efficiency volume, they can invest to other tasks which cannot be automated or even they can get engaged with tasks that they didn't have the time to deal with before. The focal point is that the automation of the process should be proper, suitable and customized for the business and therefore, it can be sufficient and successful.

1.1 Motivation

As technology is constantly evolving, companies are aiming to find ways and methods to model and automate their business processes, which are getting more extensive and becoming increasingly complex. Business process modeling and automation requires a high level of information, management, maintenance, techniques and tools. Business Process Management (BPM) as a project can be designed and analyzed by different designing, semantic and modeling languages. One of the most common, preferable and user-friendly semantic languages is BPMN (Business Process Model and Notation). BPMN has been established to be a de facto modeling language. Semantic technologies have been evolved and have included many semantic and presentation languages, tools and techniques. [40]

The most challenging issue is today's Knowledge Management. Human resources cannot process all the knowledge for a number of reasons and therefore the necessity of management and modeling tools and automation techniques can be easily observed. Semantic languages, such as BPMN, use a standardized graphical notation and provide assistance in order to improve the communication within the company and with the external business partners, third parties, customers etc. A

well-structured model can pinpoint dynamic solutions of high quality, which are user-friendly and understandable by either technical or non-technical users. For this reason, a well-structured business process modeling can become vital and an asset for the business.

In addition to BPM and business process modeling, Artificial Intelligence approach manages to share, store and execute efficiently all the knowledge which is extracted from the business processes. A solid workflow cannot be implemented and run unless the data mining, migration and analysis has been correctly managed and stored. Businesses are trying more and more to improve their processes by finding ways to measure them, evaluate them, optimize them and automate them. Consequently, a new era has made an appearance, the era of Business Process Automation. With the Industry revolution 4.0, technologies and automation have been dramatically increased and evolved. The new AI technologies, techniques and tools have brought into light Robotic Process Automation. The integration of Robotic Process Automation (RPA) as a fast-emerging automation technology to the business processes gives the ability to the companies to improve their business processes regarding the end-to-end process context and to achieve a level of process performance that has never been reached before. Since RPA is a sub-field of the Artificial Intelligence sector, the possibilities that are presented for businesses are numerous. Additionally, RPA has as a main feature to help businesses to focus on the proper sub-processes and to use software to replace manual tasks that are time-consuming. Overall, RPA tools associated with AI can provide the chance to businesses to improve and enhance their processes and long-term to reduce costs and increase revenue.

1.2 Aim and Objectives

The ultimate aim of this thesis is to analyze firstly the business process modeling and the associated semantic languages and modeling tools and deep-dive into the Business Process Modeling world. Additionally, the new era of Business Process Automation is analyzed and the associated benefits that this new era can offer to businesses. Business Process Modeling in combination with Business Process

Automation and Artificial Intelligence can provide a wide range of techniques and tools that businesses can take advantage of, such as Robotic Process Automation. Furthermore, this thesis presents not only the ways to model a business process, but also the methods and the techniques to automate a workflow. Additionally, this thesis provides a real example of a business process that Robotic Process Automation has been applied. In order to accomplish that firstly, there is the need to use a standard notation language which is BPMN and a decision model language which is DMN and the overall end-to-end process will be implemented using Camunda Modeler and Camunda's Platform 8 tools. Furthermore, this thesis targets to explore the full potentials of BPA by combining RPA with BPMN capabilities and to propose a methodology which can optimize the full automation of business process. When it comes to RPA there is a limit of academic research on theoretical and practical analysis and for this reason, this research will indicate various methods of smoothing the process execution and analyze the benefits of digital initiative.

The existing literature on the subject will be thoroughly examined in order to better identify the meaning of RPA in relation to BPMN. Continuing, a variety of cases and scenarios will be reviewed regarding the integration of RPA within business processes. Theoretically, there will be a detection of the proper way to orchestrate and monitor RPA, so that unexpected errors and incidents can be prevented and addressed.

More particular, the main objectives can be indicated as below:

- Analyze the meaning of Business Process Management.
- Discuss the trends of different management models.
- Describe the necessity of modeling and automation in the business processes.
- Present BPMN notation as a useful tool to model simple and advanced business processes.
- Introduce Camunda and Camunda's tools as a technique to model business processes using BPMN.
- Explain how the process logic of BPMN models can be combined with Camunda DMN models in an end-to-end business process.

- Explain how the process logic of BPMN models can be combined with Camunda Platform's tools such as Forms, Connectors, Database etc. in an end-to-end business process.
- Explain the Business Process Automation world and the ways to automate a business process
- Introduce Robotic Process Automation (RPA)
- Present the main benefits and problems when using RPA tools.
- Introduce UiPath as an RPA tool.
- Develop an end-to-end invoice creation business process for Account Payables module using Camunda's tools.
- Automate the invoice creation process with the help of RPA by using UiPath as an RPA tool.
- Introduce Mitos.gov platform and automate a Mitos's procedure with the help of RPA by using UiPath as an RPA tool

1.3 Thesis Structure

A briefly structure of the specific thesis can be described below.

In Chapter 2 an analysis of the Business Process Management is taking place by focusing on the importance of the correct management of each and one of the processes in an organization. The business processes are described thoroughly in order to clarify the meaning of the BPM including the business process management lifecycle. It is also mentioned how crucial it is to improve the performance on a daily basis. Generally, it introduces the ways to illustrate Business Process Management (BPM) and the semantic languages. The language that this thesis is focusing on is Business Process Model and Notation (BPMN) which is a language used for modeling purposes and for executing semantics in end-to-end processes. Furthermore, the importance of this chapter is that presents the ways that BPM can integrate with Artificial Intelligence (AI) and AI's tools. Therefore, an introduction to Business Process Automation (BPA) is accomplished. Since there is a plethora of opportunities and research challenges around BPA, the Robotic Process Automation (RPA) is just an example of the possible ways to implement an automation into

BPMN. Last but not least, the benefits that ensue from the digital transformation are mentioned and the necessity of modeling and automation in business processes. Lastly, the Mitos.gov platform is described in order to introduce the usage of Mitos and the procedures that are included in this platform.

In Chapter 3 it is presenting the activity of modeling and automate a business process by using graphical notation and artificial intelligence techniques. In particular, the graphical notation that is used is BPMN. Besides the standard modeling, a business process requires also decision model. For this reason, the DMN graphical notation is described. This set of activities, tasks, events, decisions is going to be illustrated with the use of Camunda Modeler. An introduction to Camunda Platform and all Camunda's tools is going to be described in order to understand deeply how all these tools can be combined so that an entire business process can be presented as a model, can be executed, monitored and optimized. Furthermore, it is described the way to include an artificial intelligence technique such as Robotic Process Automation using UiPath. Lastly, it is necessary to mention that the last section focuses on the overview of a specific department, Account Payables. The case study is the invoice creation which is a business process that is performed by Account Payables department.

In Chapter 4 the scenario in use is taking place. Using Camunda Modeler a business process for AP department is implemented. Specifically, this chapter presents an end-to-end deployment of an invoice creation, from the moment the user receives the invoice until the payment of the invoice. The business process is developed in order to reflect a real invoice creation and the steps in between which an AP specialist should follow. This is a recurring process and the tasks can be much more complicated or simple depending on the company. It is also presented the creation of a DMN and the related DRD and how a DMN is linked to the main BPMN. It is highlighted the meaning and the use of the DMN since the proper and valid implementation is a crucial part.

In Chapter 5 is described the integration between BPMN and RPA using UiPath tool. The automations that are described, are the generation of files and messages by bots. As it is highlighted, the benefits that ensue from this implementation are many.

An organization can decrease the costs with just one bot and also decrease a lot the manual effort.

Chapter 6 presents Mitos.gov and a specific procedure from Mitos.gov in order to apply the RPA in another real preexisting example. The aim is to improve the procedure described in Mitos.gov by implementing RPA. This procedure has already been illustrated using BPMN and for this reason, the purpose is to modify the BPMN model by including RPA techniques.

Chapter 7 is referring to the conclusions, the research contributions and the future work.

CHAPTER 2: Theoretical Background

This chapter introduces the theoretical background of the main concepts to be discussed and analyzed. The overall aim concerns the more sufficient management of the business processes and the ways to illustrate Business Process Management (BPM). Alongside, taking into account that Business Process Model and Notation (BPMN) language is mainly introduced for modeling purposes within literature, the establishment of its execution semantics in end-to-end processes has yet to be highly adopted within academic works. Furthermore, the importance of this chapter is that presents the ways that BPM can integrate with Artificial Intelligence. This way an introduction to Business Process Automation (BPA) is accomplished. Since there is a plethora of opportunities and research challenges around BPA, the Robotic Process Automation (RPA) is just an example of the possible ways to implement an automation in BPMN. Additionally, it will be analyzed the necessity of the automation of an end-to-end business process and the ways in place in order to link a business process to an RPA tool. Finally, Mitos.gov is going to be described in order to introduce Mitos.gov platform and purpose.

2.1 Business Process Management (BPM)

Business Process Management (BPM) is more or less the way of how the organizations are performing the daily activities in combination with the tools and methods that businesses are using in order to evaluate these activities. The evaluation of the activities has as ultimate purpose the improvement of the less efficient ones. The improvement of the performance of those activities basically relies on how the organizations are taking advantage of the different opportunities that might be presented. For instance, an organization can improve the performance by reducing the costs but without downsizing. Another example can be the improvement of financial ratio which is an important indicator of growth. The above can lead to the identification of the foundations of the BPM which can be process improvement and process development. [24] Process improvement, as mentioned previously, can be recognized as the constant effort to enhance business processes.

Process development or reengineering can be analyzed as the need to rebuild or redesign a process even if it requires to start from scratch. [24] In order to be more detailed, the most important feature of BPM is that indicates the way of improving and managing the entire network i.e., customers, vendors, third-parties, employees, and generally each and one of the events of this network i.e., activities, decisions. The combination between network and events is the definition of the process. [1] Processes are everywhere even if we are referring to a non-profit organization or to a private company. Some really simple examples of the regular business processes are:

- Cycle Count: this process is performed at Central Warehouse (WH) module on a periodic basis in order to align periodically the available stock. This is required because the Serial Number that has been registered when the goods are received might be wrong due to several reasons i.e., the Suppliers communicate wrong Serial Number. If the Serial Number is incorrect in the Central WH at the moment of shipping, the warehouse operator might attempt to ship a Serial Number that have not been previously received in the Warehouse.
- Source-to-Pay (P2P Direct): During the good receiving activity the Shop Operator and the Warehouse Operator will be the ones in charge of registered receipts for goods directly delivered to the shop and to the Warehouse. The Receipt will be used to perform a match with the Invoice when it comes to an invoice with a Purchase Order match and, in case of correct match, will automatically authorize the payment of the invoice. As a result, the final user (shops vs Warehouse Operator) has to be committed in to perform this activity in a timely manner, in order to simplify and speed up invoice matching and payment process.
- Supply Chain Management – Repair process: During the Repair process after receiving the item to be repaired by the customer, the Shop Operator creates a new Repair Order using the front-end system and selecting the right repair item code for the product. The Shop Operator indicates the item to be repaired, with reference to the Serial Number and the type of item, the causal

of repair if possible and all the other relevant data. Once all data are filled-in, the operator releases the Repair Order.

- Procure-to-pay: During the receiving of a product or a service, the purchasing process must be registered. This includes activities regarding the approving of the purchase (inventory item or expense item), selecting the vendor, issuing a purchase order, issuing the invoice and paying the invoice.
- Invoice Approval: An invoice is a commercial document issued by a seller to a buyer. The invoice indicates the products, quantities, and agreed upon prices for the goods or services the seller has provided to the buyer. An invoice indicates how the buyer has to pay the seller according to the payment terms. One of the most important and difficult aspects in paying an invoice is to verify the invoice details and obtain approvals from the relevant or appropriate approvers. Approval process also enables organizations to review their internal processes and controls to prevent any fraud or scandal that may arise due to the lack of such controls. When invoice approval starts, the invoice approval task determines whether an invoice requires approval. Every invoice that requires approval must be approved before its payment, unless the invoice is forced approved.
- Payment Approval: This process allows to companies to send payments to approvers for review before final payments are made to suppliers or employees. If enabled, the payment process stops and approvers can optionally remove payments directly from a payment process request and then approve it. Approvers can approve or reject payment process requests.
- Invoice Matching Option: This process indicates the invoice matching approval level. Invoices in Account Payables must be matched with PO or Receipt. If the receipt or PO are missing the invoice cannot be paid.

Those examples of business processes can be included in the BPM only if they are combined with the definition of how they are processed, how they are designed and how they are performed in order to make a valid and positive impact on the quality of services to the network. The lifecycle of BPM can begin with phase of *process identification* which leads to process architecture. Process architecture collects the

inter-linked processes and tries to fill the gaps that an organization might have. The next step is to measure the results and to ensure that these outcomes have a meaningful impact, they have a positive aspect and they add value to the company. After that, the understanding of the as-is business process in-depth is crucial in order to implement the to-be process. This next phase can be described with the term *process discovery*. For this cause the process modeling can help a lot due to the fact that a diagram can clarify much better a process, especially when it is combined with text. Diagrams help to comprehend the process, but it is essential that all the users are familiar with these diagram's notations and have the sufficient knowledge to understand them. Once the business process has been analyzed, then we move to the next phase which is the *process analysis*. During this phase all the issues must be collected and be prioritized based on their effect and on the estimated effort required to resolve them. Besides that, there is also the *process redesign* or *improvement* which is more or less the to-be process. Last but not least, there is the phase where everything must be aligned with the to-be process (practitioners and systems) which is called *process implementation*. Lastly, the *process monitoring* can be identified as the final phase which is basically the maintenance phase of new or recurring issues. [1]

All these phases of BPM lifecycle are presented below:

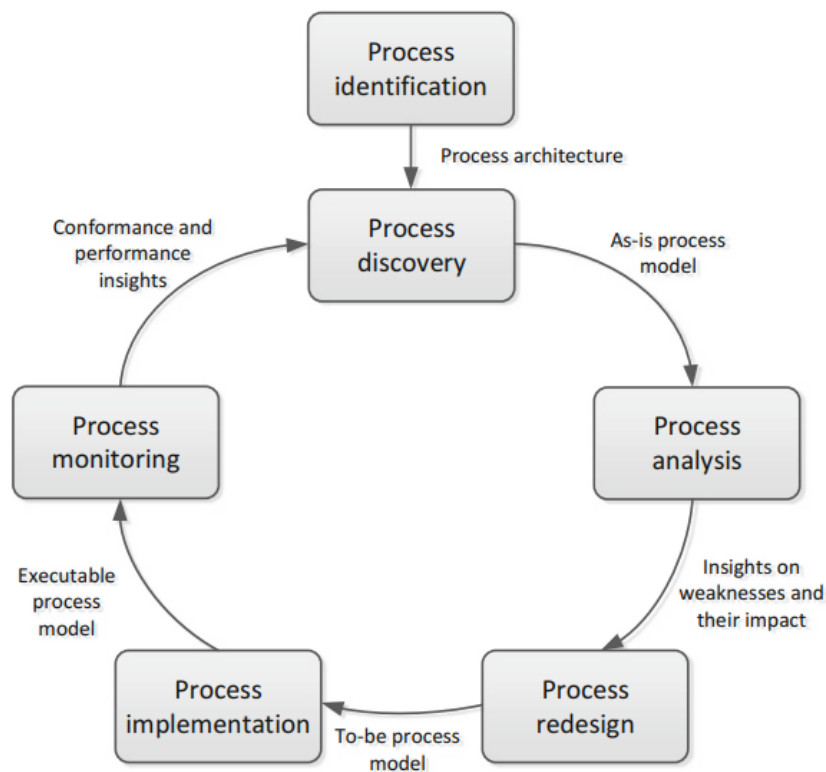


Figure 1. BPM Lifecycle [1]

The more processes a business has the more need for management is required. The complexity of the business processes can be simplified if it is analyzed from the high-level processes to the corresponding sub-processes. Thus, processes can be modeled starting from the general levels and getting into more detailed levels in order to describe the process flow, the liabilities, the input and the output. The focal point is to assign a specific role to each process, so that each process can have a purpose, each process can be measured based on the productivity, and for each process an outcome must be produced in order to measure the improvement or the lack of it. [24]

The complexity of business processes in combination with the increasing complexity of information systems forced businesses to adapt a dynamic management model that can optimize and monitor the processes. This era started with the building of an entire information system, which had a lot of difficulties and challenges, then moved to buying existed software applications in order to integrate the old system with the new applications through an integration known as

Enterprise Application Integration (EAI). [25] Due to the fact that this approach had also a lot of difficulties and complexity, businesses switched to a new trend which allows to the users to have flexibility, independency, automations, controls, more functionality with less complexity. This could be achieved with the Enterprise Resource Planning (ERP) systems. [25] ERP systems allows users to divide the business processes into different modules i.e., Procurement, Inventory, Account Receivables, Account Payables, Fixed Assets, Order Management, General Accounting etc. and as follows users can manage, monitor and modify their processes based on their demands in real-time. Naturally many of the processes are not passing through the configuration which means that there is a necessity to create a flow which can combine all the areas of a business. This flow basically is a business process modeling of a business life cycle. There are many languages to help businesses to illustrate the modeling of their processes i.e., BPMN which will be analyzed in the next paragraph. [25]

2.2 Business Process Model and Notation (BPMN)

Business Process Model and Notation (BPMN) is basically the standard notation that businesses use in order to illustrate the business process modeling. The focal point is to provide the proper training to the respective practitioners so that they will have the knowledge about the meaning of the notation and be aware of how to use and interpret the notation. This way BPMN diagrams will be always up-to-date and any kind of modification will not impact the process in a negative way. According to Recker [2] approximately 70% of BPMN users are self-taught, which means that there is a risk of lack of skills or deep knowledge. So typically, maintenance and knowledge are the main reasons that the modeling of the business process is running correctly and up-to-date which can ensure that the knowledge can be transfer properly and all the users will be able to understand the model and the diagrams of the processes even if the process modeling will change. This approach will contribute to better communication of the business process for its users from different departments including analysts and software developers. The

condition to achieve a sufficient BPMN modeling is to provide the means or tools that facilitate the evolution of BPMN diagrams.

Additionally, Business Process modeling is helpful due to the fact that provides an in-depth overview of the business process and therefore the practitioners can understand the process further and analyze, modify and redesign the model based on the needs. As described previously, the BPM lifecycle, which includes the 6 phases, requires this knowledge. If users and practitioners don't have the skills then the lifecycle will be disturbed. A variety of businesses and organizations use BPMN (Business Process Modelling and Notation) to illustrate and present different kind of processes. The aim of BPMN is to provide a notation that everyone who is involved to the process can understand. Through BPMN the business tasks, events and, processes can be described in a form of diagrams, modelling tasks, responsible people, and the order in which tasks occur. [3]

Martínez et al. [4] highlights that the aim of software development from business process models can improve the software's compliance with the needs of its users. Doing that, the software can be in line with user's requirements and expectations and the user has a clearer picture of the software's activities. Also, Martínez et al. [4] refers to the need of maintenance of the software since the inconsistent maintenance can cause misalignments and can decrease the efficiency of the business process. The business process must match to the version in use of the software. [4]

A high-level overview of the standard notation that BPMN uses can be described below:

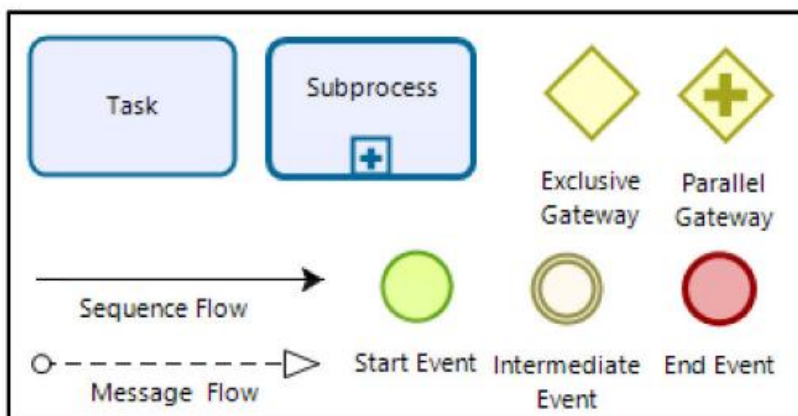


Figure 2. BPMN notation [3]

This core notation though can be divided into 4 categories based on the use of each element.

- Flow objects. Flow objects include events, activities and gateways. They are used to create the basic structure of the flow (business process). [5]
- Artefacts. Artefacts include data object, group and annotation. They are used to add additional information to the flow. [5]
- Connecting Objects. Connecting objects include sequence flow, message flow and association. They are used to connect the rest of the elements i.e., the activities, events, gateways inside of a pool. Basically, connecting objects are useful for the sequence of the flow. [5]
- Swimlanes. Swimlanes include the pools. Each pool can be divided into different lanes or departments, users that share the same privileges and roles. A pool can also have no lanes. [5]

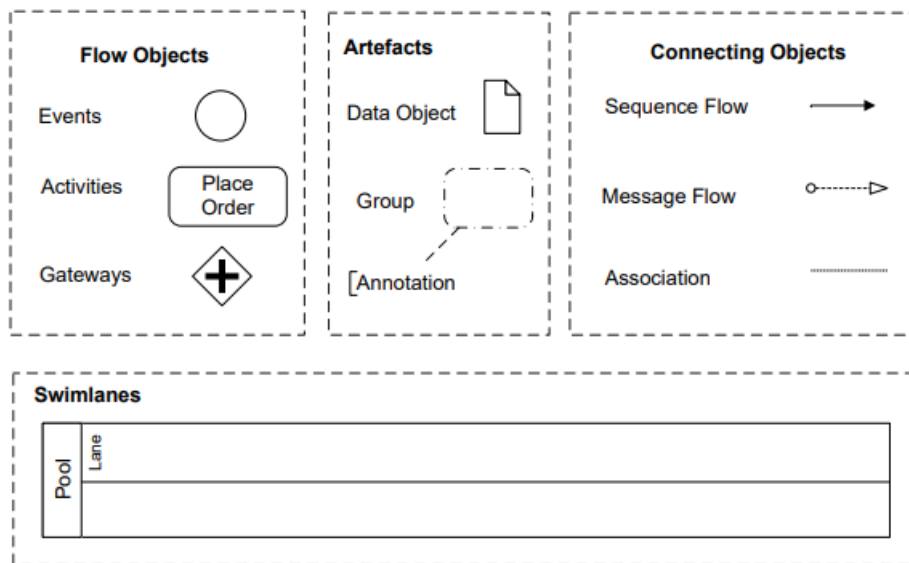


Figure 3. BPMN basic elements [5]

In order to go deeper, in the next paragraph there is the explanation of the core elements regarding flow objects.

- Events. Events play a central role in a flow due to the fact that they are the link between situations in business organizations and processes that will be active and enabled if these situations occur. Events can be divided into three types, based on their position in the flow: start events which are used to

initiate a process, intermediate events which are used to delay a process, and end events which are used to terminate a process.



Figure 4. BPMN Events [6]

- **Activities.** Activities are parts of the flow which indicates the major tasks of the business process. Each activity can be either a manual task, user task, a script task, a service task or even a subprocess. A subprocess explains in a more detailed way a main process which should be divided into more steps and it is better to be shown as a separate process in order to make the flow simpler and avoid complexity.
- **Gateways.** Gateways have an interactive use and can be divided into exclusive, inclusive, parallel and complex elements. The gateways are associated to conditions. In order to select the proper gateway, there is the need to analyze which is the purpose of the task that follows the gateway.

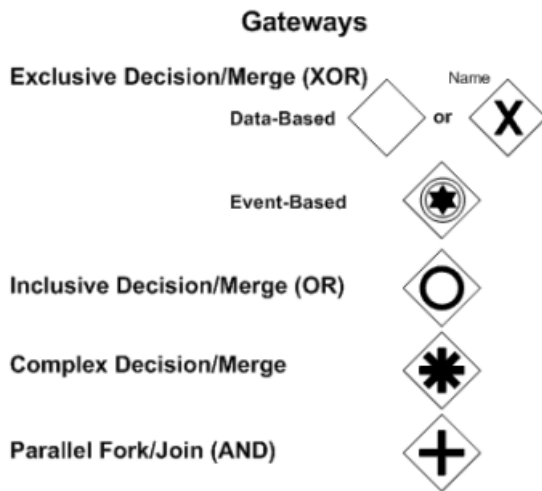


Figure 5. BPMN Gateways [6]

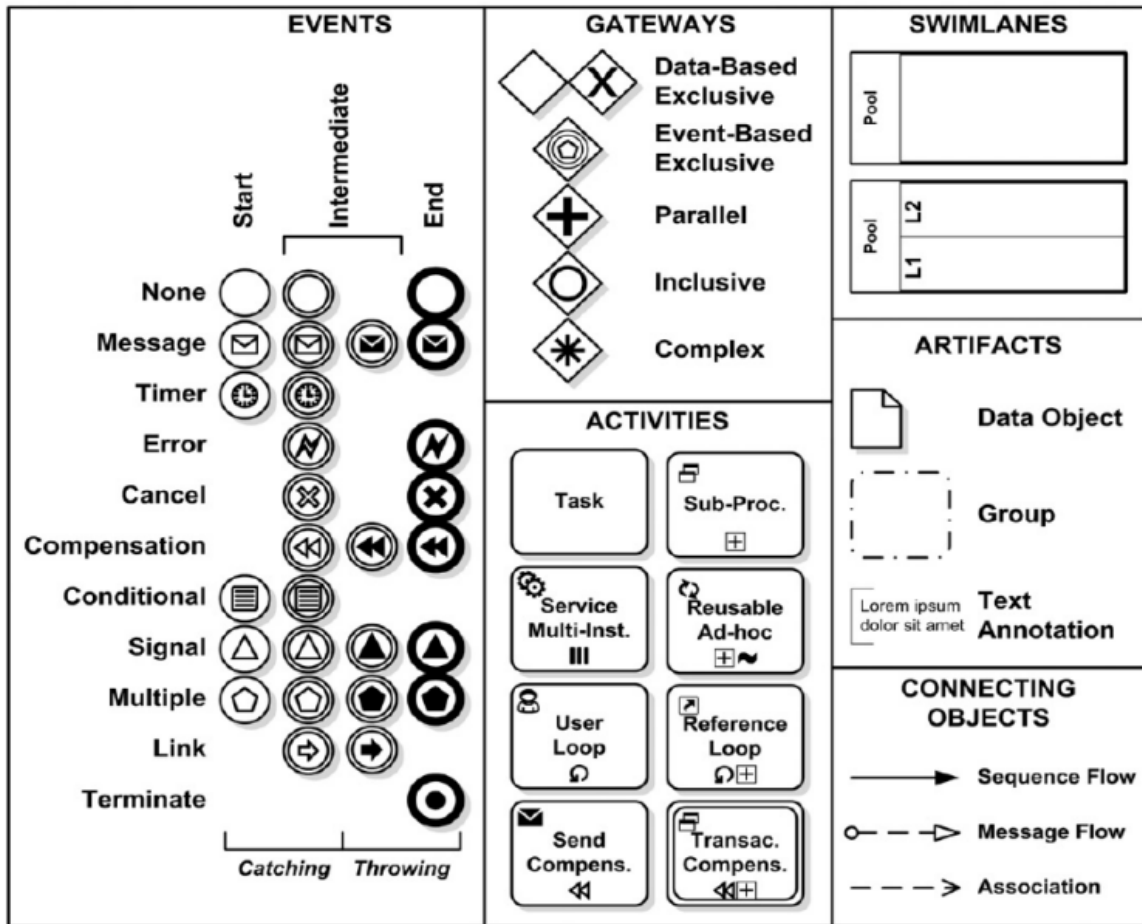


Figure 6. The entire set of BPMN elements [26]

A basic structure of a business process is presented below.

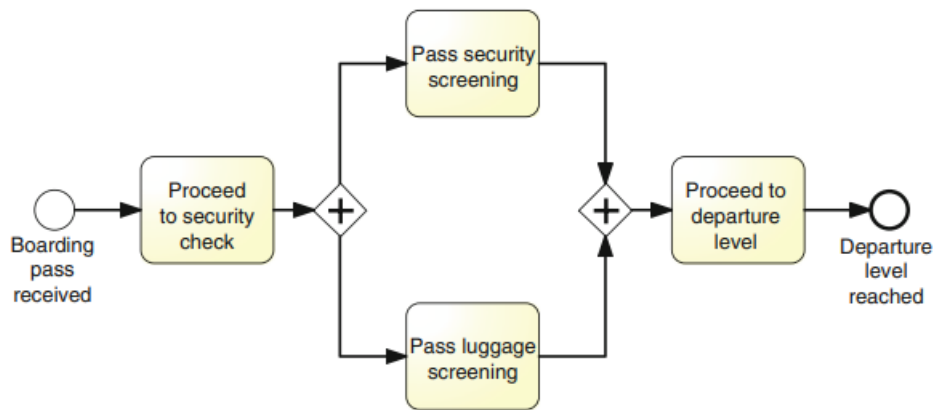


Figure 7. Modeling a simple Business Process using BPMN [1]

In figure 7 the process starts with the start event “Boarding pass received” which means that the whole process can start once the boarding pass is received. With the boarding pass arrival, a number of processes will be triggered. The first activity is the “Proceed to security check”. In other words, once the boarding pass has been received, then the security check is in place. Once the security check is completed, a gateway follows with parallel use which is divided into two activities which are going to happen in parallel sequence. The two activities that will happen simultaneously are “Pass luggage screening” and “Pass security screening”. Once these two activities are completed, the parallel gateway closes and after that there is another activity “Proceed to departure level”. This is the last activity of this process. Once this activity is completed, the entire process is completed as well with the end event “Departure level reached”.

2.3 Business Process Management (BPM) and decisioning modeling

While businesses indulging more in managing and modeling their processes, they couldn't help but notice that the decisions are an essential part of their processes. The focal point is that the decisions complicate a lot a process if they are not clarified and simplified. BPMN notation does not provide the possibility to include decisions in the main business process model due to the fact that the BPMN diagram will become extremely complicated. [27] Over time the decision making has become

increasingly important since the business's requirements and activities are getting more and more complicated. [28] Considering this situation, Business Decision Management (BDM) has been appeared as a component of BPM [26] and this new appearance requires an understandable and common notation in order to illustrate and present the decision model. In this regard, Object Management Group (OMG) developed the Decision Model and Notation (DMN) which has become the language to help businesses to design their decision models. [1] Additionally, DMN notation has been included as a parallel designing tool in the standard BPMN. [26]

2.3.1 Notation (DMN) and Decision Requirements Diagram (DRD)

A proper and clear BPMN diagram is a model that doesn't confuse the users. But in the business processes where many departments are involved and many tasks should be illustrated, this can become really difficult. When it comes to decisions and conditions, DMN model can provide assistance and help to clarify a BPMN diagram. DMN standard provides a two-level modeling for decisions. This two-level modeling includes the decision requirements and the decision logic level. [19], [20] The Decision Requirements Diagram (DRD) presents in a graphical and hierarchical way the decisions. Despite the fact that DRD is sufficient for the purposes of business analysis in a high-level, more details are given by the decision logic level. In this way, the decision logic is encapsulated into decision tables, where the decision logic expressions are defined with the Friendly Enough Expression Language (FEEL). [21]

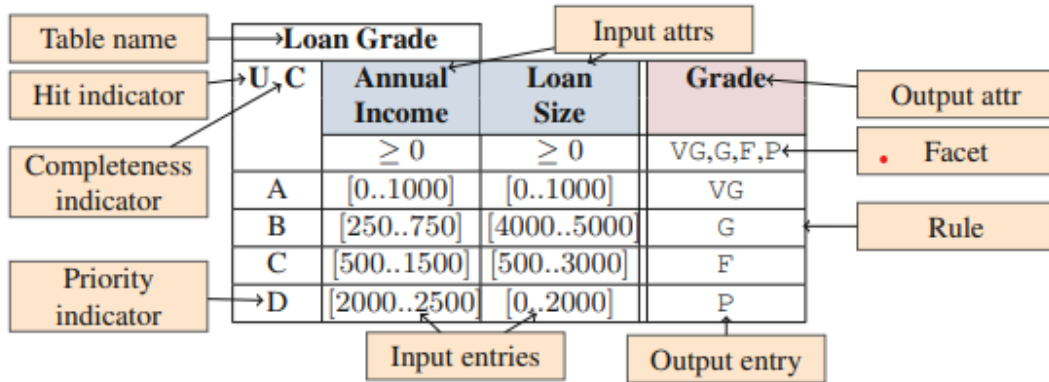


Figure 8. Example of a Decision Table for a loan application [1]

In figure 8 a decision table is presented which allows the process to make a decision regarding the loan. Firstly, the hit indicator is the hit policy which specifies how many rows can be matched to a given input. [1] Secondly, the different lines are the scenarios and the rules that must be validated. Based on the rule validation, a decision can be made. These different scenarios are the inputs and the decision is basically the output.

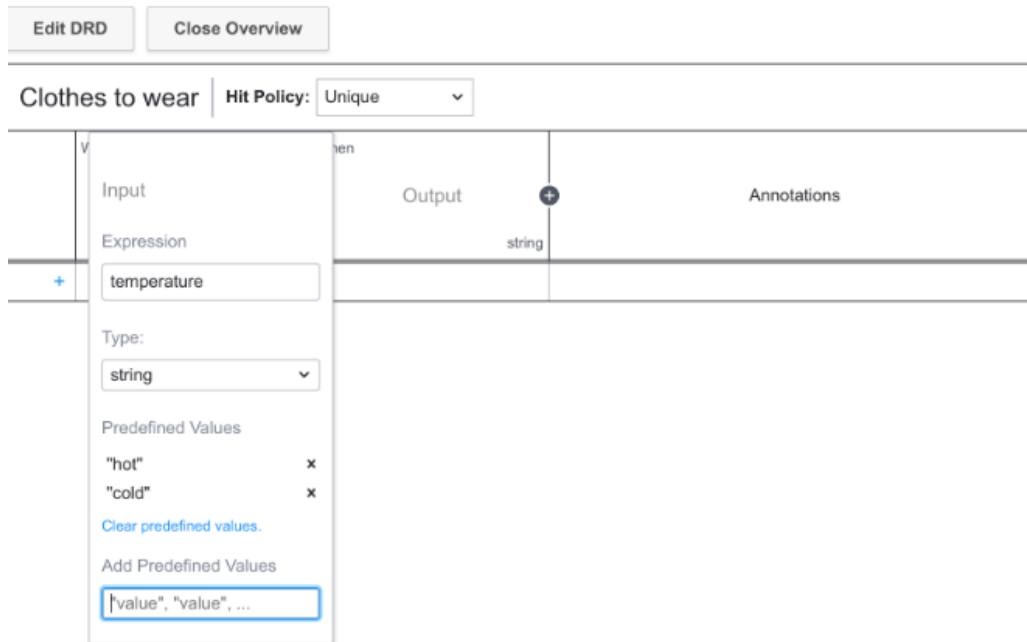


Figure 9. Decision rules in DMN [22]

In figure 9 another decision table is presented with the DMN structure. The approach is the same since DMN requires hit policy, input parameters which are the scenarios and output parameters which are the decisions. There is the possibility to define as many rules as needed and identify specific names in order to distinguish them.

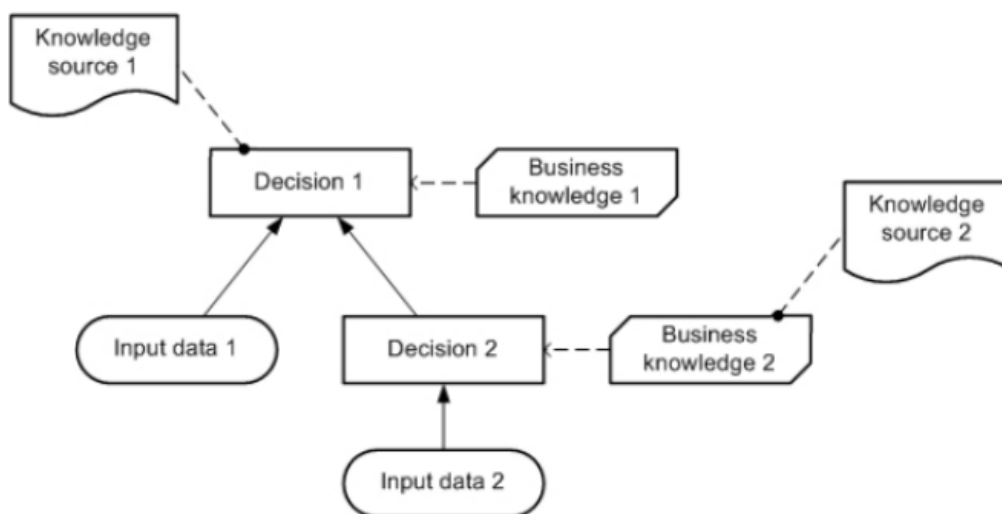


Figure 10. DRD structure [22]

In figure 10 a DRD diagram is presented. More or less a DRD described the different input parameters that are linked to different decision tables. For instance, the Decision1 has as input parameter the Input data 1 and the Decision2 and has as sources the Knowledge source 1 and Business Knowledge 1. This means that the Decision 1 cannot be completed if the input parameters and the sources are not applicable.

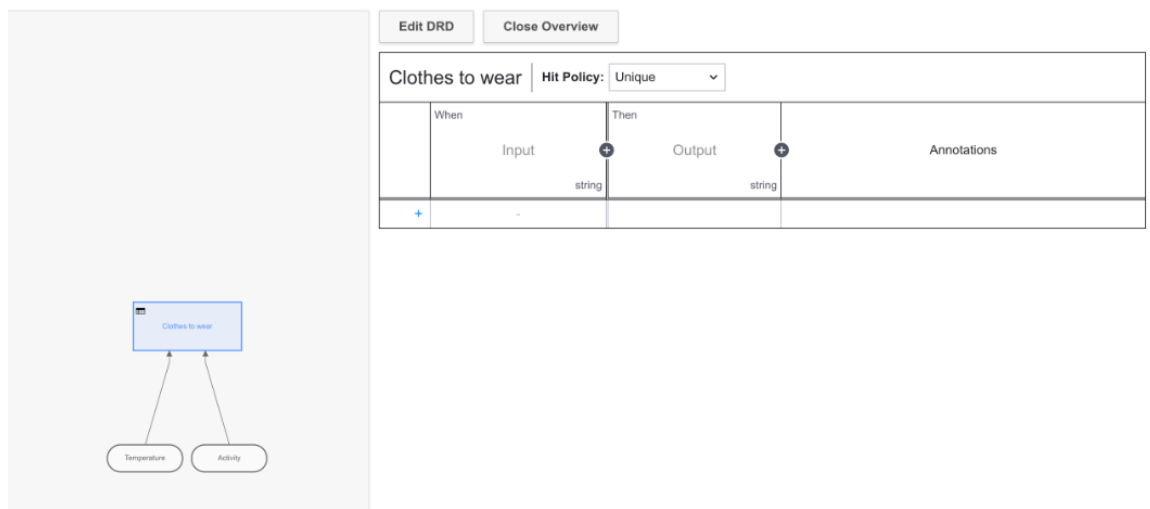


Figure 11. Basic Structure of DMN and DRD [22]

In figure11 it is crystal clear that the DMN is linked to the DRD which means that if for example the input parameters of DMN are changed or the name of DMN table is changed, then the DRD should change accordingly.

2.3.2 Integrate DMN into BPMN

With decision modeling necessity to be increased day-by-day, OMG has introduced DMN as the standard notation for the decision modeling. Likewise, BPMN has linked the processes with DMN so that the business process flow can integrate with the decision model. The integration between DMN and BPMN was a topic that was investigated by a respectable amount of literature. BPMN notation specifies the activities, when or by whom the activities must be completed, the order and the sequence of the activities, while the DMN notation is linked to business rule activities. For these business rule activities, a decision must be made. [26]

Furthermore, these BPMN business rule tasks can replace the BPMN gateways because the decision logic is now implemented by DMN models. This replacement can simplify the overall BPMN flow. [26] The real challenge is noticed when changes or modifications on decision models have impact on the process models and vice versa [20].

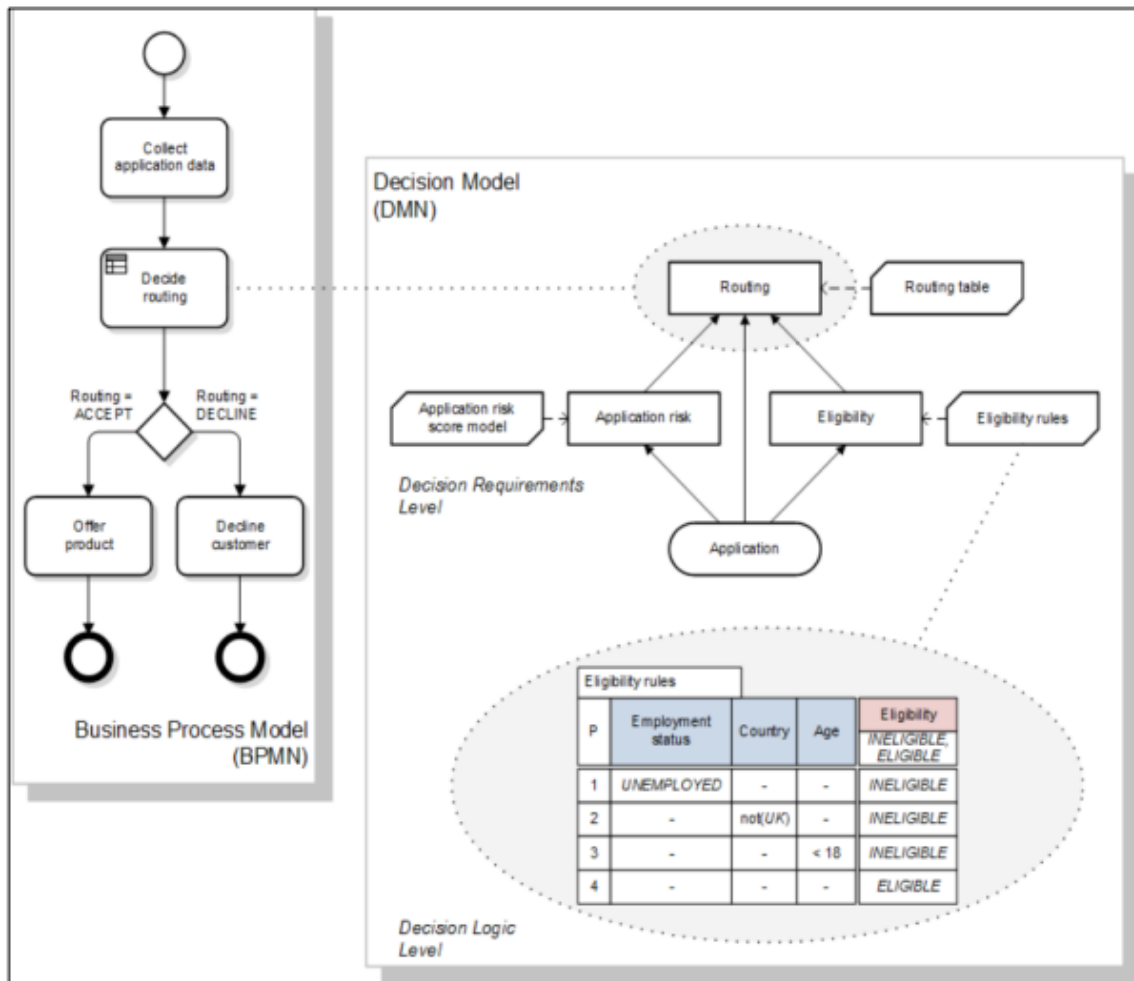


Figure 12. Integrate DMN into BPMN [26]

2.4 Artificial Intelligence in Business Processes

The radical growth of Information Technology (IT) has brought to the fore a variety of e-services, choices and possibilities to digitalize, automate and optimize the different processes. These possibilities have provided convenience and a lot of advantages to businesses but on the contrast, the insufficient knowledge or the

wrong use can cause severe incidents. One of the fast-developing fields of IT is the Artificial Intelligence (AI). [32] AI's goal is to achieve the optimization and automation of intelligent behaviors. [32] AI has plenty of techniques and for this reason each sector needs its customized and personalized AI technique. The six main AI areas are: [32]

1. knowledge engineering,
2. reasoning,
3. planning,
4. communication,
5. perception and
6. motion

The first area, knowledge engineering, is used for knowledge mining, analysis and modelling in order to migrate the knowledge to the machines so that the machines can understand and process this knowledge. The second area, reasoning, refers to the ways of problem solving. The third area, planning, is basically a strategy to achieve goals. The communication area provides more or less the techniques to translate the natural language and achieve the communication with humans. Last but not least, the perception area provides the image or speech recognition. Lastly, the motion area is all about movement and handling. [32]

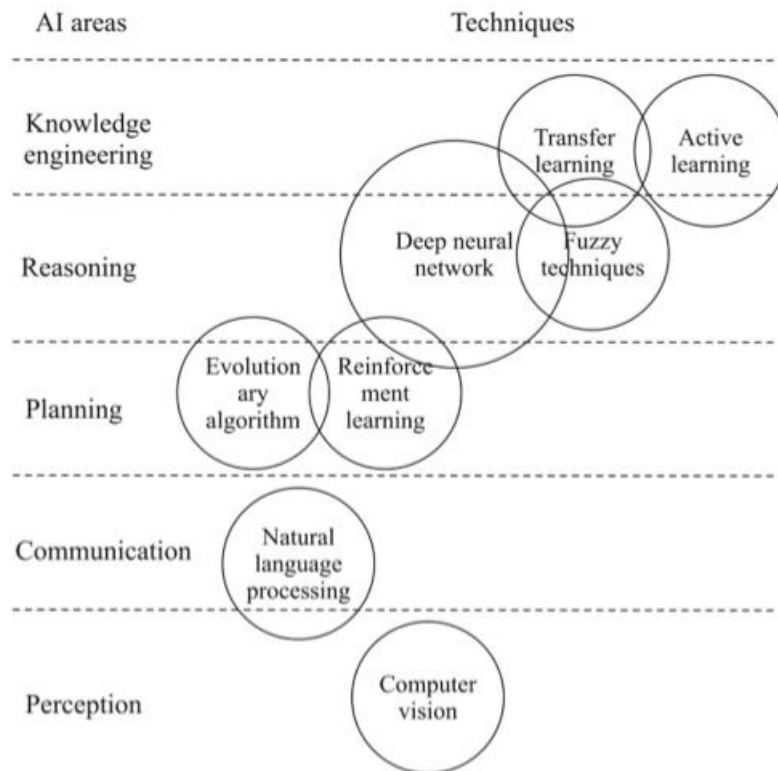


Figure 13. Artificial Intelligence areas [32]

The introduction of Artificial Intelligence (AI) was a total revolution for the businesses. Many AI techniques have been contributed to the improvement of the efficiency in business processes, of the user's experience and satisfaction, of data mining and analysis, of the performance etc. [32] For instance, the implementation of machine learning methods and algorithms in the systems which is part of the knowledge acquisition and learning, has offer accuracy, safety and capacity when it comes to data store, analysis and migration. [32] [33] Another example could be about action processing and robotics. This area has provided a huge assistance when it comes to user's satisfaction. With the help of robots and bots, a faster guidance, response to questions or to doubts can be achieved. [33]

There are many types of robots. Based on Gheorghe Tecuci [33] "*One may distinguish between three main types of robots*":

1. manipulators which are robotic arms attached to their workspace,
2. mobile robots with wheels, legs or wings,
3. mobile manipulators, that combine mobility with manipulation to accomplish more complex tasks.

Naturally, robots are applicable to many areas i.e., industries, transportation, health care, personal use etc. [33]

2.4.1 Business Process Automation

Business Process (BP) is an algorithm that presents the way in which an organization operates. This means that a business process determines how an organization is divided into different teams, how the teams work collectively and efficiently as a group, how each team communicates internally and in correlation to other teams. Furthermore, the teams are making an impact by delivering the values of the organization to the partners, to the suppliers, to the customers/clients and generally to the entire network. The new era has transformed not only the daily processes into a digital form but also the business processes due to the fact that there is an undeniable link between them. The daily processes leave a strong imprint on the business processes and vice versa. This is the reason why more and more organizations are tending to automate their business processes and recognize the new opportunities which are arising from the digital transformation.

Business Process Automation is the ultimate combination between IT and engineering. [31] Based on Meidan [31] *“BPA projects focus on implementing process automation technologies to execute processes in the digital environment within an organization for the purpose of improving efficiency and reliability”*. The benefits that ensue from the capitalization on the Business Process Automation (BPA) are countless. If there is the need to point out the most important aspects, we can highlight that an organization can be flexible in real time, improve customer experiences and be more competitive by ensuring maximum efficiency with lower cost and higher revenue. [30] In conclusion, the reinventing of the traditional BP into BPA is highly and vitally important. Day-by-day the number of companies, government agencies, and organizations of all sizes is increased as they have found the opportunity to combine technology with their business activities and to take advantage of the tools of technology in order to manage consumer’s expectations, client’s requirements, third-party’s difficulties and create meaningful, real-time digital relationships with all the parties i.e., their customers, partners, suppliers and employees. These new business models have turned the corporate world upside

down and have helped organizations to thrive. Therefore, the organizations that haven't so far adapt this digital transformation are sooner or later left behind. [29] Businesses can find a plethora of BPA tools i.e., BPM suite, BPM system, BPM platform, or BPA tool, Enterprise Resource Planning (ERP), Customer Relationship Management (CRM) in order to automate tasks or entire processes. [31] Some of these tools are complex and really heavyweight. For this reason, BPA targets to automate specific tasks individually. A solution to this issue is Robotic Process Automation (RPA). [31]

2.4.2 Robotic Process Automation (RPA)

Robotic Process Automation (RPA) is a tool that allows businesses to replace manual low-value single tasks, such as manual input, keystroke, paperwork, daily time-consuming tasks. Using RPA businesses can automate a high variety of manual and recurring tasks. By accomplishing that, companies can have many benefits such as the businesses can decrease their costs, they can save time, they act in-real time in order to succeed high efficiency, they can invest to other tasks which cannot be automated or even they can get engaged with tasks that they didn't have the time to deal with in the past. At the end of the day, RPA is value for money. According to Camunda's issue *Beyond RPA: How to Build Toward End-to-End Process Automation*, "*Robotic Process Automation has come of age and Forrester Research predicts RPA market revenue is on target to reach \$2.9 billion in 2021.*" [7]

Generally, RPA seems to be a necessary tool for the businesses since fundamental processes can be automated efficiently i.e., payroll, employee management, inventory management, AP/AR/GL management, such as invoice creation, journal creation, payment creation, expenses report creation. [30]

Some examples of companies that have established RPA in their processes are:

- Deutsche Telekom Service [7]
- Nokia [7]
- NatWest Group [7]

Speaking at CamundaCon LIVE 2020.1, [7] these companies agreed that: "*RPA has improved data quality, especially when compared to manual data entry completed by employees. Equally, introducing RPA frees employees from manual data entry, allowing them to concentrate on more valuable activities, like customer engagement*

and process optimization.”. Furthermore, Camunda mentions in their issue *Beyond RPA: How to Build Toward End-to-End Process Automation* which they have published, that the State of Process Automation Report 2020 after research with a sample of 400 IT users in North America and Europe who they implemented RPA in their businesses, has found that 65% reports that RPA helped to deliver automation quickly. In addition, Camunda mentions that “By 2019 Deutsche Telekom had automated more than 450 processes, managed by 3,000 unattended bots, achieving savings of more than EUR 93 million per year.” [7]

Of course, when it comes to RPA operations there is no efficient documentation to analyze this topic. According to the authors of the book *Robotic Process Automation* [30] “RPA offers several operational benefits to multifunctional and diverse businesses.” Some of these are presented in the figure14.

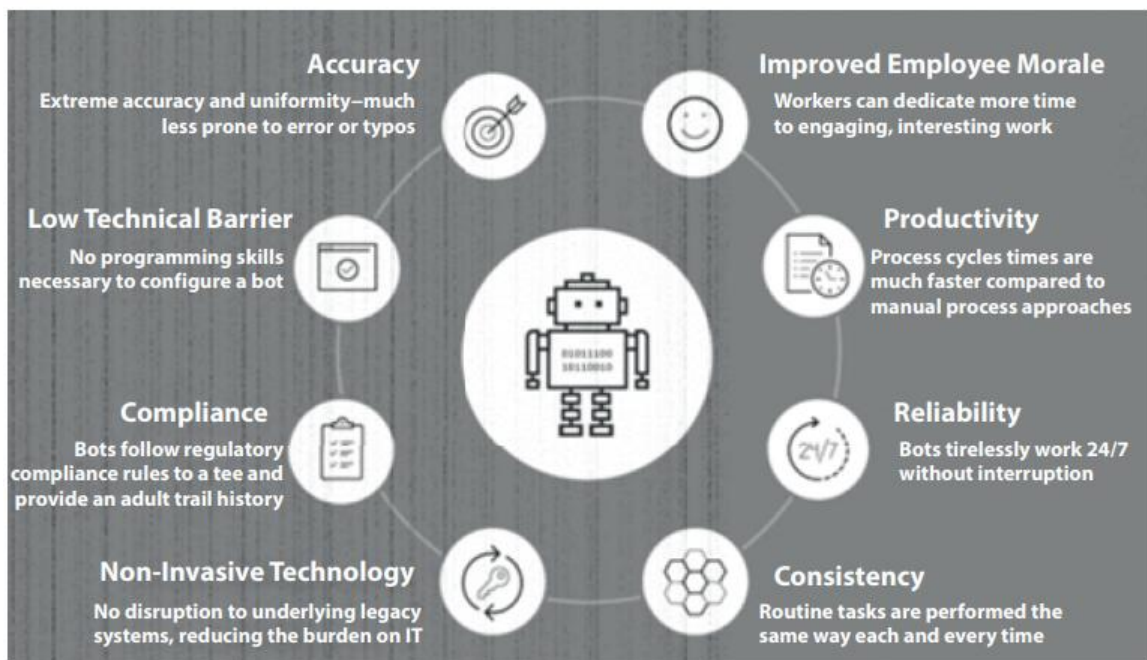


Figure 14. RPA benefits when use in businesses [30]

To summarize, some of the benefits that ensue from RPA can be listed as below:

1. Saves time
2. Saves money
3. Improves data quality
4. Improves data accuracy
5. Ensures reliability without interruption

6. Ensures consistency since the manual errors or users' neglects are decreased
7. Decreases the necessity of heavy coding
8. Minimizes the diversion from the rules
9. Improves productivity and efficiency since the users are not occupied with low importance manual tasks
10. Leads to growth in profits since the users are occupied with more important tasks
11. Improves the working environment since the users don't deal with tedious work and routine tasks

However, there is the other side of the matter. There are some problems reported when it comes to RPA. One of the problems seems to be that RPA bots are brittle when it comes to updates. This means that there is the necessity to perform high level maintenance really often in order to ensure the smooth performance of the bots and to avoid any kind of breaks and bugs. Another problem is the RPA bot security which is an effect of the bot's brittleness. Basically, each time a bot breaks there is always the security risk and businesses are forced to manage and fix those breaks and bugs by keeping up-to-date the RPA scripts. In addition, RPA tools seems to lack capability of timeouts, escalate stock processes and process migration. This has as a result that businesses have a hard time controlling the long-running processes. Lastly, RPA struggles to cooperate with processes outside the RPA process and this can indicate lack of orchestration.

To sum up, below there is an overview of the main problems that so far users of RPA tools have pointed out. [7]

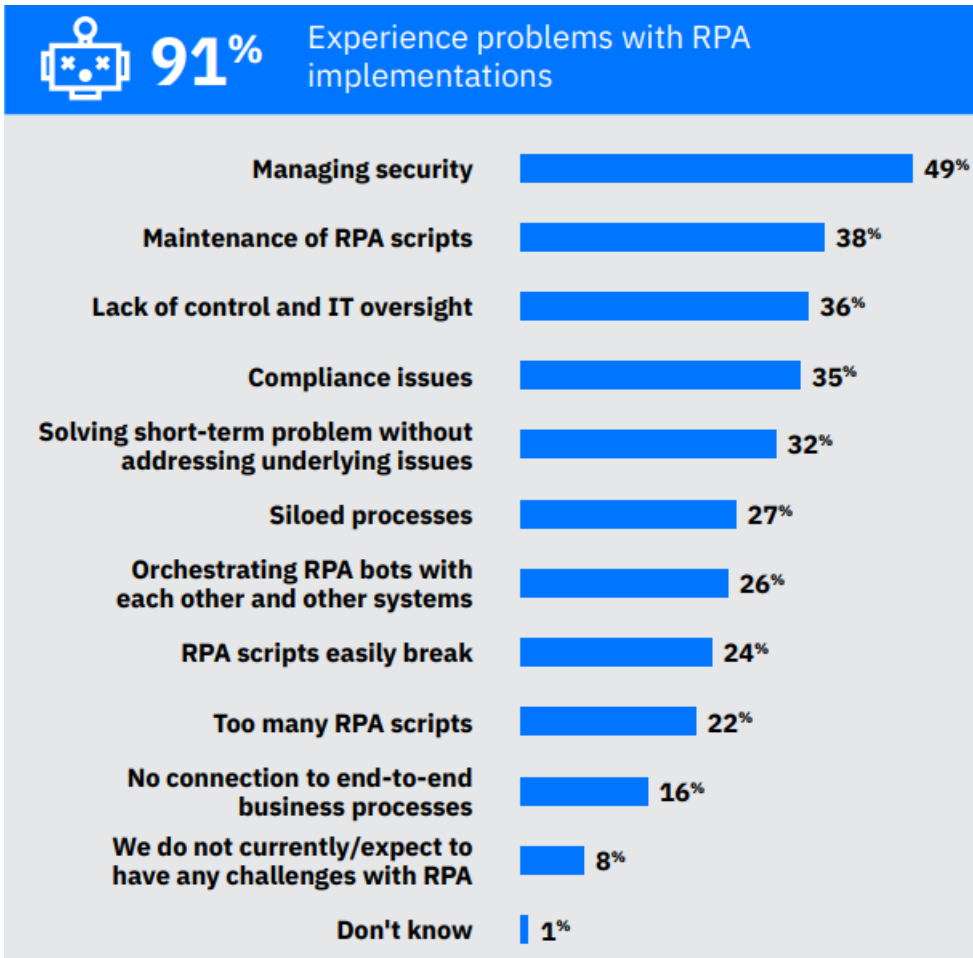


Figure 15. RPA problems [7]

2.4.3 Integration of RPA into BPA

It is more useful if RPA models are directly created and developed by companies themselves because business analysts and developers know better how and why a process must be automated. This way the automation of the process can be proper, sufficient and successful and as an outcome the automation can save time and costs. [30] Naturally, during the automation design, different phases must be in place such as refine sessions, fit and gap sessions, validate sessions and lastly, training sessions. These sessions aim to define the tasks that need to be automated, the structure of the flow, the requirements, the inputs and the outputs, to identify the gaps, to provide the necessary training to the rest of the users and to recognize the overall system efficiency.

The focal point to take into consideration before to include an automation in the business processes is to establish a long-term strategy to ensure the success of the RPA. Businesses should realize the problems with RPA and include a strategy in order to manage the problems in real time. The following 3-step framework provides a practical approach to get started: [7]

- 1) Firstly, the bots should be managed centrally so that users can monitor them better and be able to detect any kind of misalignment and/or bug. This approach will give the opportunity to users to achieve better effectiveness, minimize losses and disruptions and ensure a long-term performance.
- 2) Secondly, it is better to use the process automation platform to implement the full business process including all RPA bots. This way each bot will be included in the end-to-end process with specific roles.
- 3) Lastly, by orchestrating the infrastructure based on the above, RPA bots will be replaced in long-term with micro-services that are accessible via API without changing the underlying process.

2.5 Introduction to Mitos.gov - National Register of Administrative Procedures

Mitos is the official register of procedures of the Greek Public Sector. Mitos renders the possibility to sign-in and either find necessary documents or implement different procedures. There are different procedure categories for citizens, businesses, legal entities, public bodies etc based on specific purposes, such as audit reasons, certificates, benefits etc. [41] Mitos has published 3.186 procedures, 41 are under publication, 287 procedures are under approval and 967 under process. The procedures that can be registered into Mitos should have as an output an administrative product which can be a certificate, a permission, a compensation, a registration, an audit purpose etc. In case that a procedure that has been registered, is not applicable for Mitos's purposes, during the validation process from the supervisor of the Administrative Procedures of the Greek Public Sector, it will be identified and rejected. [41]

2.5.1 Procedures Categories of Mitos

The procedures that Mitos provides are listed below: [41]

- Arable and livestock farming
- Justice
- Education
- Business activity
- Employment and insurance
- Family
- Property and taxation
- Citizens and day-to-day life
- Culture, sport and tourism
- Conscription
- Health and welfare

These procedures are offered to citizens, businesses, legal entities, civil servants, public bodies and foreigners. Each of these procedures has a huge variety of subcategories. For instance, in education category students can search for digital skills, educational matters, education resume, enrolling pupils in schools etc. Another example can be business. Business activity category has as subcategories business taxation, business support, staff employment etc. In general, Mitos offers 3.186 procedures to 27 organizations. [41]

2.5.2 Register in Mitos

The users that need to be registered in Mitos should provide the below information in order to be identified during the registration: [41]

- name
- last name
- TaxisNet username
- father's name
- mother's name
- year of birth

- tax registration number

For the provision of electronic services, the Ministry of Digital Governance processes, needs to gather also the below data from the users: [41]

- The IP address of the user's device
- Browsing data within the website, through the cookies
- The timestamp relating to the use of the service
- Data with regard to the connection device
- All the information included in the comments submitted by the user.

2.6 Summary

In conclusion, the proper and sufficient evaluation and improvement of business processes can be accomplished by BPM. BPM is the way of how the organizations are performing the daily activities in combination with the tools that businesses are using in order to evaluate these activities. The aim of the process improvement is to take advantage of the different opportunities that might be presented i.e., improve the performance by reducing the costs but without downsizing. The more processes a business has the more need for management is required. The complexity of the business processes can be simplified with business process modeling from high-level processes to the corresponding sub-processes. A variety of businesses and organizations use BPMN to illustrate and present different kind of processes. BPMN is a user-friendly notation language that provides the possibility not only to modeling a process but also to share it between different departments and to ensure that even non-technical users will understand it. Alongside, when it comes to decisions and conditions, DMN model can provide assistance and help to clarify the BPMN diagram.

Furthermore, based on the nowadays demands the process modeling is not always enough in order to improve the performance of a business. Businesses must adapt also a BPA approach and implement tools to automate the activities and provide better services to the clients. The benefits that ensue from the capitalization on the Business Process Automation (BPA) are countless. Many AI techniques have been

contributed to the improvement of the efficiency in business processes, of the user's experience and satisfaction, of data mining and analysis, of the performance etc. These new business tools have turned the corporate world upside down and have helped organizations to thrive. Therefore, the organizations that haven't so far adapt this digital transformation are sooner or later left behind. Finally, BPA provides many tools and business can identify the requirements and choose the tools that fit better and will provide a different and positive perspective.

This is where RPA's importance appears. RPA is a tool that allows businesses to replace manual low-value single tasks, such as manual input, keystroke, paperwork, daily time-consuming tasks. Using RPA businesses can automate a high variety of manual and recurring tasks. By accomplishing that, businesses can decrease their costs, they can save time, they act in-real time in order to succeed a high efficiency, they can invest to other tasks which cannot be automated or even they can get engaged with tasks that they didn't have the time to deal with in the past. At the end of the day, RPA is value for money.

It is important also to mention that, the last section describes Mitos.gov platform in order to present the usage of Mitos and the areas that Mitos covers.

CHAPETR 3: Modeling Business Processes

This chapter presents the activity of modeling and automate a business process by using graphical notation and artificial intelligence techniques. In particular, the graphical notation that is going to be used is BPMN. Besides the standard modeling, a business process requires also decision model. For this reason, the DMN graphical notation is going to be used. This set of activities, tasks, events, decisions is going to be illustrated with the use of Camunda Modeler. An introduction to Camunda Platform and all Camunda's tools is going to be described in order to understand deeply how all these tools can be combined so that an entire complex business process can be presented as a model. Of course, there are many languages that can be used to develop a business process model besides BPMN, such as BPEL, Petri Nets (PNs), EPC, and UML Activity Diagrams (AD). [34] Based on another research by Pedro Valderas, Victoria Torres and Estefanía Serral [34] *“The level and the purpose of the BP model being created will determine the modelling language used in each case. For example, while the BPMN modelling language is more appropriate to represent high-level BPs, PNs work better for low-level BPs that in addition can be analyzed from a mathematical point of view.”* The combination of Camunda's tool can be achieved by microservices which are basically small independent building blocks that can communicate to each other. [34] Additionally, in this chapter the way to include an artificial intelligence technique such as Robotic Process Automation using UiPath will be described. Lastly, it is necessary to mention that the last section will focus on the overview of a specific department, Account Payables, which is the department that is in charge of the case study which is going to be presented in another chapter. The case study is the invoice creation which is a business process that is performed by Account Payables department and this case study is going to be used as an applied example of BPMN and RPA.

3.1 Implement BPMN in a Process

Business Process Model and Notation, known as BPMN, was initially introduced in 2004 by the Business Process Modeling Initiative (BPMI) as a graphical notation for

modeling business processes. [26] Later, Object Management Group (OMG) espoused BPMN on 2006 and since then it has been established to be the de facto modeling notation for business processes [26]. With the launch of BPMN 2.0 in 2011, both academic and industrial sectors adopted BPMN 2.0 for modeling and executing business operations. As a conclusion, BPMN was accepted as an ISO (ISO/IEC 19510:2013) standard [26] and for that BPMN can be considered as the most dominant notation in the BPM spectrum.

Additionally, BPMN is helpful due to the fact that provides an in-depth overview of the business process and therefore the practitioners can understand the process further and analyze, modify and redesign the model based on the needs. As has been described in a previous chapter, the BPM lifecycle, which includes the 6 phases, requires this knowledge. If users and practitioners don't have the skills then the lifecycle will be disturbed. The aim of BPMN is to provide a notation that everyone who is involved in the process can understand. Through BPM notation the business tasks, events and, processes can be described in a form of diagrams, modelling tasks, responsible people, and the order in which tasks occur. [3]

The basic elements and the basic structure have already been described in Chapter 2. For this reason, this chapter will go deeper and will present more complex scenarios. In figure16 a business process is modeling which includes many departments. The departments are presented in different lanes of the same pool "ACNS". The four lanes in this diagram are:

1. Clerk
2. Senior Acceptor
3. Regular Acceptor
4. Account Manager

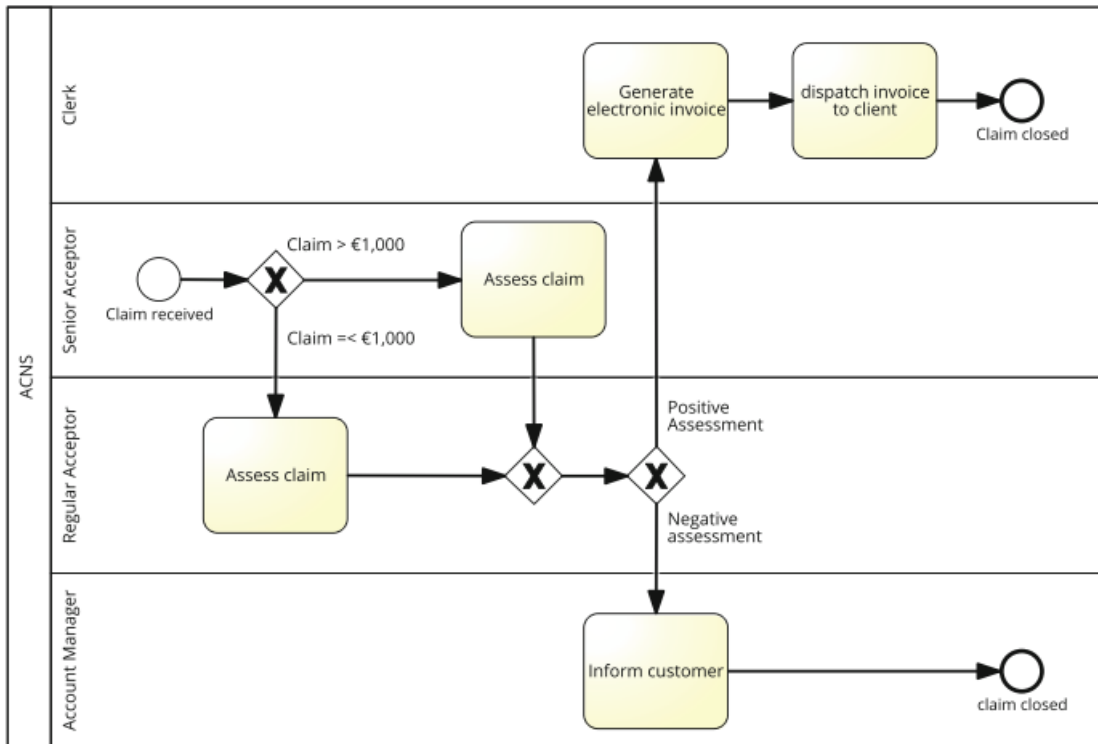


Figure 16. Business Process model with BPMN with many pools [1]

Each department is responsible for its own activities. For instance, Account Manager is in charge only for “Inform customer” task.

The process starts with the start event “Claim received”. This start event is a “none start event” since it doesn’t include any specific input. This event will occur in Senior Acceptor Lane. Once this is completed, the next step is the “exclusive gateway (XOR)” which is based on a condition. One of the 2 conditions can be true, either Claim is higher than 1,000 euros or claim will be equal or less than 1,000 euros. If the first condition is true then the next step is the task “Assess claim” by Senior Acceptor Lane. Tasks are included in the Activities elements of BPMN. If the first condition is not true then the second condition is true which means that the task “Assess claim” will be triggered by Regular Acceptor Lane. The gateways must always close. For this reason, the second gateway is presented in order to show the end of this gateway. Later, a new gateway is initiated which includes new conditions but this time this will take place in Regular Acceptor Lane. This gateway is again an “exclusive gateway” only this time the conditions are: Positive or Negative assessment. If the assessment is positive then an electronic invoice must be created

by Clerk department. This activity is presented as a task “Generate electronic invoice” directly in Clerk Lane. After that the task “dispatch invoice to client” is initiated again in Clerk Lane. Once this task is completed, the entire process has come to an end with the “none end event” which is called “Claim closed”. On the other hand, if the assessment is negative then the task “Inform customer” is triggered in Account Manager Lane and once this task is completed, the entire process is coming to an end with the “none end event” which is called “Claim closed”.

In order to go deeper and observe even more complex activities below other figures which include advanced modeling elements. In figure17 there is one pool with one lane which means one department, the “CUSTOMER”, there is one start and one end event, there are 4 user tasks, two gateways and tree intermediate catching events. The points to take into consideration are:

- User tasks are performed by specific users, the assignees, with the help of an IT system or an application. The users can review their tasks in the user’s task list. All the completed tasks are marked as such.
- The event-based gateway will choose the triggered event which means it will pause until one of the subsequence event triggers, ignoring all the other events that might occur. For this reason, this gateway is usually replaced by the XOR gateway.
- The intermediate catching events are utilized based on an event that should be occur either it is a message that the recipient should receive or a due date.

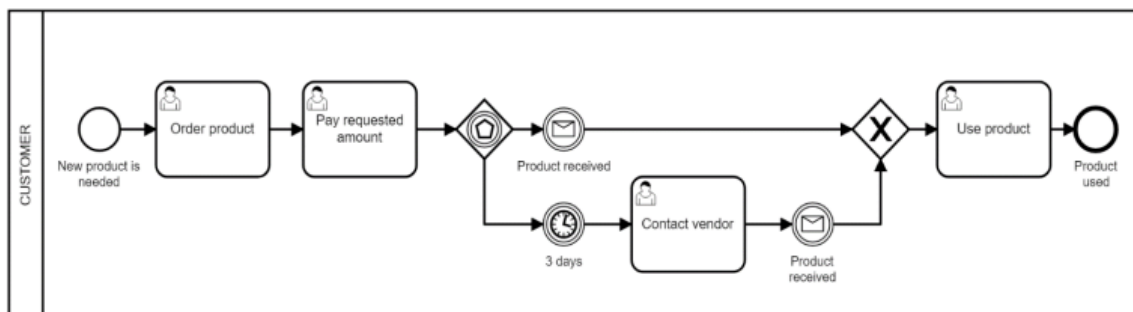


Figure 17. Business Process model with BPMN with intermediate events [26]

Another example is visible in figure18. The importance of this example is the sub-process “Verify degrees validity”. The sub-processes are self-contained, composite activities [1] that can be divided into smaller parts of work. For example, in order to verify the accuracy of a degree, smaller tasks must be operated such as “post documents to agency” and “receive results from agency”. These smaller internal tasks are included in a macro-activity called “Verify degrees validity”. [1]

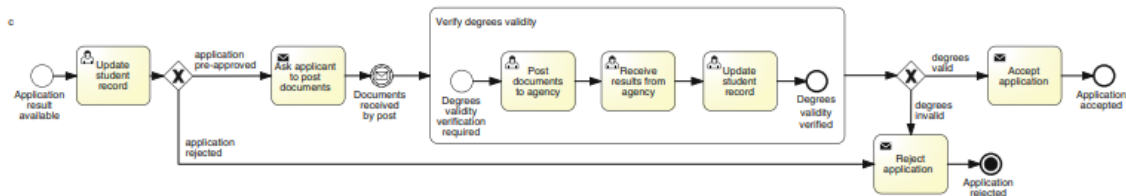


Figure 18. Business Process model with BPMN with sub-process [1]

As a final example, it is illustrated below a business task with two boundary interrupting events. The importance of these events is that if they occur while the task is active, they can interrupt the task on which they are attached to. Furthermore, the compensation task “Cancel booking” which is outside of the normal flow of the process, is attached to the boundary interrupting event and as such the activity is called boundary compensation event and it is triggered only if the activity to which they are attached to, is completed and no active. [26]

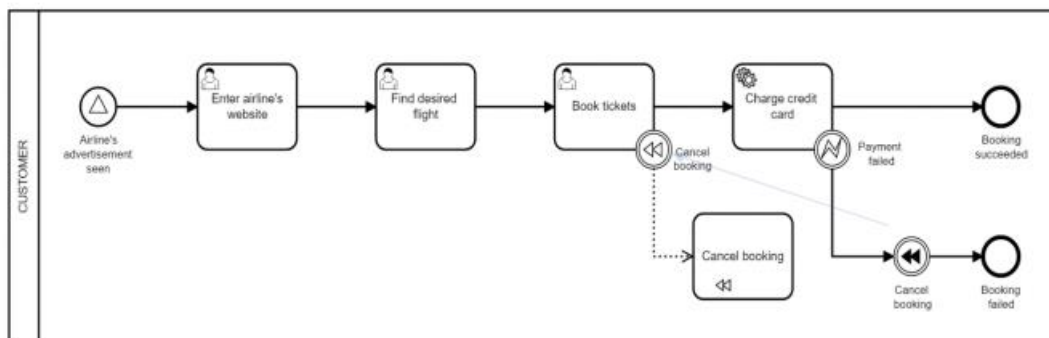


Figure 19. Business Process model with BPMN with boundary events [26]

To summarize BPMN provides fundamentals and advanced elements to help businesses to illustrate and to model their processes. BPMN has been established as a de facto modeling notation since provides a huge range of elements. As a recap in

figures20-23 these elements are summarized, starting from task types, then tasks market types and finally event types.









BPMN Tasks		
Task Type	Symbol	Functionality
Task		BPMN tasks are utilized for rendering a specific activity that needs to be executed.
Manual Task		An activity that is executed by human actors without the usage of IT systems. This type of task is not automatically assigned by a workflow engine to a user's task list.
User Task		An activity that is executed by human actors with the assistance of an application or an IT system. It might be assigned to them by a workflow engine, since this type of task is placed automatically to a user's tasks list.
Receive Task		An activity that waits for the arrival of an external message. The execution of the process cannot be continued unless a specific message is received.
Send Task		An activity that sends a specific message to an external recipient. Send tasks can be automatically executed by engines.
Service Task		An activity that uses some sort of service, such as a Web Service or an automated application. This type of task is performed automatically without human intervention.
Script Task		An activity that is automatically executed by a workflow engine. This type of tasks is written in a language that the workflow engine is able to interpret.
Business Rule Task		An activity utilized for the implementation of business rules in a process model. This type of task might additionally be linked to DMN notation, as a means of referencing DMN models from BPMN models.

Figure 20. BPMN Tasks List [26]

BPMN Task Markers		
Marker Type	Symbol	Functionality
Compensation Marker		Represents a compensation handler task in case of a compensation event is triggered in a process. In fact, it is utilized for compensations only and indicates a task that is outside the normal process flow.
Loop Marker		Indicates a repetition of a task until a defined condition either applies or ceases to apply.
Multiple instance Marker	Parallel Multi Instance	Indicates a task that needs to be executed multiple times, either in parallel or sequentially.
	Sequential Multi Instance	

Figure 21. BPMN Task Markers [26]

BPMN Events							
Event							BPMN events are utilized for capturing important milestones of a process execution.
Event type	Start event	Intermediate catching event	Intermediate throwing event	Boundary interrupting event	Boundary non-interrupting event	End event	Functionality
Message event							The message event is utilized when a message is forwarded to a specific recipient or when the process instance receives an external message.
Timer event			-			-	The timer event is utilized so as to denote the concept of time in a process model.
Error event	-	-	-		-		The error event is utilized so as to denote potential errors during a process execution.
Conditional event			-			-	The conditional event is utilized so as to denote a condition that needs to be satisfied during the process execution.

Figure 22. BPMN Events List (1) [26]

Signal event							The signal event is utilized when messages (i.e., signals) are forwarded to a global audience, rather than a specific recipient, or when the process instance receives an external signal.
Link event	-			-	-	-	The link event is utilized so as to connect two sections of a process, avoiding long sequence flow lines.
Terminate event	-	-	-	-	-		The terminate event is utilized so as to preciously terminate process instances.
Compensation event	-	-			-		The compensation event is utilized in the context of triggering or handling compensations in a process execution.
Escalation event	-	-					The escalation event is utilized so as to communicate events from subprocesses to parent processes.
Cancel event	-	-	-		-		The cancel event is particularly utilized in the context of transaction subprocesses so as to denote the cancellation of an entire transaction.
Multiple event							The multiple event is utilized in a way that several event types can be encapsulated to a single symbol.

Figure 23. BPMN Events List (2) [26]

Lastly, we can't help but notice that there are also some data modeling elements that they are utilized to illustrate every little detail and step of the process, such as Database or Data store, data object and data association flow. In figure24 there is the illustration of these data modeling elements.




BPMN data modeling elements		
Element	Symbol	Functionality
Data object		The data object element is utilized in order to graphically illustrate every piece of information (e.g., paper documents, electronic data, etc.), which flows inside a process.
Data store		The data store element is utilized in order to represent a software, a database or any other place where information is stored (e.g., journal), indicating how data is retrieved and stored within a process.
Data association flow		The data association flow is utilized in order to connect flow objects and sequence flows with data object and data stores.

Figure 24. BPMN data modeling elements [26]

3.1.1 Introduction to Camunda Platform 8

Camunda Platform 8 is an orchestrator of complex business processes that spans people, systems, and devices. Using Camunda, organizations have the possibility to connect users with developers in order to allow the collaboration between different departments and automate an end-to-end process using BPMN 2.0 standard notation, alongside DMN decision tables that promote speed, scale, and decision logic. With Camunda Platform 8 businesses can automate processes as-a-service with execution engines for BPMN processes and DMN decisions, and paired with tools for collaborative modeling, operations, and analytics. [8]

Camunda Platform 8 consists of six components:[8]

- Console to configure and deploy clusters
- Web Modeler to model a process and deploy using either Desktop Modeler or Web Modeler
- Zeebe which is the cloud-native process engine
- Tasklist to monitor and operate human tasks
- Operate to manage the processes
- Optimize to enhance the process

In figure25 it is captured all these components to clarify the sequence of these components.



Figure 25. Overview of the Camunda platform components [8]

A more technical diagram that provides a high-level overview of the Camunda Ecosystem is presented below:

Camunda Ecosystem

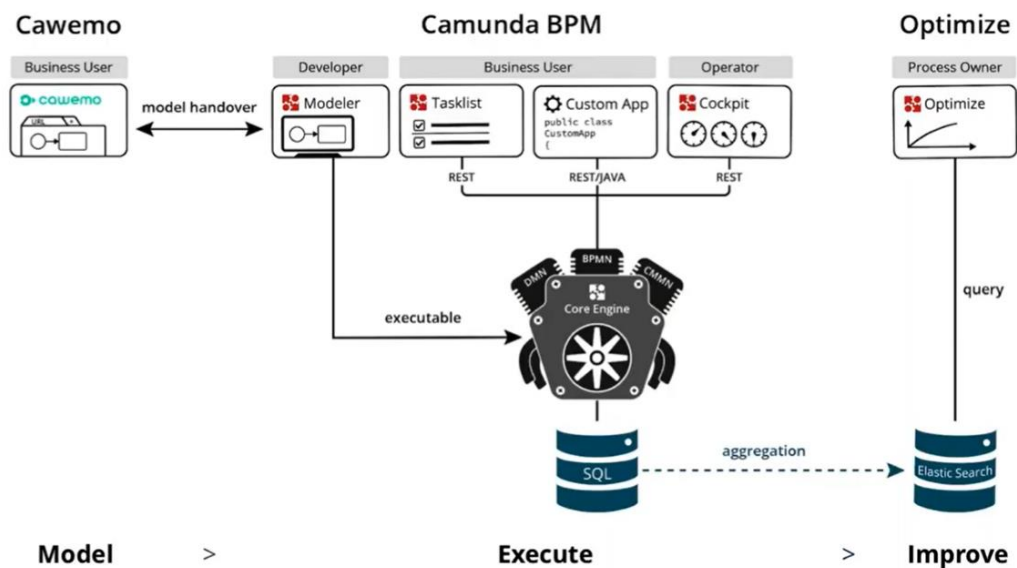


Figure 26. Camunda ecosystem [8]

In more details, the entire process is modeling in Camunda Modeler using BPMN and adding Forms, DMN, Connectors, which are some techniques that are presented in another section. Cawemo is a web-based BPMN and DMN modeling application which is interactive and helps with the communication and collaboration between users and/or different departments. It can be connected to Modeler through a

plugin. The focal point is that with Camunda users can share comments, communicate, add details or specifications about tasks in real time.

The Console is an application which allows businesses to manage clusters, manage API clients, interact with Zeebe, manage Tasklist, manage errors, manage IP Whitelists and in general manage the organization by reviewing the organization activity. Below an overview of the console:

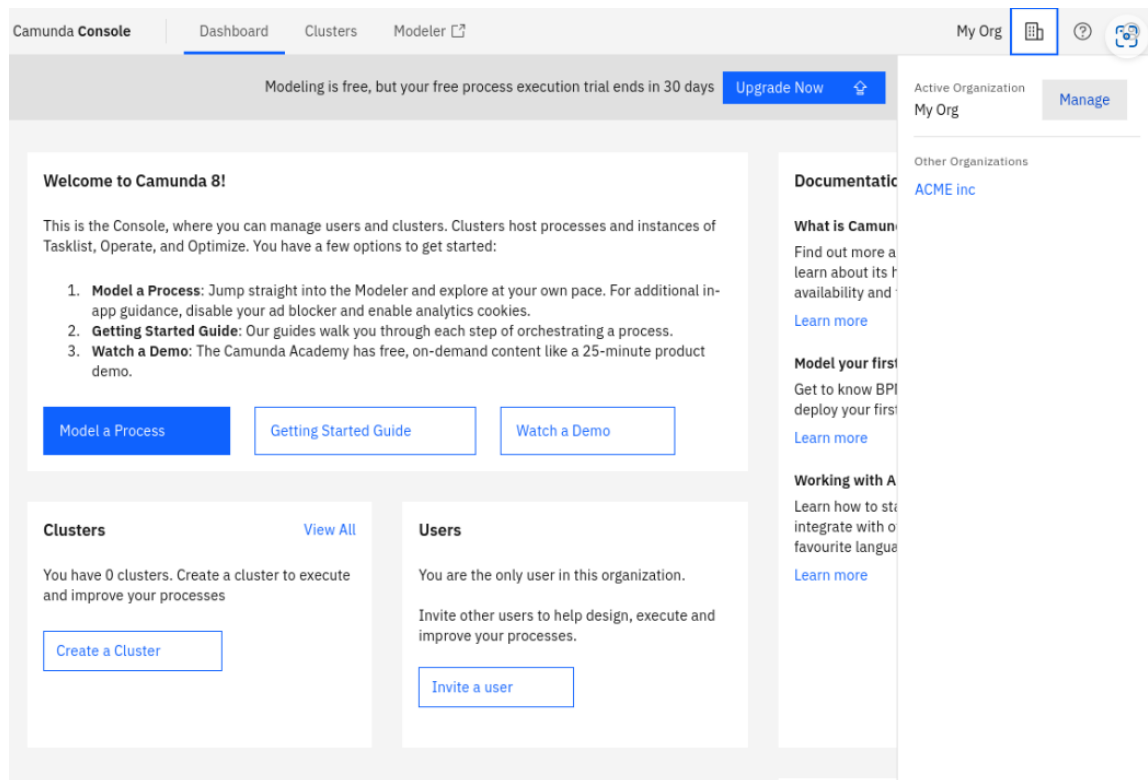


Figure 27. Camunda Console [9]

Below an overview of the organization activity:

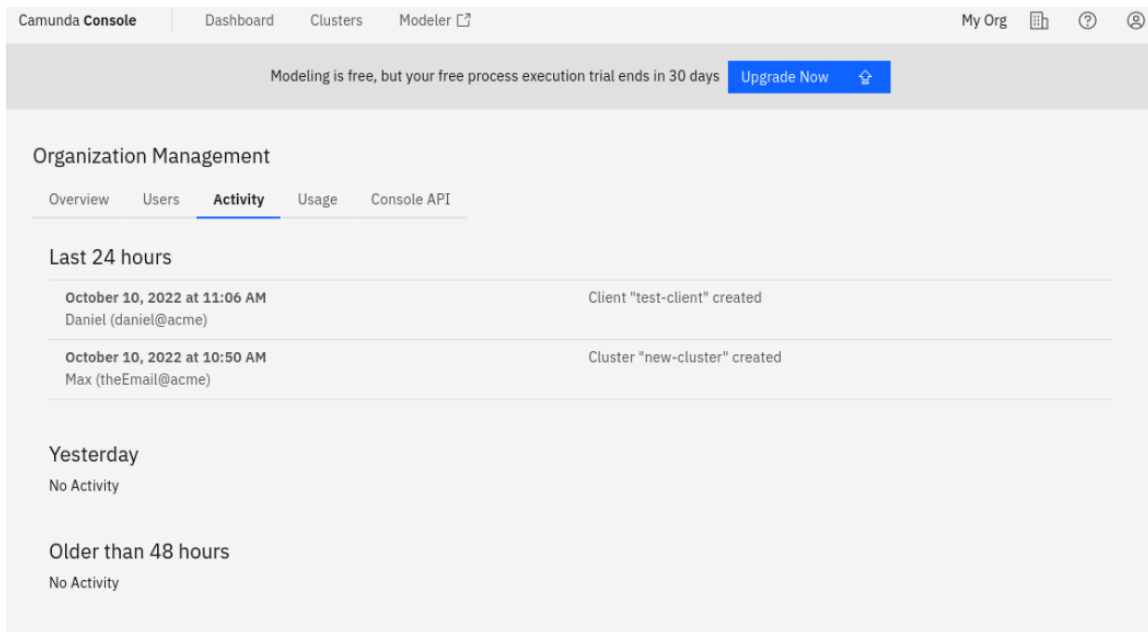


Figure 28. Camunda Console [9]

The Modeler helps to create a BPMN, DMN diagram or a Form, and deploy it to Zeebe. The Camunda Modeler provides an element palette where the user can choose the elements to build the business process. To configure the elements, the user can modify the properly panel. Once the deployment is successful a Process Instance ID will be populated as below:

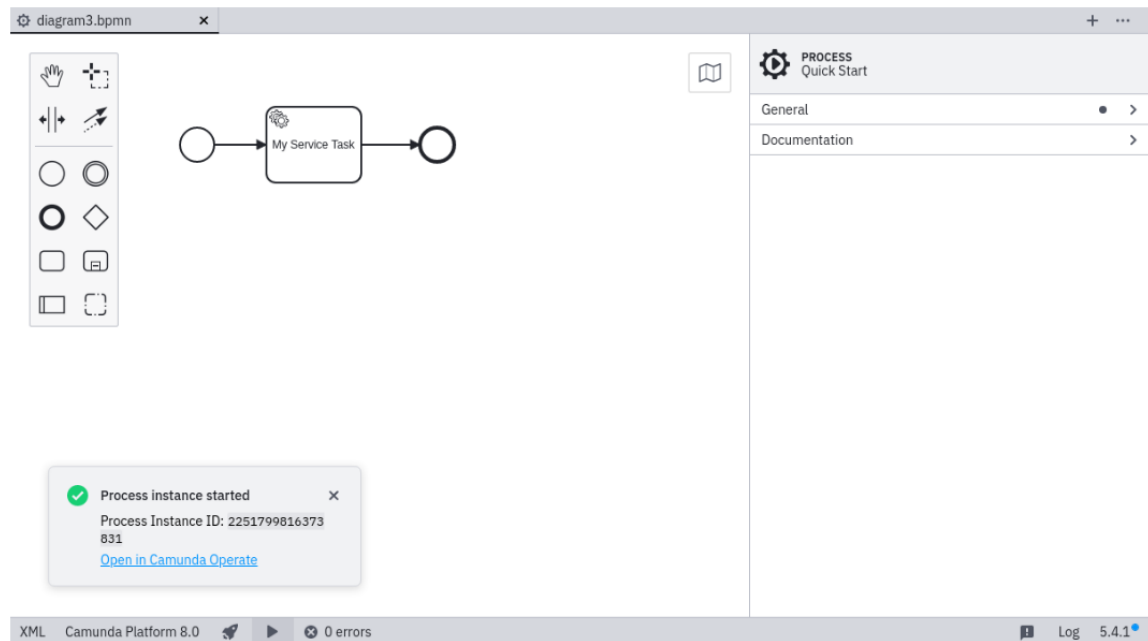


Figure 29. Camunda modeler [10]

The architecture of Zeebe can be described with the below image:

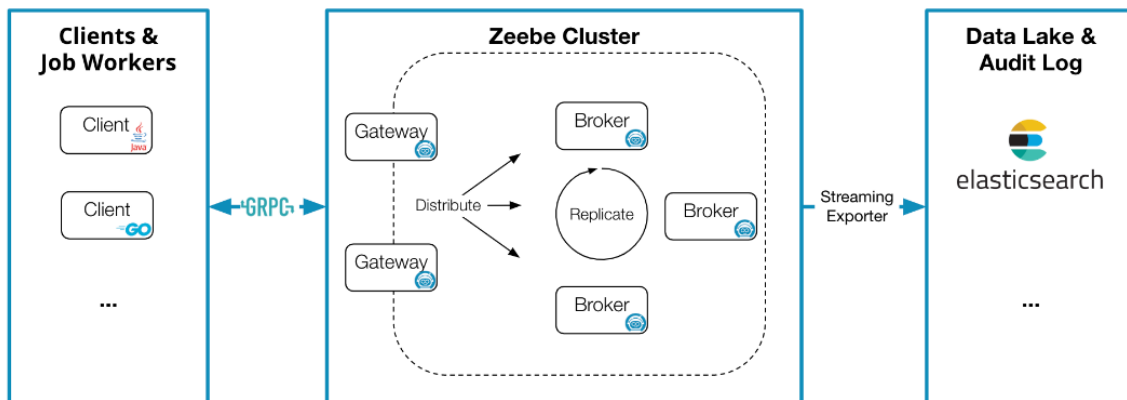


Figure 30. Zeebe structure [11]

The main components are:

1. Clients; send commands to Zeebe to deploy processes, manage business logic, resolve issues. [11]
2. Gateways; are a single entry point to a Zeebe cluster, Gateways send requests to brokers. The gateway is stateless and sessionless, and gateways can be added as necessary for load balancing and high availability. [11]
3. Brokers; distributed workflow engine that tracks the state of active process instances. Brokers can be divided for horizontal scalability and replicated for fault tolerance. A Zeebe deployment often consists of more than one broker and the brokers perform the same activities which means that a broker can have the responsibilities of another broker. [11]
4. Exporters; is a system that provides an event stream of each change within the process. This means that the users can monitor the process which is running, analyse the previous runs, review data for auditing, track incidents and issues. [11]

The Tasklist tool is used to review and monitor tasks assigned to users. The users can review the open tasks, the unclaimed and claimed ones and the completed ones. Also, they can perform actions, i.e., add variables, claim a task, complete a task.

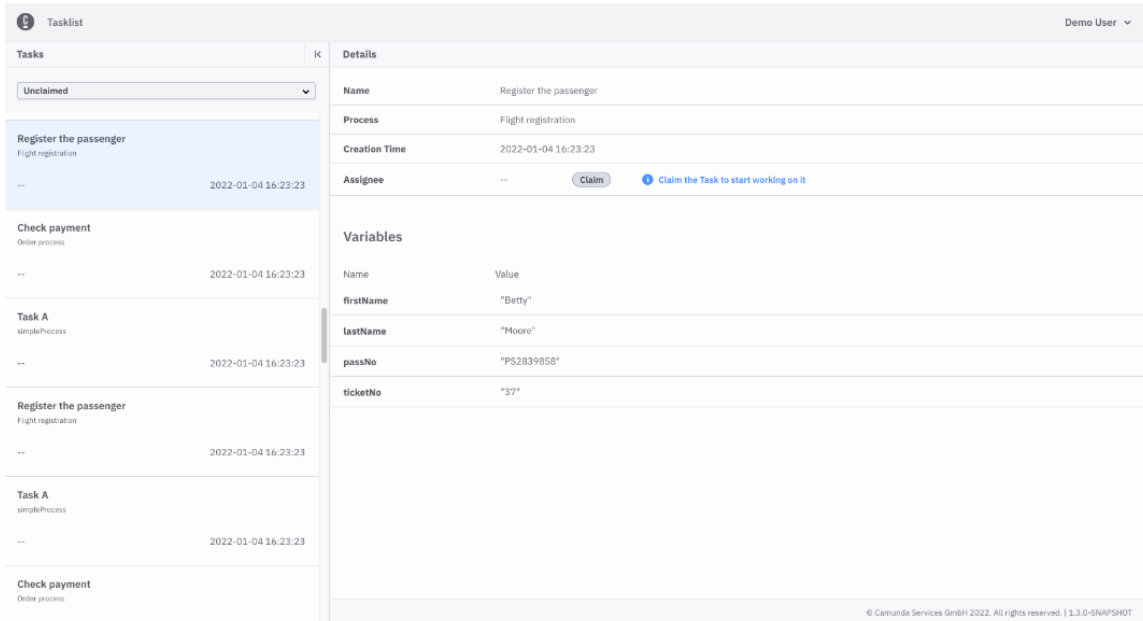


Figure 31. Camunda Tasklist [12]

The Cockpit is a web-based applications, as the Tasklist. The Cockpit tool is more or less a dashboard that facilitates the monitoring and the analysis of running and historic operations.

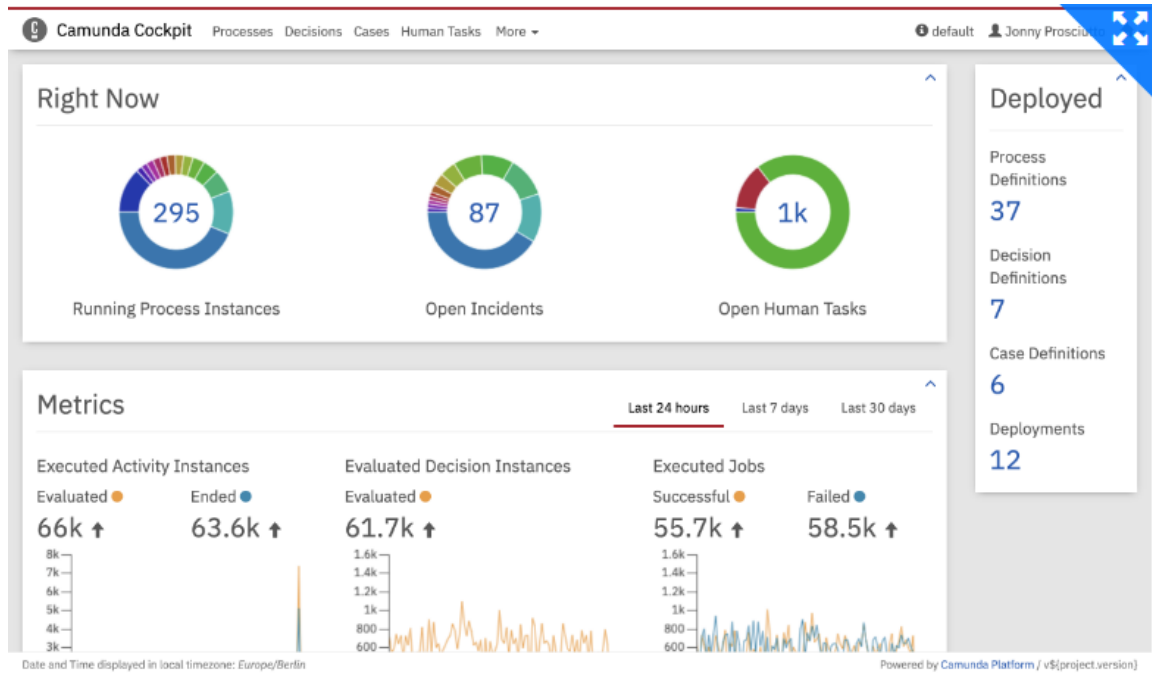


Figure 32. Camunda Cockpit [13]

The Operate tool is useful to monitor and track the incidents as presented below:

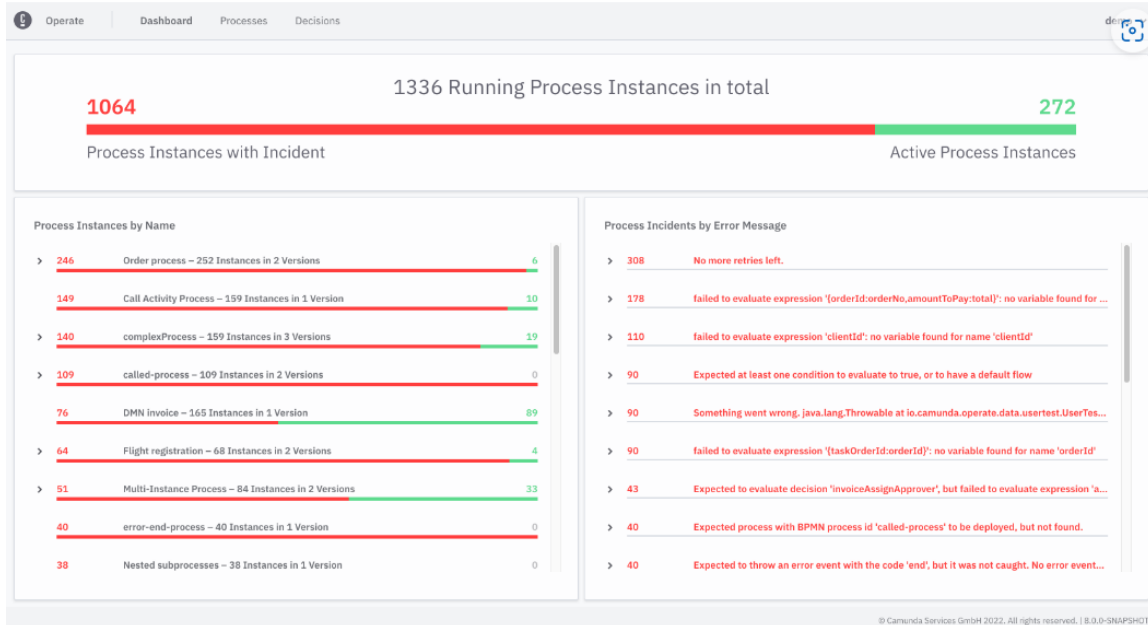


Figure 33. Camunda Operate [14]

The Optimize tool helps businesses to improve their automation by leveraging the data migration during process execution, accessing to reports, sharing process intelligence, analyzing bottlenecks, and examining areas in business processes for improvement. After each process call, Optimize makes REST API calls into the Camunda server, and stores the data on its own Elasticsearch database. As an outcome all the historic data is available and can be populated in a report and/or dashboard. For example, users can understand which instances had a longer runtime. To summarize Optimize is purpose-built which means that can identify in real time the problems and barriers of an organization's system. An overview of the Optimize is presented below:

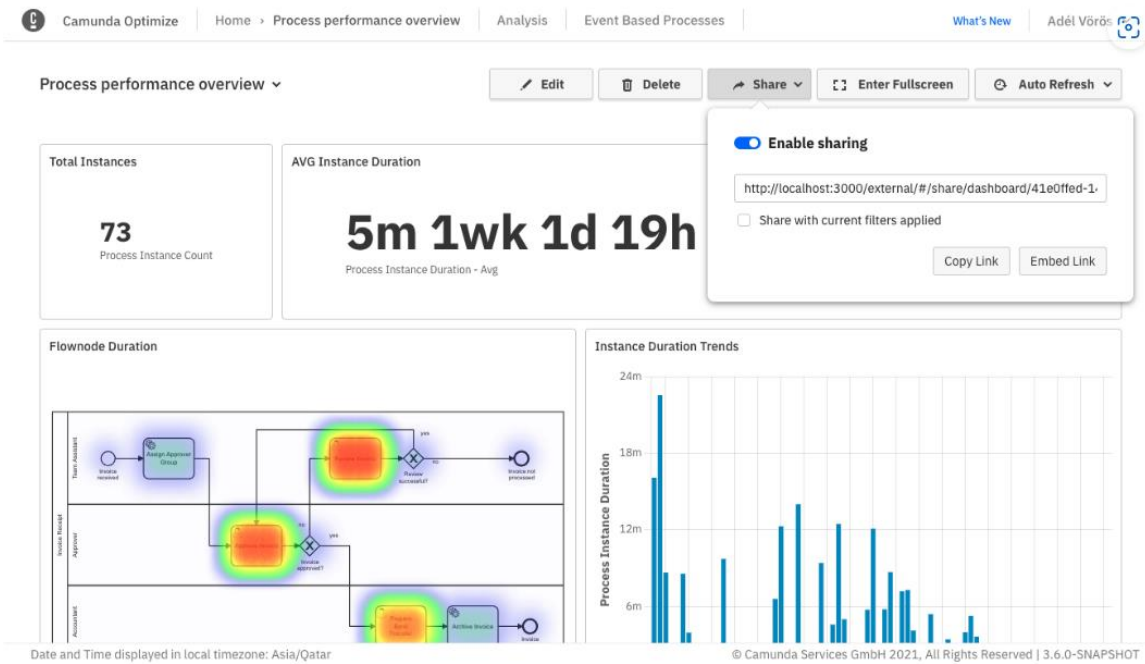


Figure 34. Camunda Optimize [15]

Moving forward, a standard business process consists of multiple microservices to generate an outcome. However, not only the communication between various microservices is difficult but also the monitoring of the performance and the problem resolution. Camunda helps organizations to overcome these issues without compromising autonomy and coupling of microservices because the platform offers speed, scale, and security. In parallel, Camunda provides an easy-to-use and developer-friendly platform to achieve the monitoring of human tasks. The solutions that Camunda platform 8 offers can be summarized below:

- Modernize Legacy IT Systems
- Orchestrate, Monitor and Analyze RPA Bots
- Replace Homegrown Workflow Automation Software
- Modernize Legacy Business Process Management Systems (BPMS)
- Build a Centralized Process Automation Platform [8]

In order to analyze more what Camunda provides below an overview: [8]

- Horizontal scalability and no dependence on an external database. The cloud-native process engine, Zeebe, links data directly to the filesystem on the same servers where it is deployed.

- High availability and fault tolerance via a pre-configured replication mechanism. It is crucial that Camunda Platform 8 can guarantee the data safety because the platform can recover from machine or software failure.
- Audit trail is written to an append-only log.
- Reactive publish-subscribe interaction model. This helps to monitor and manage more efficient the microservices that connect to Camunda Platform 8 including control over processing rates. This way Camunda Platform 8 can be described as scalable, and reactive.
- The standard notation in use, BPMN 2.0, which is an ISO-standard language, is easy to use by non-technical users. This enhances the collaboration and communication between different departments by using a common language.
- Since it is a language-agnostic client model, there is the possibility to build a client in almost any programming language that an organization uses to build microservices.

3.2 Implement DMN in a process

When it comes to decisions and conditions, DMN model can provide an assistance and make less complex a BPMN diagram. DMN standard provides a two-level model for decisions: the decision requirements and the decision logic level [19], [20]. The Decision Requirements Diagram (DRD) models in a graphical and hierarchical way the decisions. Despite the fact that DRD is sufficient for the purposes of business analysis in a high-level, more details are given by the decision logic level. In this way, the decision logic is encapsulated into decision tables, where its expressions are defined with the Friendly Enough Expression Language (FEEL). [21] DMN replaced (X)OR gateways because the models turned to be really complicated, especially when it comes to many decisions. With DMN users can define business rules separately and link them directly to BPMN business rule tasks or conditional events. [1]

DRD uses some basic elements, as they are presented in the figure35. A DRD diagram describes the different input parameters that are linked to different

decision tables. For instance, the “Decision” elements have an input parameter which is the “Input data” element and can also has as input parameter different sources which are the “Knowledge Source” elements. This means that the decisions cannot be completed if the input parameters and the sources are not applicable.









DRD elements		
Element	Symbol	Functionality
Decision		A decision node illustrates an output from a number of inputs, after invoking the decision logic of one or more business knowledge models.
Input Data		An input data element illustrates the information that is required as input by one or more decisions.
Business Knowledge Model		A business knowledge model renders the decision logic and the business “know-how” behind each decision.
Knowledge Source		A knowledge source illustrates an authority for a business knowledge model or decision, from which the desired logic is derived (e.g., source document, domain expert, etc.).
Information requirement		An information requirement arrow renders input data, as well as decision
		outputs, that are utilized as inputs to a decision.
Knowledge requirement		A knowledge requirement arrow illustrates the invocation of a business knowledge model by a decision.
Authority requirement		An authority requirement arrow illustrates the dependency of a DRD element on another DRD element that acts as an authority and a source of knowledge.
Text annotation	 Text annotation	A text annotation artifact illustrates an explanatory text or comment, associated with a DRD element.

Figure 35. DRD elements [26]

Behind any decision there is the “Business Knowledge Model” in order to define the reasons of the decisions in the business process. In figure36 an example of DMN is captured which explains that each lines represents a rule (a condition) and the decision will be made based on the inputs of each rule. More precisely, if the “Occupation” is “Employed” and if the “Employed” has an “Age” less than “21” then the decision is that it is “Ineligible”. The output is the decision and the annotations

can provide further details of this decision. This example is under “unique” hit policy which means that only one rule can be true. There are also other hit policies, such as first, any, collect, collect sum. In figure39 all the hit policies are described.

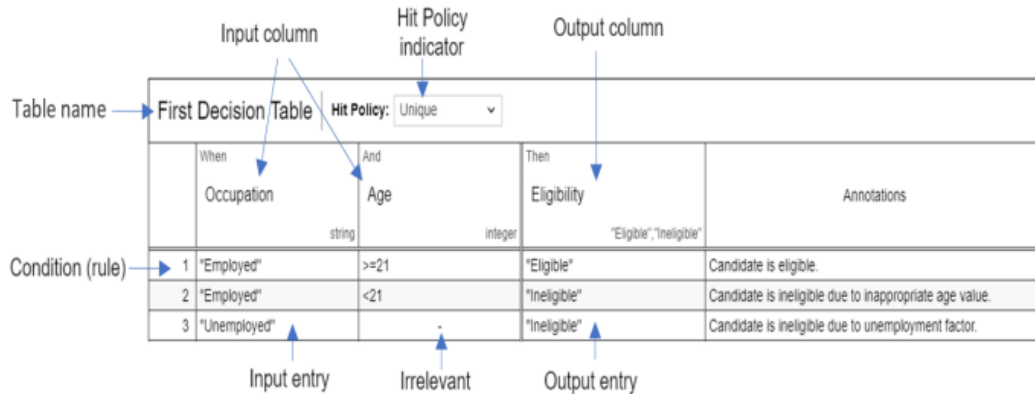


Figure 36. Decision Table – define the rules [26]

The rules have been translated from FEEL syntax and a corresponding JavaScript as presented in the next figure.

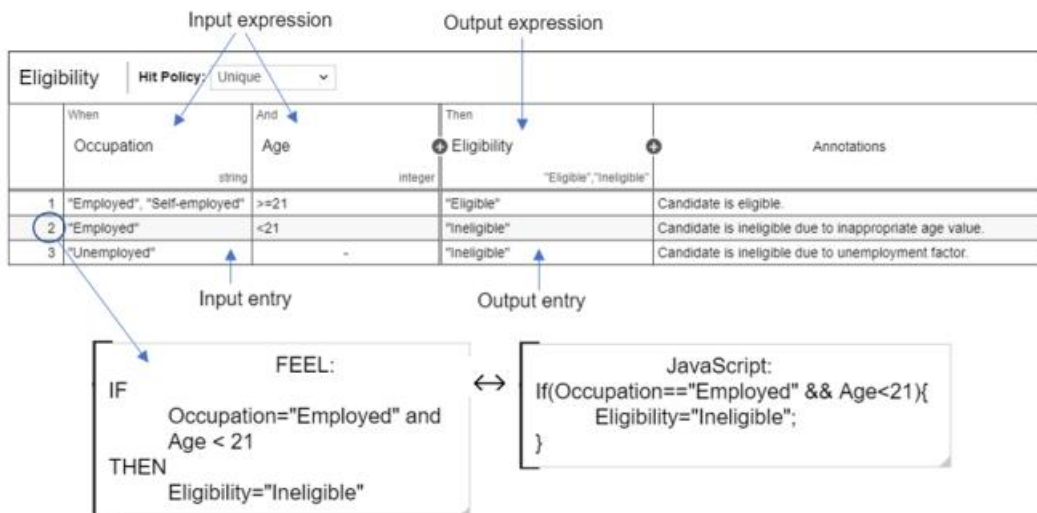


Figure 37. DMN with FEEL expression language [26]

In the next figure is explained the integration between DRD and DMN. The decision about the “Eligibility” has been built after the calculation of “Eligibility rules” and the final outputs are going to be transmitted to the main business process in the BPMN model.

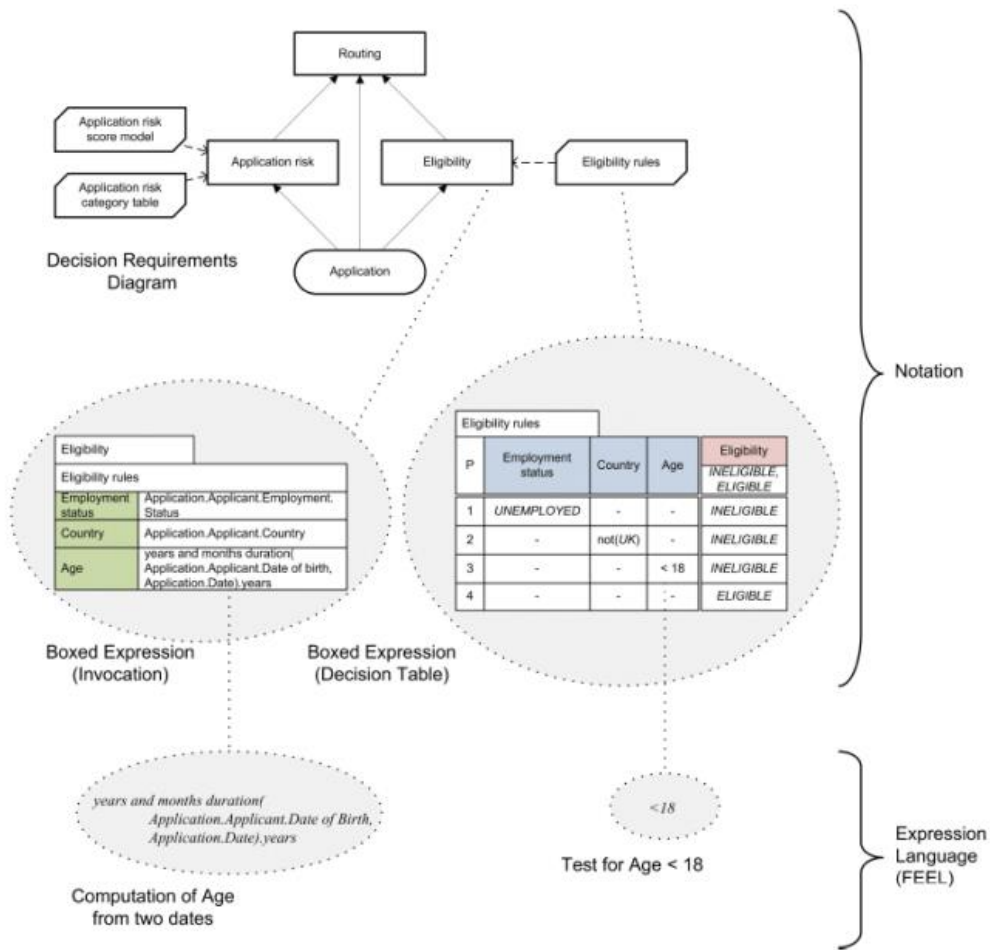


Figure 38. DMN and DRD connection [21]

Hit Policies			
	Hit policy	Indicator	Functionality
Single hit	Unique	U	The Unique hit policy determines that exactly one rule has to apply and no overlapping rules are allowed.
	First	F	The First hit policy denotes that the result is determined by the first matching rule, while all the other matching rules are ignored.
	Any	A	The Any hit policy denotes that all matching rules must

			generate the same output entry for each output.
	Priority	P	The Priority hit policy assigns a priority to each output entry. The result with the highest priority of all matching rules is returned.
Multiple hit	Collect	C	The Collect hit policy determines the decision result as a list of all output entries of all matching rules.
	Collect sum	C+	The Collect (sum) hit policy returns the aggregation of all output entries of all matching rules.
	Collect max	C>	The Collect (max) hit policy returns the maximum output entry of all matching rules.
	Collect min	C<	The Collect (min) hit policy returns the minimum output entry of all matching rules.
	Collect count	C#	The Collect (count) hit policy returns the number of all matching rules.
	Rule order	R	The Rule order hit policy determines a list of output entries, ordered based on the matching rules order.
	Output order	O	The Output order hit policy determines a list of outputs entries, ordered in a decreasing order of output priority.

Figure 39. DMN hit policies [26]

3.2.1 Using Camunda to create a DMN model

In Camunda Modeler besides the BPMN project, the user has the possibility to create a DMN project as well. Once a task is assigned as a “Business Rule Task” in BPMN, it can be linked to a DMN table. In figure40 the DRD diagram has two different DMN tables and each table has its own rules and outputs. Of course, the decision about “Assign Consultant to Project” is affected by the previous decision “Decide Project Complexity Score”. The output of the first decision will become an input for the second decision.

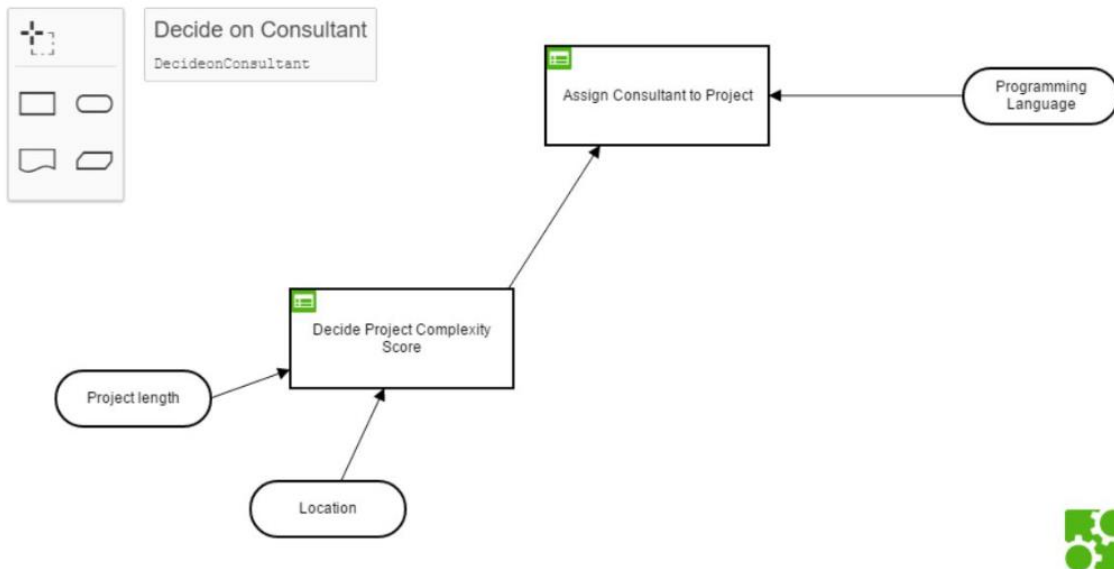


Figure 40. DRD example using Camunda [22]

Once the decisions in DRD are expanded, the decision table appears with the rules, as shown in the figure below.

Decide Project Complexity Score				Enter Advanced Mode	Show DRD
C+	Input +		Output +	Annotation	
	Project Length (Months)	Location	Complexity Score		
	integer	string	integer		
1	>= 12	"Europe", "North America"	60	-	
2	[1..3]	"Europe", "North America"	5	-	
3	]3..6]	"Europe", "North America"	15	-
4	[6..12[	"Asia", "South America"	85	-
5	]1..6]	"Asia", "South America"	30	-
6	>= 12	"Asia", "South America"	100	-	
7	-	"Africa"	150	Because we have no consultants in Africa	
8	[1..3]	-	5	-	
9	]3..6]	-	15	-
10	]6..9]	-	40	-
11	]9..12]	-	80	-
12	> 12	-	100	-	
13	-	not("Europe", "Asia", "South America", "North America", "Africa")	300	-	

Figure 41. DMN example using Camunda [22]

The DMN diagrams can be evaluated in the “DMN Simulator” provided by Camunda in order to ensure the credibility of the results. In the next example, the simulator based on the inputs, run and provided the output. The user should decide on the inputs i.e., “Guests with children”, “Season” and “How many guests”. Based on the first decision table “Dish”, the output is “Spareribs”. The output of the first decision

table “Dish” is an input of the second decision table “Beverage”. Based on the two inputs, “Dish” and the “Guests with children”, the second decision table returned the output “Beverage” equals to “Water”. The tricky point is that the policy is not unique, but collect which means that the decision is a collect answer of all the matching rules.

Figure 42. Example “Dinner Decisions” in Camunda DMN Simulator

Dish		Hit Policy: Unique			BPMN.io
	When	And	Then		
	Season string	How many guests integer	+ Dish string	+ Annotations	
1	not("Fall", "Winter", "Spring", "Summer")	>= 0	"Instant Soup"	Default value	
2	"Fall"	<= 8	"Spareribs"		
3	"Winter"	<= 8	"Roastbeef"		
4	"Spring"	<= 4	"Dry Aged Gourmet Steak"		
5	"Spring"	[5..8]	"Steak"	Save money	
6	"Fall", "Winter", "Spring"	> 8	"Stew"	Less effort	
7	"Summer"	-	"Light Salad and a nice Steak"	Hey, why not?	
+	-	-			

Figure 43. “Dish” decision table in Camunda DMN Simulator

Beverages		Hit Policy: Collect	BPMN.io	
	When Dish string	And Guests with children boolean	Then + Beverages string	Annotations
1	"Spareribs"	true	"Aecht Schlenkerla Rauchbier"	Tough Stuff
2	"Stew"	true	"Guinness"	
3	"Roastbeef"	true	"Bordeaux"	
4	"Steak", "Dry Aged Gourmet Steak", "Light Salad and a nice Steak"	true	"Pinot Noir"	
5	-	true	"Apple Juice"	
6	-	false	"Water"	
+	-	-		

Figure 44. "Beverage" decision table in Camunda DMN Simulator

3.3 Implement Forms using Camunda

Camunda provides the possibility to create forms and connect them to the BPMN by using a user task or start event. Camunda Forms are supplied by the open source bpmn-io-form-is-library. [35] The Camunda Form creation can be accomplished directly to Camunda Modeler or to Camunda Platform 8 by initiating a Form Project. The structure is user-friendly and as BPMN or DMN, Camunda Forms use elements. In figure below, these elements are presented.

Symbol	Name	Description
	Text view	Display static information
	Text field	Read and edit textual data
	Text area	Read and edit multiline textual data
	Number field	Read and edit numeric data
	Datetime	Read and edit date and time data
	Checkbox	Read and edit boolean data
	Radio	Small dataset single data selector
	Select	Large dataset single data selector
	Checklist	Small dataset multi data selector
	Taglist	Large dataset multi data selector
	Image view	Display images
	Button	Trigger form actions

Figure 45. Camunda Form elements

For instance, “Text field” is basically a free area where the user can use to insert details or information with no restriction. On the other hand, the “number field” element requires only positive or negative numeric data. In order to create a more interactive form, the user can insert “checkboxes” or “select” from dropdown list elements. Lastly, the user can select the “button” element for submit or reject option.

A Camunda Form example is visible in the figure below.

Figure 46. Camunda Form example [35]

Each and one of the elements that can allow data manipulation, has an identifier i.e., Key attribute, which is used for identification and for submission. Once the form is submitted it is visible to Tasklist where the key attribute will be used to assign a variable. [35]

3.4 Implement Connectors using Camunda

The fact that Camunda Platform 8 is a process orchestrator for every endpoint, means that the connectivity is universal. Camunda Connectors are divided into two types:

1. Inbound. Inbound connectors give the possibility to workflows to receive data from external systems making possible to integrate workflows into a wider business process or system architecture. They can also be used to create a new instance or to send a new message to a process instance that already runs. They divided into 3 further types: [36]
 - A) Webhook
 - B) Subscription or message subscription
 - C) Polling which uses HTTP polling to poll an external system or service
2. Outbound. Outbound connectors trigger external systems in order to integrate with specific business process's parts

With Camunda it is possible to use four categories of connectors in order to integrate with an external system. The below four categories can be either inbound or outbound: [36]

1. Out-of-the-box connectors which are pre-built connectors

2. Connector templates which can be customized using JSON configuration files
3. Protocol connector
4. Connectors SDK which is a customized Connector using Java

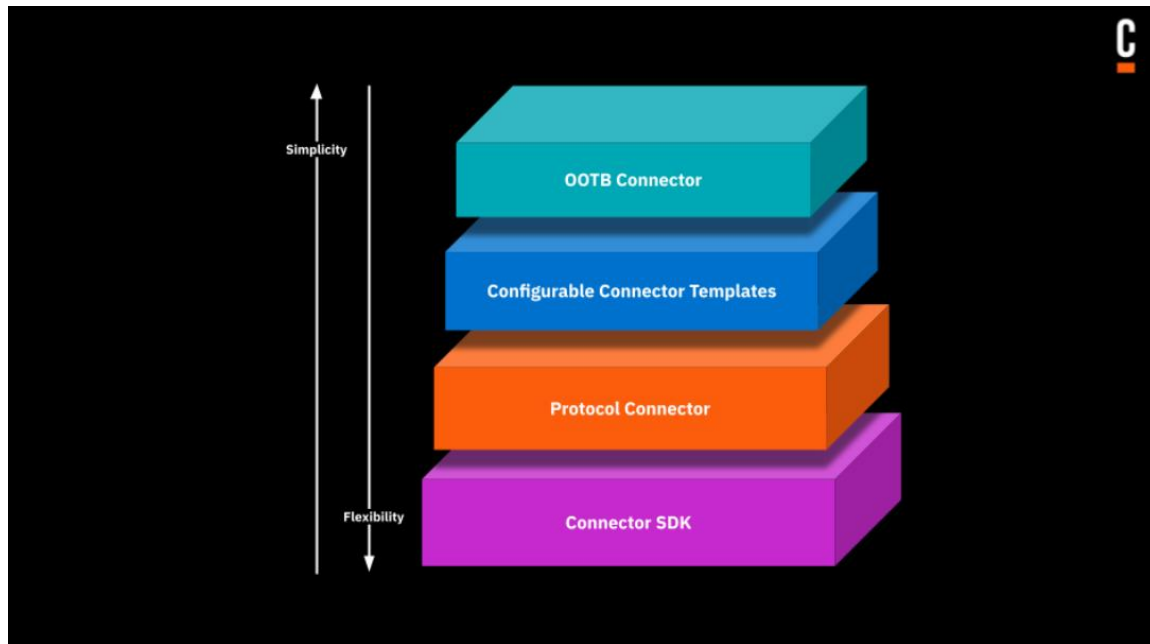


Figure 47. Camunda Connectors categories [36]

Since connectors communicate with any system or technology, this minimizes the time it takes to automate and orchestrate a business process. Some of the applications that connectors can be used for are listed below: [8]

- Cloud Connectors to integrate with cloud-native applications, i.e., Kafka, Amazon SQS, and Apache Camel message queues, AWS Lambda functions, and Amazon Eventbridg.
- Service Connectors to integrate with technology enablers, i.e., RPA platforms, AI/ML tools, and IoT services.
- Business Connectors to integrate with CRM and ERP systems, i.e., Salesforce, industry-specific applications, i.e., Duck Creek for insurance and SWIFT for banking, and proprietary software.
- Productivity Application Connectors to monitor email and tools, i.e., Slack and Microsoft Teams in order to send a notification to customers or to vendors.
- Enterprise Content Connectors to push or to pull content from systems, i.e., Box and Opentext.

- Data Connectors to deploy automated decisions by pushing or pulling data to or from provider, i.e., BI systems, data lakes, and data warehouses.

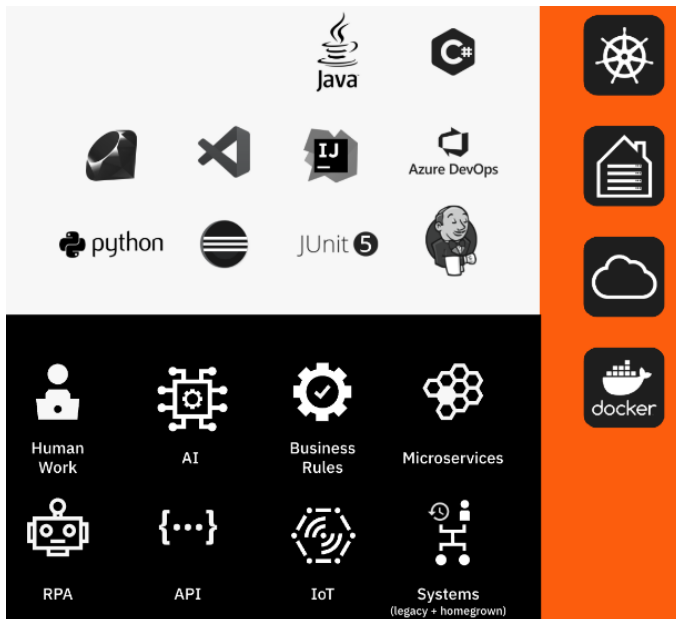


Figure 48. Camunda Connectors [8]

Camunda Platform 8 SaaS provides the possibility to transform and transmit tasks into a Connector task either inbound or outbound. The list of connectors inbound or outbound is enormous. Examples of outbound and out-of-the-box connectors are presented below. Each of the connectors has a different use: [36]

- Amazon SNS Connector - Send messages to Amazon Simple Notification Service from your BPMN process.
- Amazon SQS Connector - Send messages to Amazon Simple Queue Service from your BPMN process.
- AWS Lambda Connector - Invoke AWS Lambda Functions from your BPMN process.
- Google Drive Connector - Create folders or files from a Google Drive template from your BPMN process.
- Kafka Producer Connector - Produce messages to Kafka from your BPMN process.
- Microsoft Teams Connector - Interactions with Microsoft Teams from your BPMN process.

- RabbitMQ Connector - Send messages to RabbitMQ from your BPMN process.
- REST Connector - Make a request to a REST API and use the response in the next steps of your process.
- SendGrid Connector - Quickly send emails from your BPMN processes.
- Slack Connector - Send messages to channels or users in your Slack workspace from your BPMN process.
- UiPath Connector - Orchestrate the bots in UiPath with Camunda

Examples of inbound and out-of-the-box connectors are listed below: [36]

- Amazon EventBridge Webhook Connector - an Amazon EventBridge events triggers the BPMN model
- Amazon SNS inbound Connector - the notification is sent via HTTPS to BPMN model and it triggers the BPMN
- GitHub Webhook Connector - a process instance is triggered by a GitHub event
- Slack inbound Connector - a BPMN process is triggered via a Slack bot

In Camunda, it is really easy to choose which connector to use and based on the connector type a specific implementation is necessary.

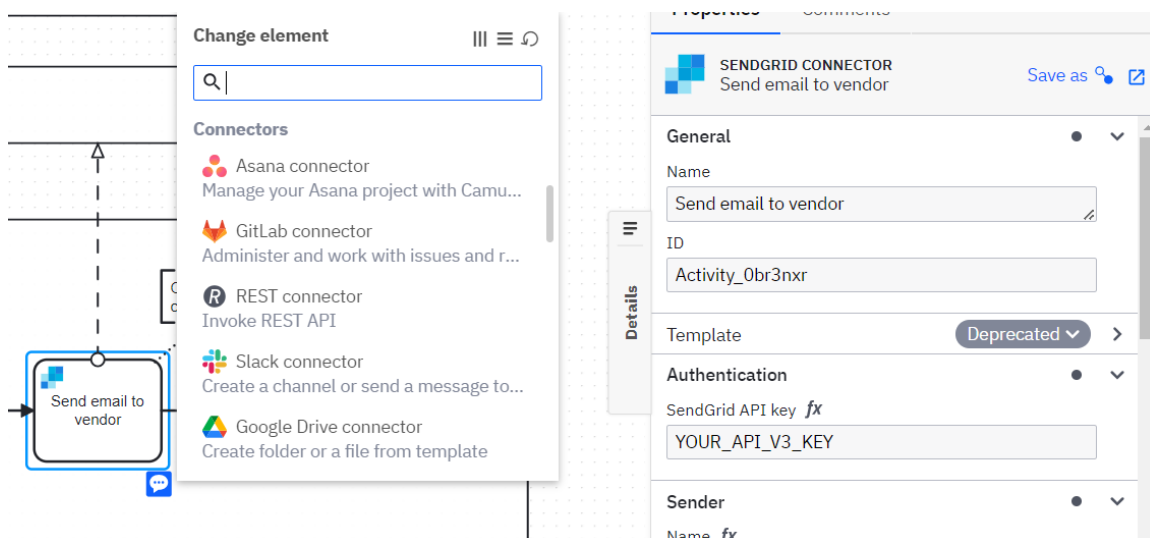


Figure 49. Camunda Connectors example in BPMN model

3.5 Connect Database to a BPMN model using Camunda

Camunda Modeler provides the possibility to connect databases to the BPMN models. This can be achieved with Spring Boot. Spring is a Java Framework which provides the possibility, through third-party libraries and through the Inversion of Control (IoC) and Dependency Injection (DI) features, to build microservices for web or streaming data flows. [37] With Spring boot the application development becomes really easy with no need to deep-dive into coding.

The main steps to follow to connect Database to Camunda are: [23]

- Create a new Maven Project in Eclipse
- Add the Camunda & Spring Boot dependencies (example in figure50)
- Add a main class as an entry point for launching the Spring Boot application



Figure 50. Example of adding the dependencies in Maven project using database MySQL Workbench 8.0 CE

Of course, the prerequisite is to create an executable BPMN project and choose a “Service Task” to link the BPMN to the maven project.

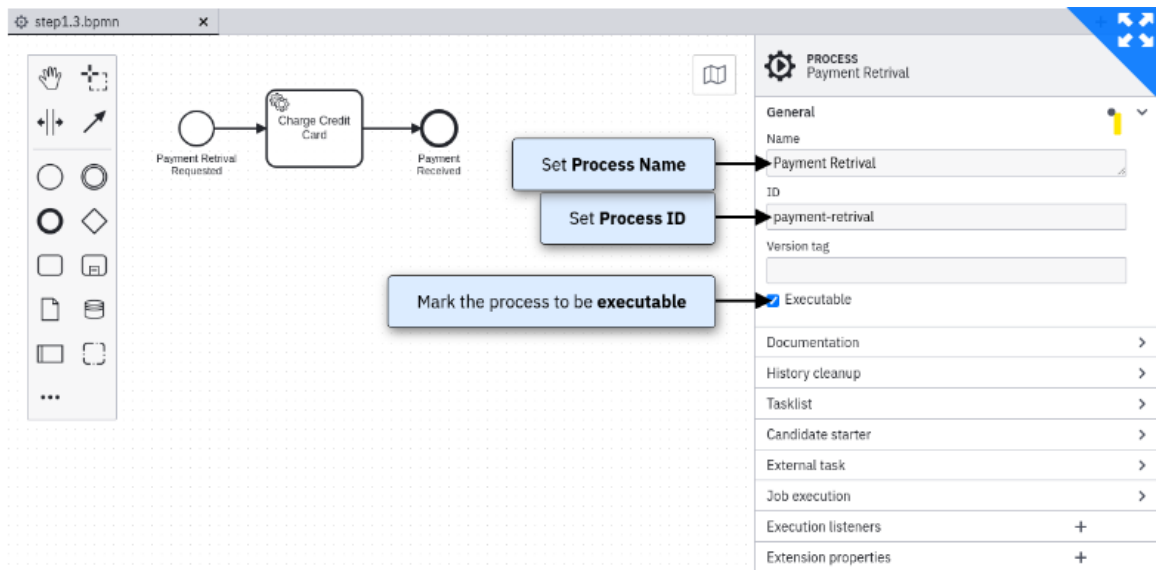


Figure 51. Camunda BPMN example with "Service" executable task

The supported database Products for Camunda are: [18]

- MySQL 5.7 / 8.0
- MariaDB 10.3 / 10.6
- Oracle 12c / 19c
- IBM DB2 11.1 / 11.5 (excluding IBM z/OS for all versions)
- PostgreSQL 10 / 11 / 12 / 13
- Amazon Aurora PostgreSQL compatible with PostgreSQL 11 / 12
- Microsoft SQL Server 2014/2016/2017/2019
- Microsoft Azure SQL with Camunda-supported SQL Server compatibility levels:
 - SQL Server on Azure Virtual Machines
 - Azure SQL Managed Instance
 - Azure SQL Database
- H2 2.0 / 2.1
- CockroachDB v20.1.3

One of the most common databases that Camunda users choose for their processes, is MySQL Workbench. MySQL Workbench 8.0 CE includes the below functionalities:

[17]

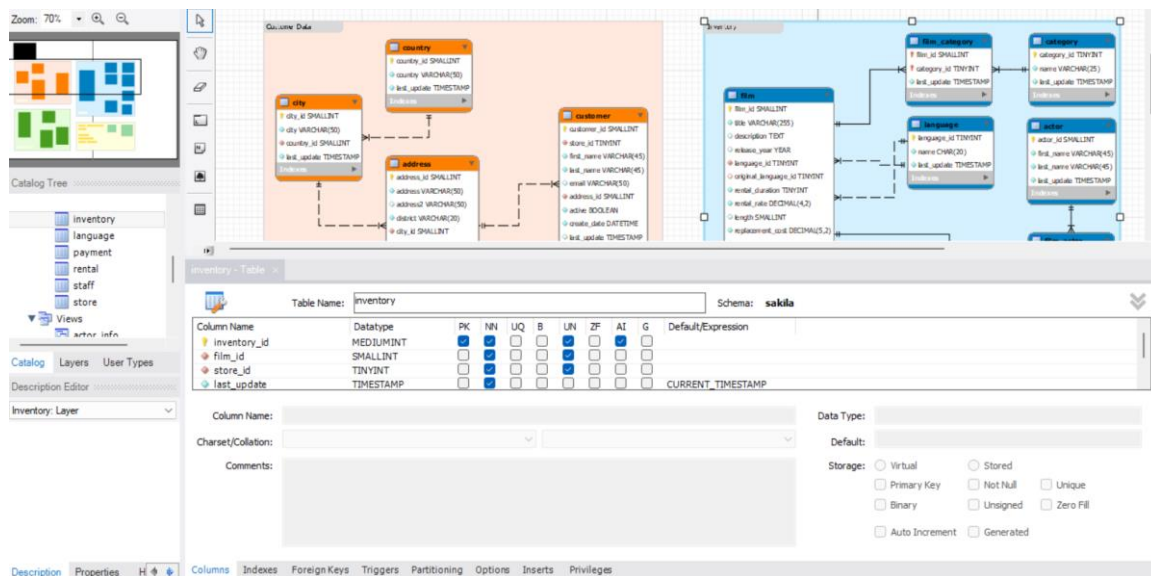


Figure 53. Database example using MySQL Workbench 8.0 CE - Catalog tree and tables

3.6 Implement RPA using UiPath

Nowadays, businesses are trying more and more to improve their businesses processes by finding ways to measure them, evaluate them, optimize them and automate them. For this reason, a new era has made an appearance, the era of Business Process Automation. According to Anant Joshi and Maximilian Stubhan [31], there are two types of BPA: lightweight and heavyweight. The distinction between these two types is that the lightweight is composed of the layers of presentation which means that the software is running on the front-end. On the other hand, heavyweight type is composed of the layers of functional and data which means that the development of software takes place on the application and on the data layer. This means that the deployment can handle a large amount of data but it is also more time-consuming than the first type which is much more simple and more user-friendly. These differences basically are forming the three-tier architecture model. [31] Furthermore, it should be mentioned that the development of a BPA application is not predominately operated by code, but by process models and it should be also often maintained in order to go along with the agile technology. [31]

As it has already been mentioned, once AI has been embodied to BPA, gave the possibility to BPA to offer a variety of techniques and methods to support businesses with their automation flows. This chapter focuses on one of AI techniques which is Robotic Process Automation (RPA). RPA is a tool that allows businesses to replace manual low-value single tasks, such as manual input, keystroke, paperwork, daily time-consuming tasks. Using RPA businesses can automate a high variety of manual and recurring tasks and can save time and decrease costs. The benefits that come with a process automation are plenty. Furthermore, the applied examples that RPA has been integrated into a business process are many. The areas that are using RPA techniques the most, are finance and accounting. [38] The functional manual processes that can be replaced by a bot are a lot from separates activities i.e., an email to be sent or an approval workflow or an invoice creation or a payment creation or a funds control, to entire accounting routine. The most efficient parts to be automated are those that won't change significantly overtime and those that don't require a lot of time. [38] For these activities we can notice that the automation can offer fast an increase on Return on Investment (ROI). [38] In parallel, there are a lot of data security issues, especially when there are financial statements or accounting data involving. In order to use bots to control sensitive information, businesses must implement high security rules to ensure that there will be no data corruption or hacking. Some recommended bot controls can be: [38]

- Apply a horizontal security policy that will apply also to bots
- Restrict the access to bots by removing the developing privileges
- Manage and often modify bot's credentials
- Determine authorizations to use the bots
- To avoid conflicts in separation of duties, bots can access to files during development stages

A real example was mentioned in the Camunda's issue Beyond RPA: How to Build Toward End-to-End Process Automation [7]. The case study was Deutsche Telekom Service which implemented a new strategy for Automation Reinvented in 2018. The aim was to separate the processes from the technical layer and moving to backend

automation. The new approach was to use a new centralized policy in order to decide if future solutions will be managed by bots or by IT. In order to achieve that they built a new platform named OREO leveraging Camunda as the workflow engine which handles all business processes in BPMN and DMN, and orchestrates RPA and user tasks across end-to-end processes. Since Camunda modeler uses a common modeling language for business specialists and developers in the form of BPMN, this language has been recognized globally as a modeling language and can minimize complexity and effort from coding point of view. Since Deutsche Telekom automated separately each step, this helped developers to decide whether tasks will be managed by RPA bot or by users manually. By accomplished the separation of the RPA and technical layer, Deutsche Telekom has the possibility to remove bots entirely and build APIs, moving from frontend to backend automation. [7]

Statistically, the Revenue Growth of companies that offer RPA applications, was radically increased according to the below diagram.

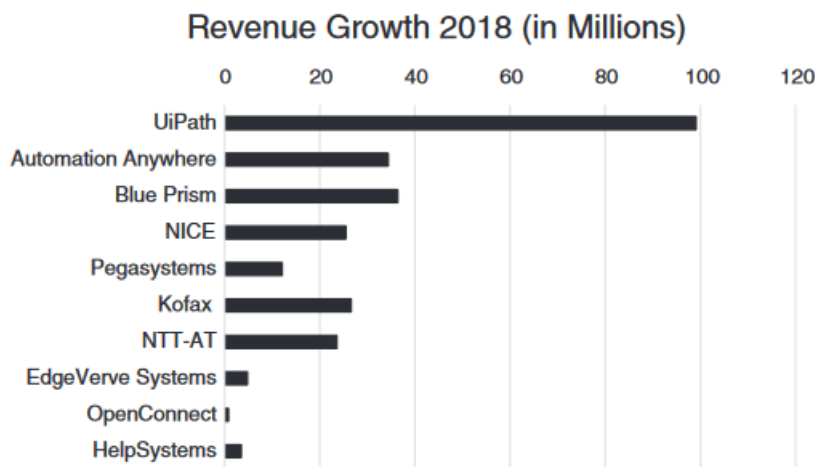


Figure 54. RPA Companies Revenue Growth 2018 [38]

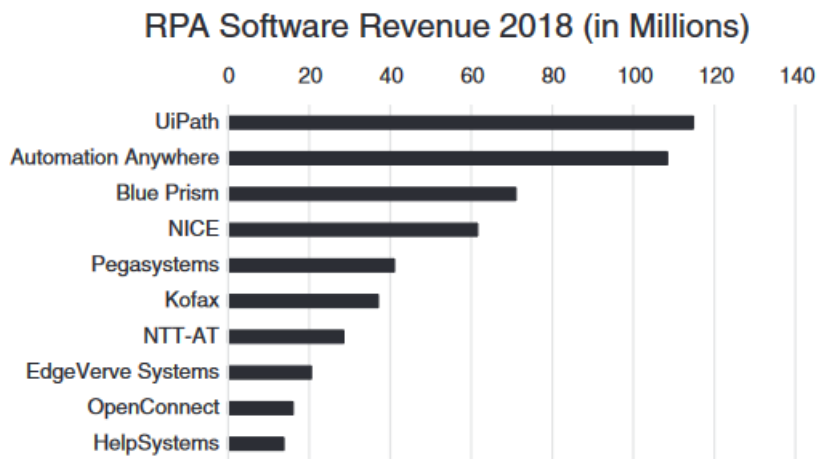


Figure 55. RPA Software Revenue 2018 [38]

The lead company seems to be UiPath with around 100% growth. This is an outcome of the ascending usage of RPA tools in the last few years since companies from different functions, use bots for a lot of processes, such as finance sector, accounting sector, healthcare sector, travel agencies, human capital sector etc. [38]

UiPath is the lead vendor when it comes to business digital transformation and has provided a variety of RPA possibilities i.e., bots can log into systems, transfer files, migrate and extract data, complete forms, offer customer support etc. The UiPath framework can execute scripts with RPA functionality. [30] The UiPath platform is divided into three areas: [30]

1. UiPath Studio
2. Robot
3. Orchestrator

In UiPath Studio businesses can easily develop their automated workflow, create their robots, maintain the connection between robots, transfer packages and then manage them in Orchestrator in order to coordinate them in real-time, and optimize them. The optimization can be supported by RPA process analytics which can be offered by log records combined with Microsoft Information Services Server and SQL Server, Elasticsearch, and a Kibana plugin for illustration. [30]

The logic of UiPath is to help businesses to focus on the most important processes to automate based on impact and ROI and to offer applications with low-code, visual

tools. In the next figure there is the comparison of AI techniques offered between UiPath and the rest of vendors.

Tool	Goal associated to IA				Artificial intelligence techniques or algorithms used								
	Recognition	Optimization	Classification	Information extract	Computer vision (*)	Fuzzy matching	Statistic methods	Artificial neural networks	Decision trees	Fuzzy logic	Natural language processing	Text mining	Recommendation system
UiPath	X	X	X	X	X	X	X	X					
Kofax	X	X	X	X				X				X	
Automation anywhere	X	X	X	X				X			X	X	
WinAutomation	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
AssistEdge	X	X	X	X			X	X					X
Automagica	X	X	X	X								X	X

Figure 56. Artificial Intelligence techniques offered per RPA vendors [30]

In order to understand the setup logic of UiPath, the next figures are referring to UiPath Studio elements and structure. In project panel the user has the possibility to use pre-defined dependencies based on the automated process and the projects that the user has created. For example, automated email, automated excel file etc. In the designer panel, the user actually illustrates the process that needs to be automated. Any automation process includes different activities which follow a sequence. The activities perform specific actions and there is the activity panel where all the actions are stored, such as assign, continue, delete row, add row etc. In the designer panel all the activities can be added one by one in the canvas. Once the workflow is completed, then it should be tested and then published.

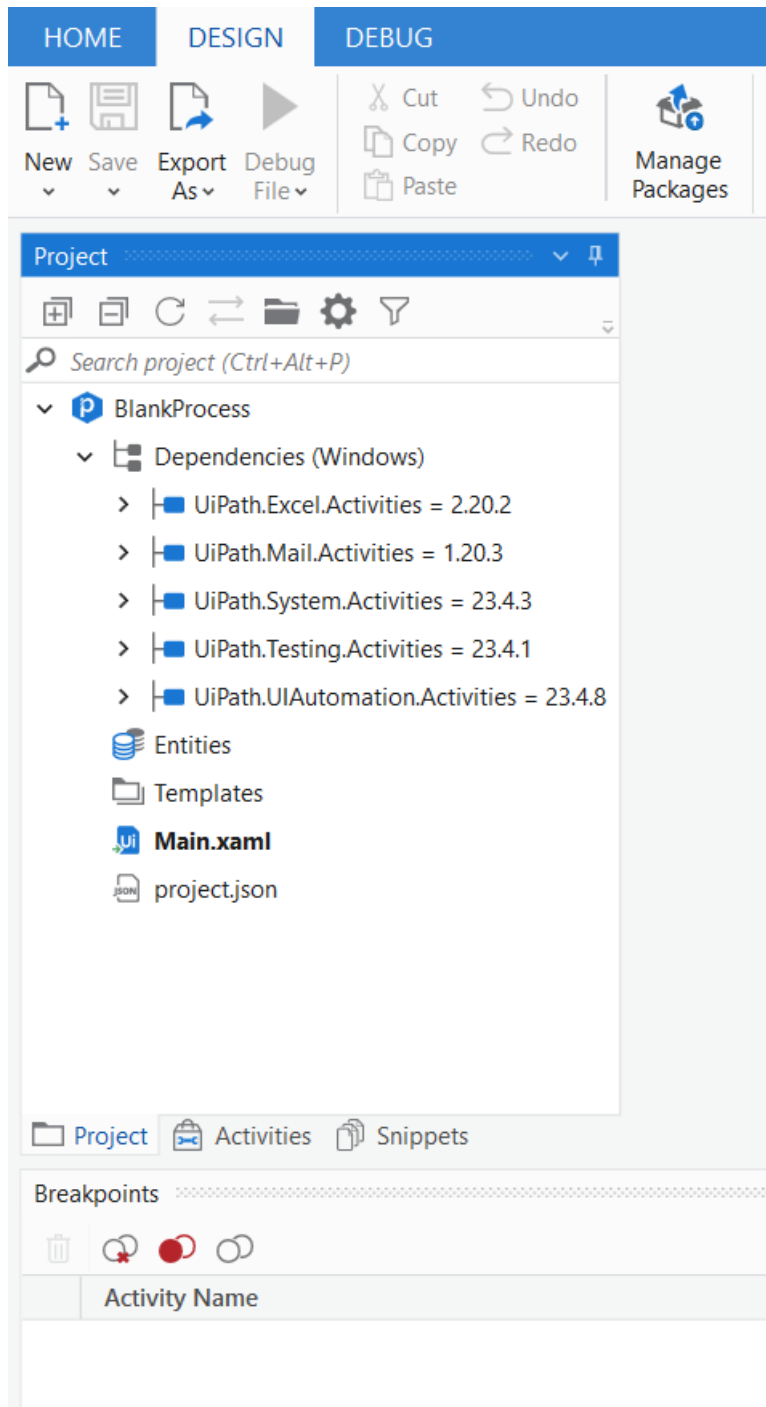
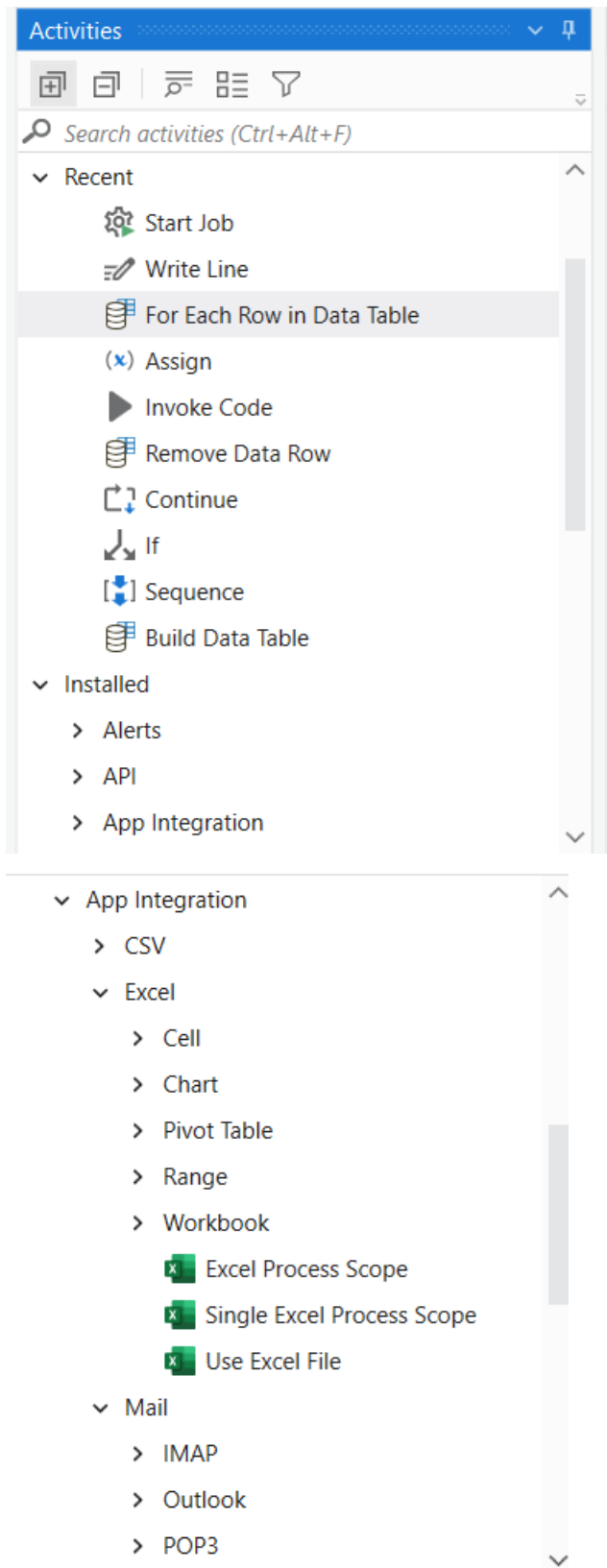
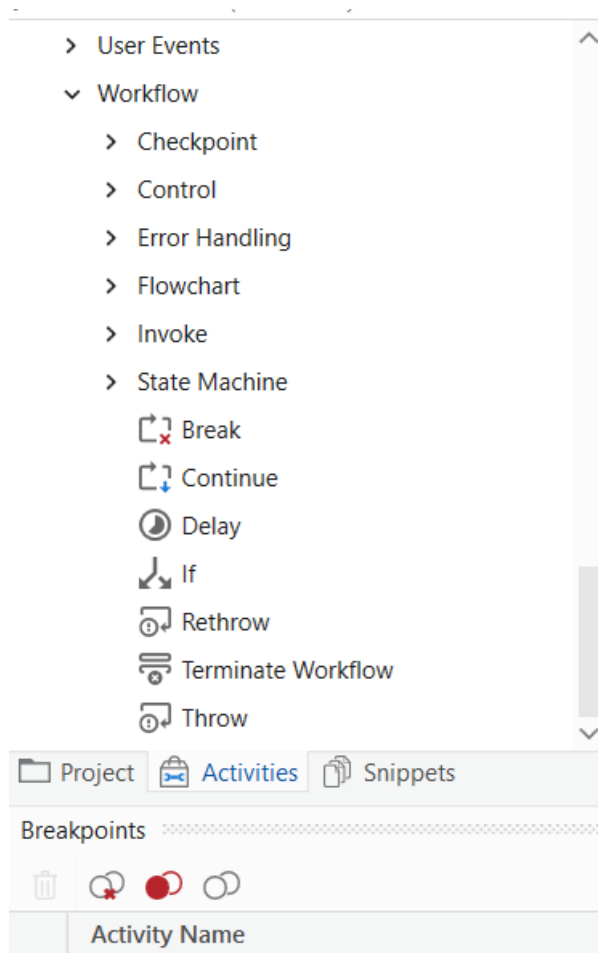


Figure 57. Project panel UiPath



- > Outlook
- > POP3
- > SMTP
 - ✉ Create HTML Content
 - 📎 Save Attachments
 - ✉ Save Mail Message
- > Assets
- > Collection
- > Computer Vision
- > Data
- > Integrations
- > Jobs
- > Logging
- > Orchestrator
- > Programming

- > Programming
 - > Queues
 - > System
 - > Testing
 - > UI Automation
 - > UiPath
 - > User Events
 - ▼ Workflow
 - > Checkpoint
 - > Control
 - > Error Handling
 - > Flowchart
 - > Invoke
 - > State Machine
 - 🛑 Break



Output Error List

Figure 58. Activities panel UiPath

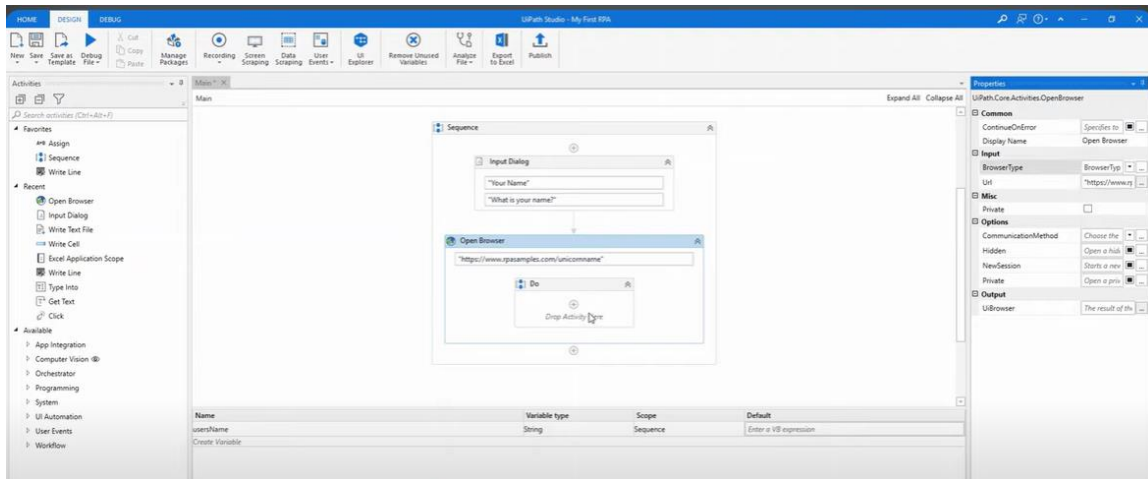


Figure 59. UiPath Studio overview

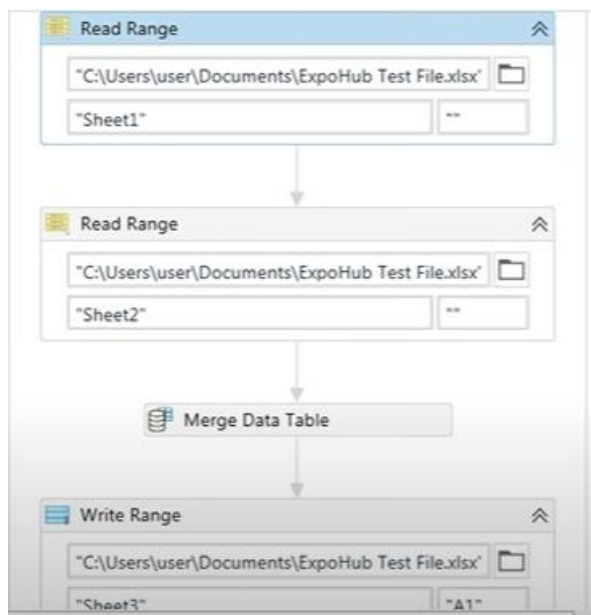


Figure 60. Designer panel UiPath - Canvas

In order to publish the automation process from UiPath Studio to UiPath Orchestrator, the user must add the machine to UiPath Orchestrator with the process machine key, create robot in UiPath Orchestrator and then publish the UiPath automation process, monitor the process on UiPath Orchestrator and optimize the process.

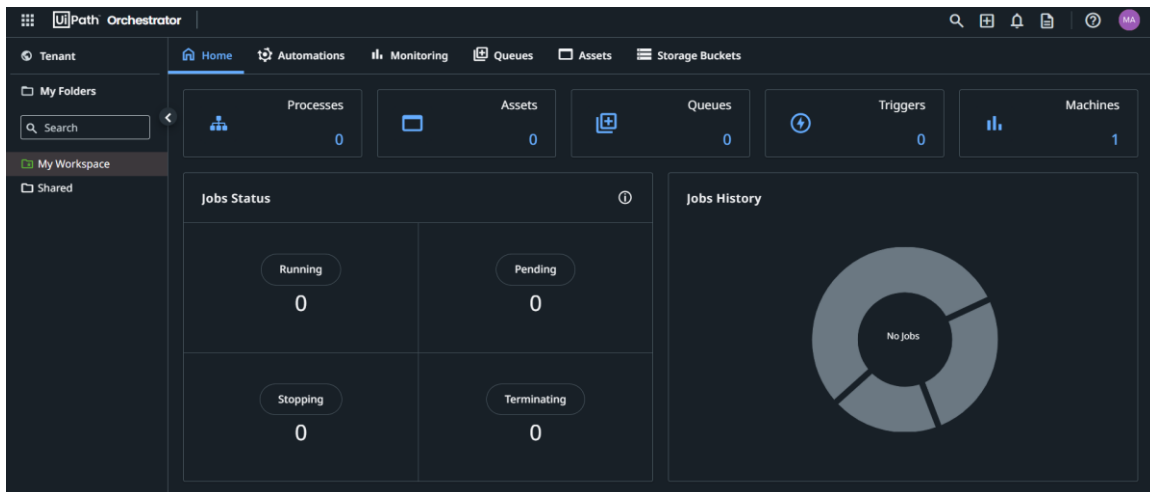


Figure 61. UiPath Orchestrator overview

3.7 Description of Account Payables Module

Since Accounting and Finance are the fields that the implementation of RPA techniques is the highest, the purpose of this paragraph is to describe the high-level process of Accounts Payable module and specifically the invoice creation process. In order to achieve that it is necessary to provide an overview of the standard business flows associated with payable's daily activities i.e., supplier management, entering payables invoices, handling PO matching and non-PO matching and managing supplier payments. This business flow covers the Manage Accounts Payable process that will be required to be executed by Payables Department in order to manage suppliers, receiving payments and payment of supplier invoices.

In general, the overall "Supplier Invoice to Payment" business process flow is represented below:



Figure 62. Supplier Invoice to payment

In more details the overall “Supplier Invoice to Payment” business process includes:

- **Manage Supplier Invoices:**
 - Submit and process supplier invoices for payable transactions manually or electronically or using Supplier portal
 - Submits Invoices. Payables Specialist receives supplier invoice information from Supplier via email/mail etc. either for raising a new invoice or adjusting an existing invoice.
 - Receive and Processing Invoices. Payables specialist will process the invoices manually, through automatic import from supplier portal or other external sources.
 - Once invoice is entered and processed, specialist will validate the invoice manually or better automatically when the Invoice Validation process is completed.
- **Record Accounting for Invoices.** Payables Specialist will account (post to general ledger) all validated invoices and transfer the accounting to General ledger for reporting manually or automatically when the create accounting process will run.
- **Manage Audits, Disputes, and Approvals.**

- Audit Invoice. Payables Auditor will review the payables transactions by running various reports like Payables Audit by voucher number reports etc. A hold can be placed on invoices if the payment has to be stalled or kept on hold.
- Manage Accounts Payable Disputes. Resolve the disputes and holds via a role-based dashboard and take appropriate action to process invoices.
- Approve Invoice. Based on the approval routing rules, payables transaction's approval notification will be sent to the approvers for their action. The approvers will give the approval on the payable's transaction for both document level and line level approval. Once transaction is approved by all the approvers, invoice status will get updated to approve.
- Approvers are defined in the approval routing rules according to different source such as Requestor of the PR, Buyer of the PO, Item type (Direct / Indirect / Asset), cost center responsible, line amount etc.
- Manage Prepayments and Discounts. Payable's team needs to manage the prepayment by applying them to new or outstanding supplier invoices and it should also optimize the discount benefits by leveraging the payment terms.
- Settle Liabilities. Payables team should monitor and process supplier and statutory liabilities via secure interactions (process electronic payments, automated pay run, or off-cycle payments):
 - Prepare and Record Payments. Payables supervisor will make a payment for the supplier invoices by using various payment modes i.e., manual payment, payment process request, pay in full, quick payment and supplier refunds.
 - Process Payment Files. Payables Supervisor will process the payment till payment file will get transmitted in the payment system.
 - Record Accounting for Payments. Payables Supervisor will create accountings for all the payments done during the period.

- Review Daily Activity. Review and analyze the day's financial activity and monthly progress.
 - Analyze Accounts Payable Balances. Payables Specialist / Supervisor will analyze payables balances in respect of outstanding instalments towards suppliers and tax authorities with help of various reports like Invoice Aging Report, Discount Taken and Lost Report etc.
 - Manage Accounts Payable Balances. Payables Specialist / Supervisor will manage payments to take advantage of discount wherever applicable according to accounts payable balance analysis.
- Schedule Payables Closure. Payable's Specialists should review payables register, trial balance and reconciliation reports.
 - Close Payables Period. Payables Manager executes period end activities.

Payable's Specialist receives supplier invoice information from Supplier via email/mail etc. either for raising a new invoice or adjusting an existing invoice through a Credit/Debit Memo. Supplier may send Invoices, Credit/Debit memo or Prepayment Invoices using any of the following modes:

- Submitting invoice to Payables department for manual entry
- Self Service. Submit invoices using Supplier portal as PO matched invoice or unmatched invoices
- Electronic Invoice by sending invoice file

The basic structure of the "Supplier Invoice" is presented below:

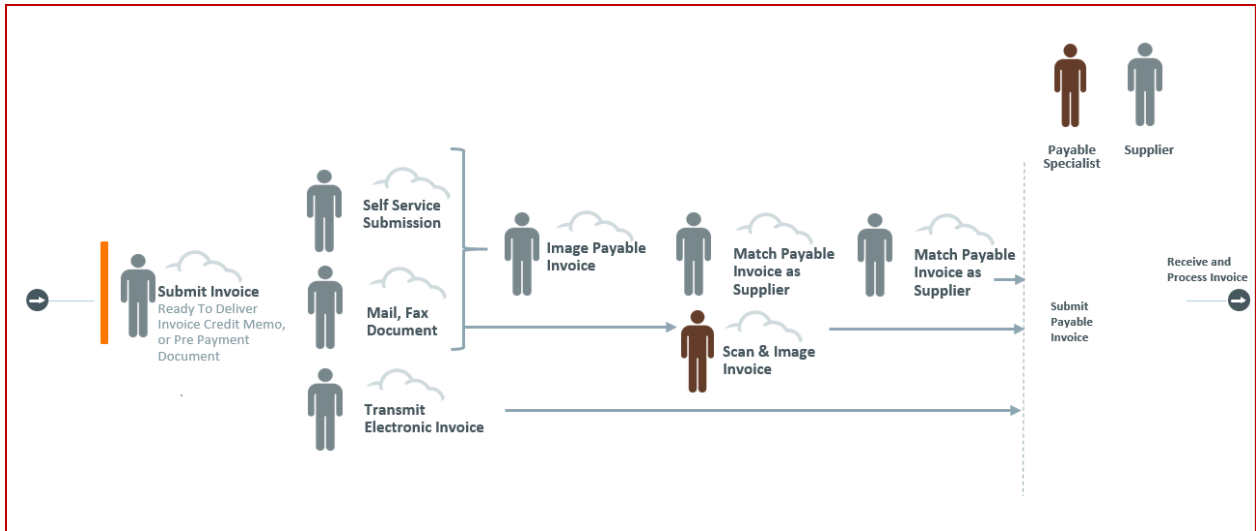


Figure 63. Invoice activity structure

3.7.1 Description of Account Payable's Business Process: Invoice Creation

Account Payables modules as a process is complex. For simplicity purposes, the business process modeling can be described with the below high-level approach:

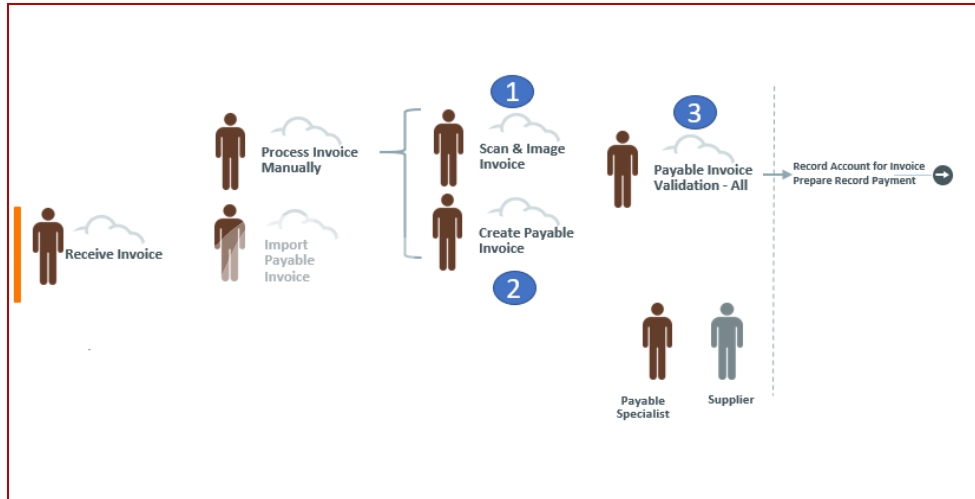


Figure 64. Receive an invoice structure

Payables specialist enters the invoice information and process the invoice to make it ready for payment. The activities involve:

- Create Invoice. Payables specialist enters the invoice information into invoice form in one of the below mentioned methods based on the PO match:

- Manual invoices: By entering invoices manually in system using a form.
 - Import Invoices: By entering invoices using spreadsheets to speed up the manual entry to enter bulk invoices or recurring invoices to book those transactions in the system.
- Invoice Processing. While entering the invoices in the system, Account Payable's specialist will process the invoices based on invoice type.
 - Invoice validation. Once invoice is entered and processed, Account Payable's specialist will validate the invoice.
 - Invoice approval. After the validation the invoice approval must be completed.
 - Invoice Payment. Once the invoice is approved the payment is in place

3.7.2 PO matching

Payable's Specialist needs to enter all mandatory invoice header level information before proceeding to the invoice line level information. The mandatory information to load invoice header level is:

- Business Unit or Legal Entity
- Invoice Number
- Invoice Date
- Invoice Total Amount
- Invoice Type
- Supplier Name or Number
- PO number

Once the header information is populated for invoice, Account Payable Specialist needs to provide the line level information:

- PO quantity
- PO unit price
- PO line
- Line net amount

- Tax code

The invoice total amount and the line level information should be entered based on the Invoice type. If the invoice type is “Standard” then the line amount is positive. Otherwise, if the invoice type is “Credit” then the line amount must be negative. The activities to be done by AP specialist can be described in the table below:

Activity	Owner	System	Description
Review the Invoice	Payables Specialist	AP Department	In this case the source of the AP Documents is Paper sent by email or PDF invoices sent by email or invoice has been uploaded to Supplier Portal
Check the supplier’s name or number	Payables Specialist	Database	Payables specialist check in Database if the supplier’s name or number exists
Check the PO number	Payables Specialist	Database	Payables specialists check if the PO is present. If not, the process cannot continue until the PO is entered
Insert the header level information	Payables Specialist	ERP/ Spreadsheet	Payable specialists complete the header invoice details
Insert the line level information	Payables Specialist	ERP/ Spreadsheet	Payable specialists complete the line invoice details
Calculate the taxes	Payables Specialist	ERP/ Spreadsheet	The taxes are calculated based on the tax code. Each tax code has a specific rate%
Validate the invoice	Payables Specialist	ERP	Once invoice is entered and processed, AP Specialist can validate the invoice manually
Approve the invoice	Payables Specialist	ERP	After the validation, the approver should approve the invoice
Post to GL the invoice	Payables Specialist	ERP	Ince the invoice is approved the AP Specialist should account the invoice

			manually
Pay the invoice	Payables Specialist	ERP and/or Bank	The final step to close the invoice is the payment. Once the payment is completed a notification is sent to the supplier.

Table 1. Activities for the Supplier’s Invoice to Payment process with a PO

3.7.3 No PO matching

Payables Specialist needs to enter all the information besides PO number. The mandatory information on header level to create an invoice is:

- Business Unit or Legal Entity
- Invoice Number
- Invoice Date
- Invoice Total Amount
- Invoice Type
- Supplier Name or Number

Once the header information is populated for invoice, Account Payable Specialist needs to provide the line level information:

- Line net amount
- Distribution Combination which is consist of Business Unit, Account, Cost Center
- Tax code

The activities to be done by AP specialist can be described in the table below:

Activity	Owner	System	Description
Review the Invoice	Payables Specialist	AP Department	In this case the source of the AP Documents is Paper sent by email or PDF invoices sent by email or invoice has been uploaded to Supplier Portal

Check the supplier's name or number	Payables Specialist	Database	Payables specialist check in Database if the supplier's name or number exists
Insert the header level information	Payables Specialist	ERP/ Spreadsheet	Payable specialists complete the header invoice details
Insert the line level information	Payables Specialist	ERP/ Spreadsheet	Payable specialists complete the line invoice details
Calculate the taxes	Payables Specialist	ERP/ Spreadsheet	The taxes are calculated based on the tax code. Each tax code has a specific rate%
Validate the invoice	Payables Specialist	ERP	Once invoice is entered and processed, AP Specialist can validate the invoice manually
Approve the invoice	Payables Specialist	ERP	After the validation, the approver should approve the invoice
Post to GL the invoice	Payables Specialist	ERP	Ince the invoice is approved the AP Specialist should account the invoice manually
Pay the invoice	Payables Specialist	ERP and/or Bank	The final step to close the invoice is the payment. Once the payment is completed a notification is sent to the supplier.

Table 2. Activities for the Supplier's Invoice to Payment process without a PO

3.7.4 What to automate in Account Payables?

Since not only the Account Payable's activities have already been described, but also the Business Process Modeling and the Robotic Process Automation, this brings the opportunity to present a sample with the AP activities that can be modelized and automated with the mentioned tools i.e., Camunda BPMN, Camunda DMN, Camunda Forms, UiPath, Database etc.

Below there is the table with Account Payable’s activities and the possible and suggested ways to be automated. Of course, some activities, such as invoice approval, invoice payment, is better not to be replaced by a bot (RPA tool).

Activity	Automation	Systems
Review the Invoice	The manual task by AP Specialist can be replaced by a bot	Camunda + UiPath
Check the supplier’s name or number	The Database can be linked to the BPMN and check automatically	The Database can be linked to the BPMN and check automatically. In case there is no data then the process is terminated.
Check the PO number	The Database can be linked to the BPMN and check automatically	The Database can be linked to the BPMN and check automatically. In case there is no data then the process is terminated.
Insert the header level information	Camunda forms or a bot	Camunda or UiPath
Insert the line level information	Camunda forms or a bot	Camunda or UiPath
Calculate the taxes	Camunda DMN	Camunda
Validate the invoice	The manual task by AP Specialist can be replaced by a bot	On Camunda + UiPath
Approve the invoice	This is important task to be replaced by a bot. Camunda BPMN is more suitable to send the notification to	Camunda

	the approver	
Post to GL the invoice	Connection between Camunda BPMN and ERP is required	Camunda + ERP
Pay the invoice	The actual payment will be completed in an external system and Camunda Connectors can be used to send the notification to supplier	External system + Camunda

Table 3. Ways for AP Activities to be automated

The benefits from automating the invoice creation in the Account Payables module can be listed as below:

1. Saves time
2. Saves money
3. Ensures reliability without interruption
4. Ensures consistency since the manual errors or users' neglects are decreased
5. Improves productivity and efficiency since the users are not occupied with low importance manual tasks
6. Leads to growth in profits since the users are occupied with more important tasks
7. Improves the working environment since the users don't deal with tedious work and routine tasks

3.8 Summary

In conclusion, firstly this chapter presented the activity of modeling a business process by using graphical notation. In particular, for graphical notation BPMN was used. BPMN provides fundamental and advanced elements to help businesses to illustrate and model their processes. BPMN has been established as a de facto modeling notation since provides a huge range of elements. Besides the standard modeling, a business process requires also decision model. For this reason, the DMN graphical notation was described. DMN model can provide an assistance and make less complex a BPMN diagram. DMN standard provides a two-level model for decisions: the decision requirements and the decision logic level. The Decision Requirements Diagram (DRD) models in a graphical and hierarchical way the decisions. Despite the fact that DRD is sufficient for the purposes of business analysis in a high-level, more details are given by the decision logic level. In this way, the decision logic is encapsulated into decision tables, where its expressions are defined with the Friendly Enough Expression Language (FEEL). DMN replaced (X)OR in order to simplify the BPMN model.

The set of activities, tasks, events, decisions are illustrated with the use of Camunda Modeler. An introduction to Camunda Modeler, Camunda Platform 8 and all Camunda's tools and Camunda Platform's components were described in order to understand deeply how all these tools can be combined so that an entire complex business process can be presented as a model. The combination of Camunda's tool can be achieved by microservices which are basically small independent building blocks that can communicate to each other. Later, the Camunda Forms was described. Camunda provides the possibility to create forms and connect them to the BPMN by using a user task or start event. The Camunda Form creation can be accomplished directly to Camunda Modeler or to Camunda Platform 8 by initiating a Form Project. Additionally, the Camunda Connectors were presented to explain the fact that Camunda Platform 8 is a process orchestrator for every endpoint, means that the connectivity is universal. Then, the possibility to connect Camunda Modeler BPMN models with databases by using Spring Boot was mentioned.

Besides the above, it was also described one of AI techniques which is Robotic Process Automation (RPA) which is a tool that allows businesses to replace manual

low-value single tasks. Using RPA businesses can automate a high variety of manual and recurring tasks and can save time and decrease costs. The benefits that come with a process automation are plenty. Last but not least, this chapter referred to the way of how to include Robotic Process Automation using UiPath. UiPath is the lead vendor when it comes to business digital transformation and has provided a variety of RPA possibilities.

Lastly, it is necessary to mention that the last section was focused on the overview of a specific department, Account Payables. The case study was the invoice creation which is a business process that is performed by Account Payables department and this case study was analyzed in order to understand how to apply BPMN and RPA.

CHAPTER 4: Modeling Case Study: “Invoice Creation” using Camunda

The invoice creation is one of the most common activities when it comes to Account Payables module (AP). The process that will be modeling using Camunda is an end-to-end invoice creation in Account Payables Department. This process is a real process with the only difference that for the purposes of this thesis, some parameters are not going to be taken into consideration. For example, the communication between Account Payables module and other modules i.e., Procurement, Taxes, Subledger Accounting. To recap, the process that is presented in this chapter, is a simplified version of the real invoice creation process.

The Key considerations about this flow are the followings:

- There are two types of invoices: with PO and without PO
- No payables transactions can be loaded without a Supplier or a PO or an expense account
- If the manager doesn't approve the invoice the process cannot continue
- In case invoice type is missing the process cannot continue
- In case tax code is missing the process cannot continue
- The invoices must be paid in order to close them

4.1 “Invoice creation” process with BPMN using Camunda

The process starts with a message start event which basically triggers the whole process. A process can have one or more message events. In this case the process is triggered when the Account Payables department and specifically the AP Specialist, receives a new invoice notification. The message flow derived from the supplier is a message about a new invoice notification in case the vendor, as a participant, sends a new invoice. The vendor is presented with a white pool which indicates that the activities from supplier's point of view are not to be concerned and this pool has more a participant role. When a process is deployed, it creates a message subscription for each message start event. When the message subscription is

created, a message can be correlated to the start event if the message name matches. On correlating the message, a new process instance is created and the corresponding message start event is activated. [16]

In order to ensure that the invoice has indeed arrived, after the new invoice notification, the flow continues with an event-based gateway. Basically, this gateway leads to a conditional intermediate catch event and to a timer intermediate catch event. Whichever of these 2 events happens first, the other will be suspended. The condition is if the invoice notification has been indeed arrived and if it does within an hour, then this way the users can ensure that it is an invoice related notification.



Figure 65. BPMN process “Invoice creation”: Invoice notification

Once the AP specialist submits the Boolean answer “true” about the conditional event, then the next step is to review the invoice sent by the vendor. This is a user task and in this user task an activity from the “accounting” group is required. This type of task is automatically assigned by a workflow engine to a user’s task list to the specific group or user. Once the user performs the overview of the invoice, the user has to decide if it an invoice with purchase order (PO) or not. This way the user can identify whether the invoice has a PO match or not.



Figure 66. BPMN process “Invoice creation”: Invoice review

In case the invoice has no PO match, so in that scenario it is an expense invoice, then the flow follows the path which is the loading of an invoice through spreadsheet. Otherwise, if the invoice has a PO match, then the flow goes to a subprocess which is the manual creation of the invoice.

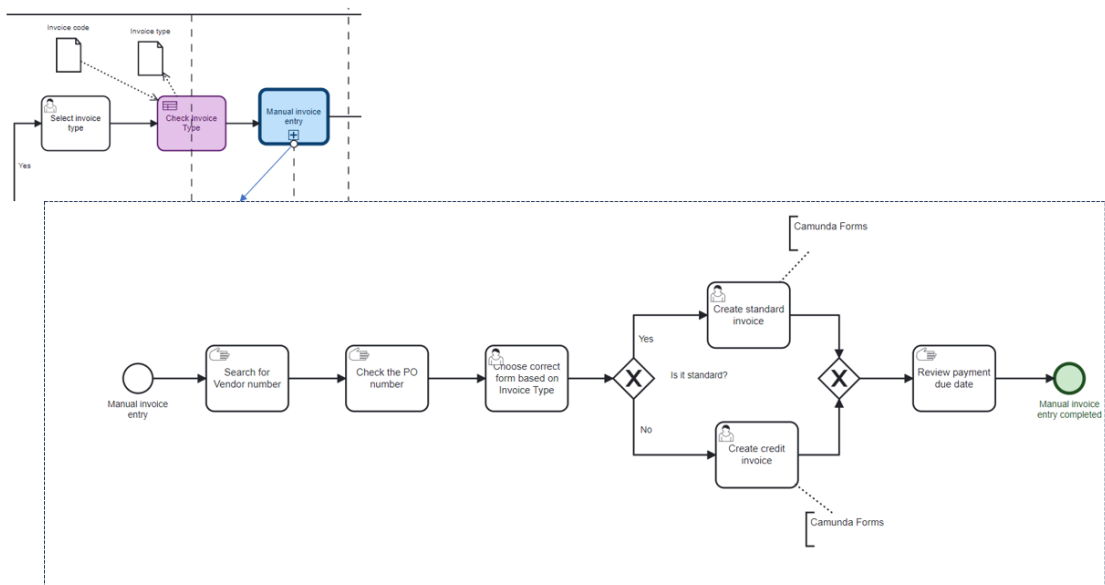


Figure 67. BPMN process “Invoice creation”: Manual invoice entry subprocess

Once the “Manual invoice entry” subprocess starts the AP Specialist should check the Vendor number and the PO number. Then based on the type of the invoice which can be either standard or credit, the AP specialist has to create the invoice manually. This activity is linked to a Camunda form.

```

<bpmn:sequenceFlow id="Flow_1f1s123" sourceRef="Activity_0a8c261" targetRef="standard" />
<bpmn:sequenceFlow id="Flow_0dthvtb" name="Yes" sourceRef="standard" targetRef="Activity_1a71rmy">
  <bpmn:conditionExpression xsi:type="bpmn:tFormalExpression">${standard}</bpmn:conditionExpression>
</bpmn:sequenceFlow>
<bpmn:sequenceFlow id="Flow_0no9hro" name="No" sourceRef="standard" targetRef="Activity_0vf2d88">
  <bpmn:conditionExpression xsi:type="bpmn:tFormalExpression">${!standard}</bpmn:conditionExpression>
</bpmn:sequenceFlow>

```

Figure 68. BPMN process “Invoice creation”: XOR gateway for Standard or Credit invoice type

The process continues with some user and manual tasks which are tasks that are not connected to any IT system. The AP Specialist should check the taxes and then validate the invoice by sign-in to “ERP” Data Store Reference. Several manual tasks are linked to ERP since there are activities that are going to be completed in external source but it’s not going to be linked to Camunda.

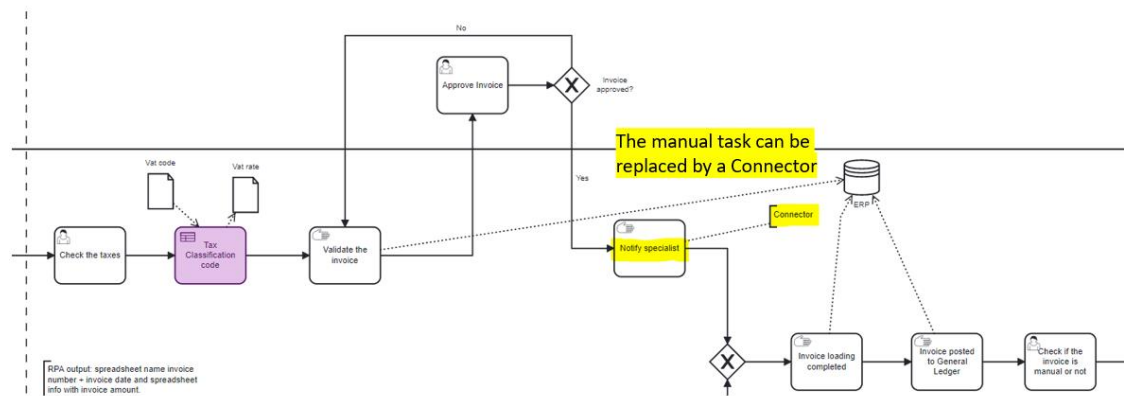


Figure 69. BPMN process "Invoice creation": Manual tasks to be replaced

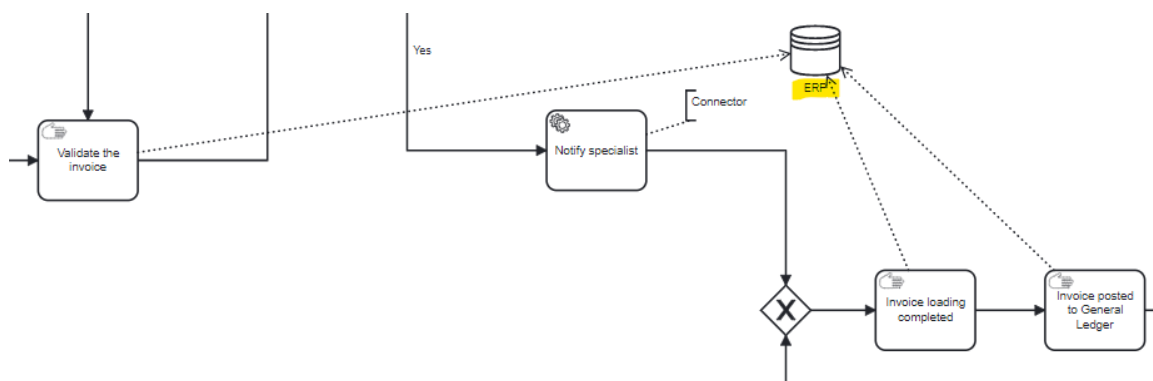


Figure 70. BPMN process “Invoice creation”: Manual tasks linked to ERP

All these tasks are taking place in “AP Specialist” Lane and are in charge of the “accounting” group. Additionally, the next step which is the approval of the invoice,

will take place in “AP Manager” lane. In order to move forward the AP Manager should claim the task from the tasklist and approve the invoice. If the invoice is not approved, the AP specialist should validate again the invoice. This will continue until AP manager approves the invoice.

```

<bpmn:userTask id="UserTask_Approve" name="Approve" camunda:candidateGroups="manager">
  <bpmn:extensionElements>
    <camunda:formData>
      <camunda:formField id="approved" label="approved" type="boolean" />
    </camunda:formData>
  </bpmn:extensionElements>
  <bpmn:incoming>Flow_0efvg7i</bpmn:incoming>
  <bpmn:outgoing>Flow_0i2988c</bpmn:outgoing>
</bpmn:userTask>
<bpmn:exclusiveGateway id="approved" name="Invoice approved?">

```

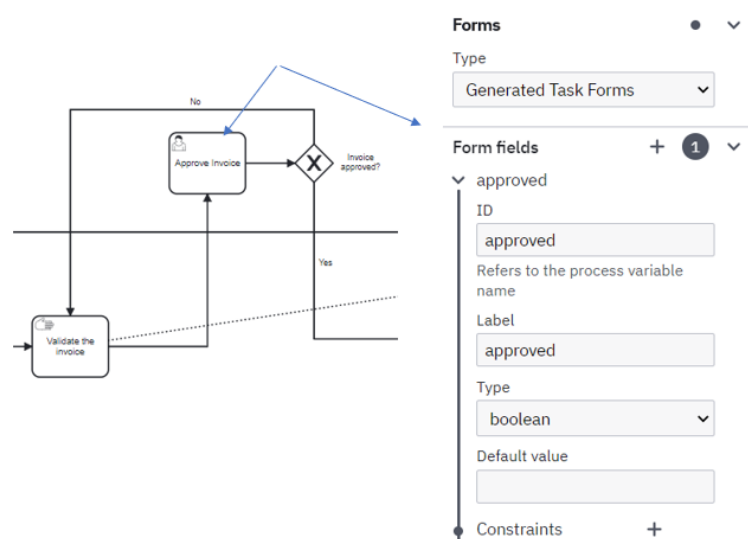


Figure 71. BPMN process “Invoice creation”: Invoice Approval by the Manager

Once the invoice is approved the process continues with the notification to specialist that the invoice is approved. The can be replaced with a Service task. Service tasks can be implemented with different ways i.e. calling java code with java class type that implements a JavaDelegate or ActivityBehavior, or an expression or delegated expression or a connector or even external task outside the process engine’s boundaries.

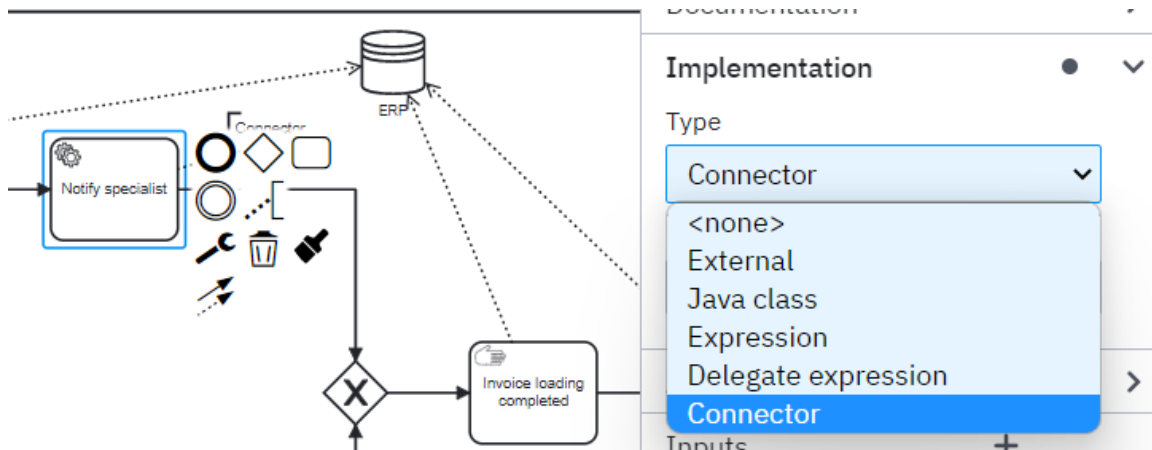


Figure 72. BPMN process "Invoice creation": Service tasks

Regarding the scenario where there is no PO match to the invoice, the sequence flow that is triggered is the one with the value "No" so the condition about the PO match is false. In that case the next process that is initiated is the manual task where the AP Specialist reviews the spreadsheet that the user received from the vendor, with the expense invoice. This predefined spreadsheet contains specific values and the user must review them in order to ensure the credibility of the data.

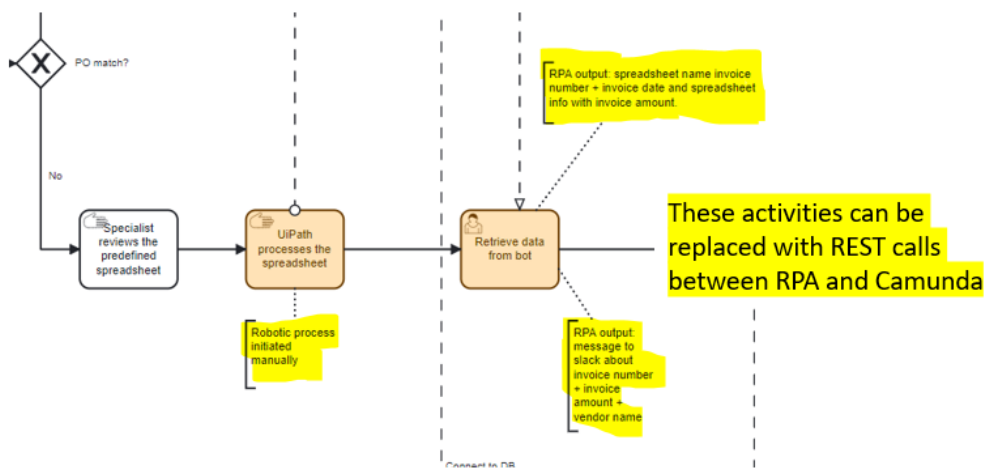


Figure 73. BPMN process "Invoice creation": replace manual tasks with RPA

The rest of the activities can be linked to the RPA instead of initiating and checking these activities manually. Once the user reviews, checks the spreadsheet and ensure

that the spreadsheets are generated by the bot and the messages arrived, then the AP specialist is in charge of the payment. The user tasks indicate the scenario where the user should claim and confirm the task about the bot's activities.

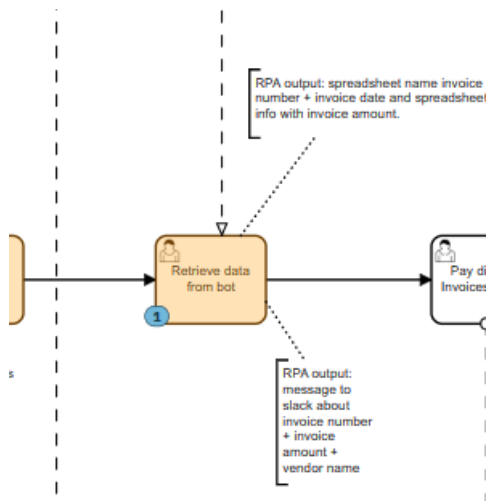


Figure 74. "Invoice creation" process: User claims the activity about bot's outputs

Figure 75. "Invoice creation" process: User claims the activity about bot's outputs in Tasklist

The user pays in bulk the invoices that are included in the spreadsheet. This activity is a user task and it is link to an empty pool which is the Bank. The AP specialist is retrieving massively the invoice amount to be paid with the help of the bot and the payment can be completed quicker. While completing this activity, the user is in charge also to complete the fields of the task form in the tasklist in order to integrate the information that is going to be uploaded to the bank.

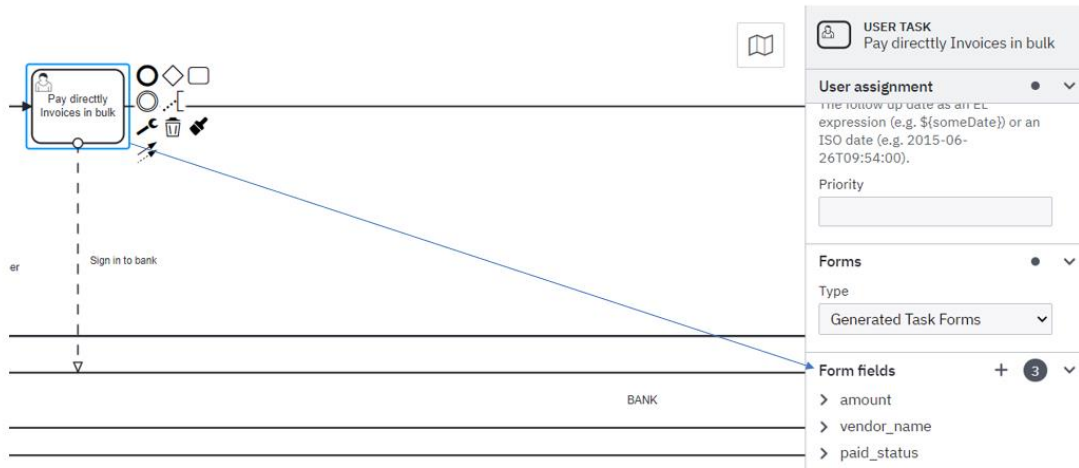


Figure 76. BPMN process “Invoice creation”: Pay invoices from spreadsheet in bulk

amount

1,000

vendor_name

Dasa Korus

paid_status

Save Complete

Figure 77. BPMN process “Invoice creation”: Pay invoices from spreadsheet in bulk in Tasklist

Once the manual activities “Invoice loading completed” and “Invoice posted to General Ledger” are completed in ERP system, then the process is called to decide whether is a manual invoice or an invoice through spreadsheet. In other words if there is a PO match or not. If there is no a PO match, so the invoice is an expense invoice and the invoice creation was completed through the spreadsheet, then the process is completed and there is no need for further tasks.

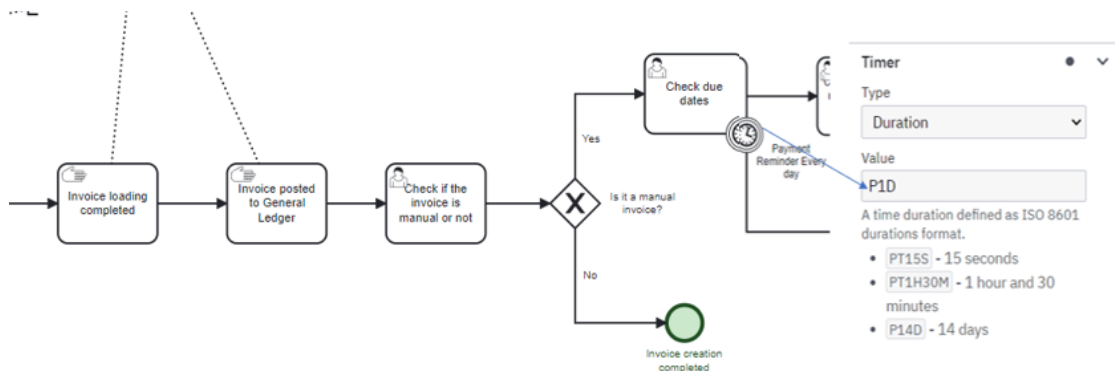


Figure 78. BPMN process “Invoice creation”: Check the due dates timer boundary interrupting event

On the other hand, if there is a PO match which means that the invoice creation was manual, then the next tasks are that the user will have to claim the task to check the due date of the invoice in order to check when the payment should be completed. A reminder will be sent daily in order to complete this task. The reminder is a timer boundary interrupting event, which means that it should be completed otherwise the process cannot continue.

In order to define the timer in Camunda, there are some protocols to be followed. The duration must be identified based on the ISO8601. Based on ISO8601, the capital letters P, Y, M, W, D, T, H, M, and S are designators for each of the date and time elements and are not replaced, but can be omitted.

- P is the duration designator (for period) placed at the start of the duration representation.
- Y is the year designator that follows the value for the number of years.
- M is the month designator that follows the value for the number of months.
- W is the week designator that follows the value for the number of weeks.
- D is the day designator that follows the value for the number of days.
- T is the time designator that precedes the time components of the representation.
- H is the hour designator that follows the value for the number of hours.
- M is the minute designator that follows the value for the number of minutes.
- S is the second designator that follows the value for the number of seconds.

There is the possibility to use again a connector and instead of complete the reminder without outputs, to send a reminder to the user in charge as a message through a connector i.e., Slack.

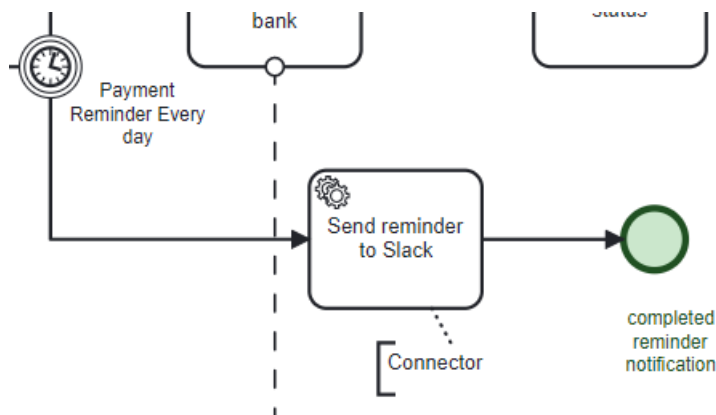


Figure 79. BPMN process “Invoice creation”: Complete reminder

Once the reminder is completed and the user claims the task and review the due dates, the next activity is to create a payment request to the bank. This is an external activity and it will be completed to the bank but once it is completed the user can mark as completed the activity in order to allow to the process to continue. There is another check to be done before to complete the payment. The payment request should be successful and the status should be changed to the bank to ensure that the payment is in order. If it not in order then the payment request must be performed again otherwise the payment can be consider as completed.

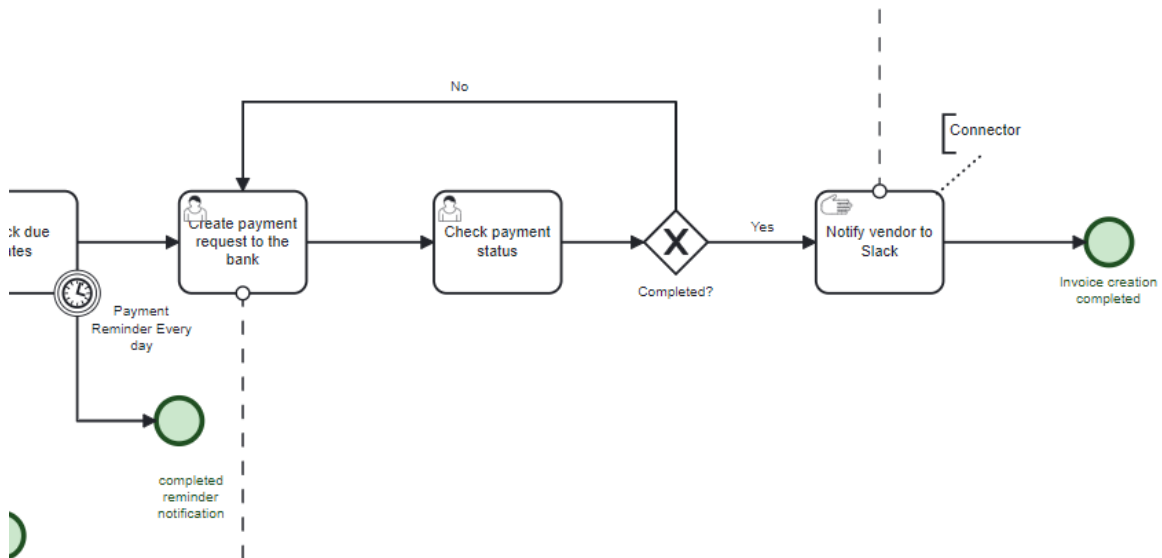


Figure 80. BPMN process “Invoice creation”: Create payment in bank for manual invoices

Once the payment will be uploaded to the bank system, a notification will be sent to the supplier. The notification instead to be a manual one, can be replaced by a connector.

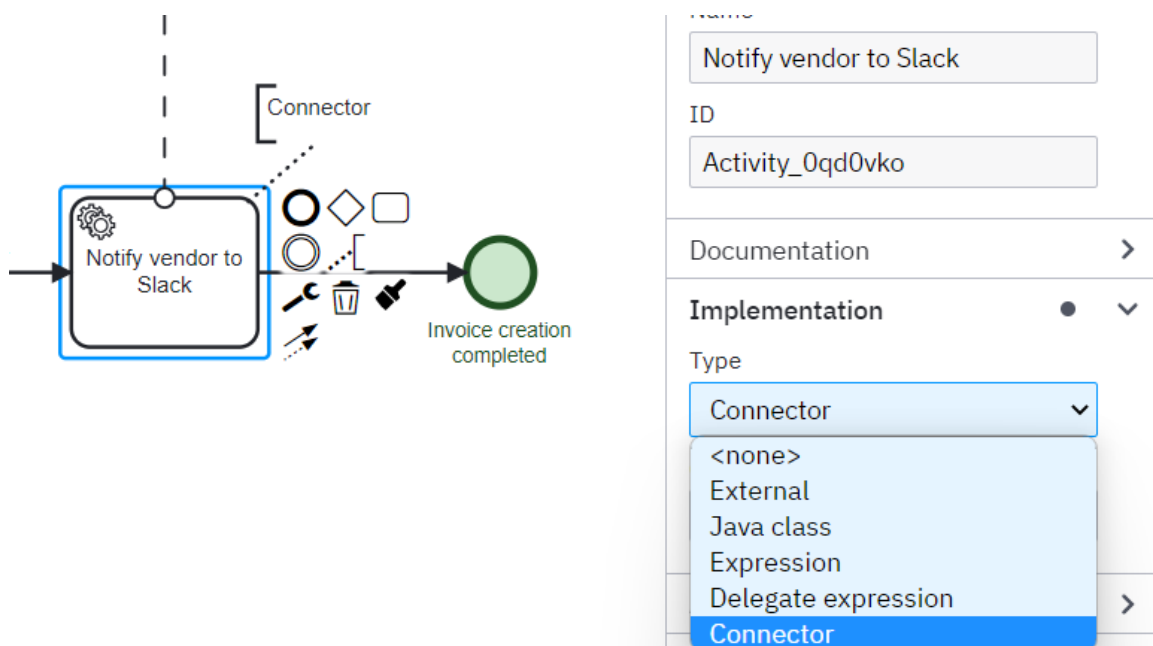


Figure 81. BPMN process “Invoice creation”: Notify the supplier about the payment

As mentioned before there are a lot of supported connectors while using Camunda Platform. For example, in order to send the notification to the vendor, SendGrid Connector can be also used or several other options. The setup is described below.

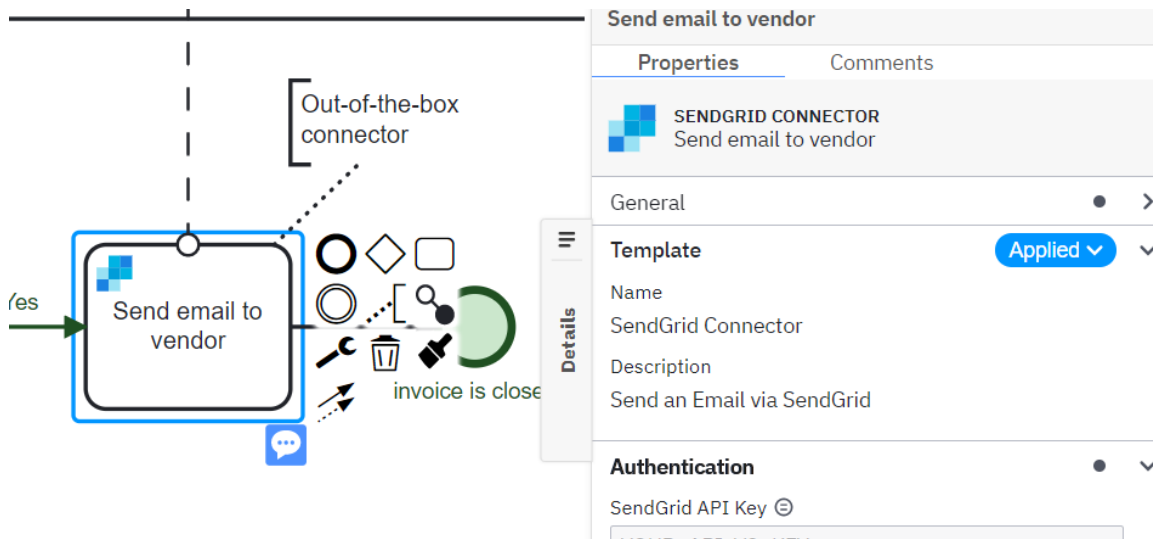


Figure 82. BPMN process “Invoice creation”: Notify the supplier about the payment (2)

In the next figure the entire BPMN process is presented.

4.2 Apply DMN to “Invoice Creation” process using Camunda

A proper and clear BPMN diagram is a model that doesn't confuse the users. But in the business processes where many departments are getting involved and many tasks should be illustrated, this can become really difficult. When it comes to decisions and conditions, DMN model can provide assistance and help to clarify the BPMN diagram. DMN standard provides a two-level model for decisions. These are the decision requirements and the decision logic level [19], [20]. The Decision Requirements Diagram (DRD) models in a graphical and hierarchical way the decisions. Despite the fact that, DRD is sufficient for the purposes of business analysis in a high-level, more details are given by the decision logic level. In this way, the decision logic is encapsulated into decision tables, where its expressions are defined with the Friendly Enough Expression Language (FEEL). [21]

In Camunda DMN is linked to a business rule task. Business Rule task is used to model the evaluation of a business rule. For more safe results, there is the cloud DMN Simulator where the specialist can simulate the DMN rules, run them and test the response. By simulating the DMN rules the specialist can validate that the rules are running properly.

In the “Invoice Creation” business process there are 2 different DMN diagrams. The first diagram includes the “Check Invoice Type” rule.

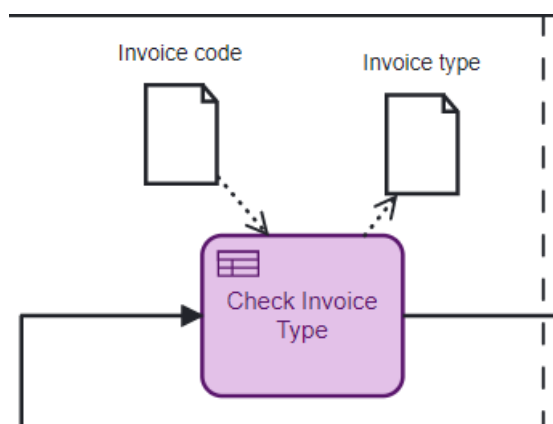


Figure 84. BPMN linked to DMN "Check Invoice Type"

The specialist can choose between two invoice types which are “Standard” (S) and “Credit” (C). Standard is an invoice with positive amount and credit is an invoice with a negative amount which implies a return of goods.

The DMN rules are presented below:

Invoice Type		Hit Policy: Unique	
	When	Then	
	Code string	+ Invoice Type string	+ Annotations
1	"S"	"Standard Invoice"	Enter positive value amount
2	"C"	"Credit Memo"	Enter negative amount

Figure 85. DMN rules for "Check Invoice Type" DMN

The DRD is pretty simple. There is expected an input value which is the code in order to trigger the decision rules.

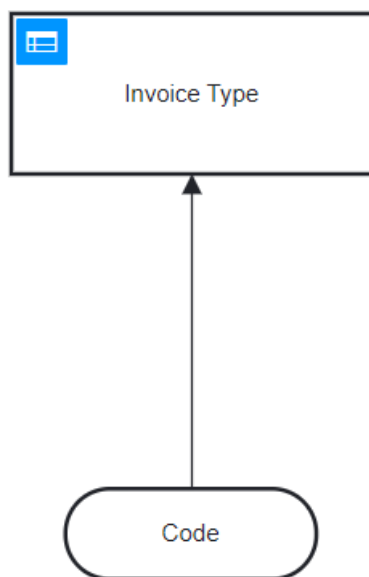


Figure 86. DRD for "Check Invoice Type" DMN

In case the user selects “S” then the results or output value will be “Standard Invoice”. Otherwise, if the user selects “C” the output will be “Credit Memo”. The

decisions can be unique which means one decision per rule. This is indicated by the “Hit Policy”.

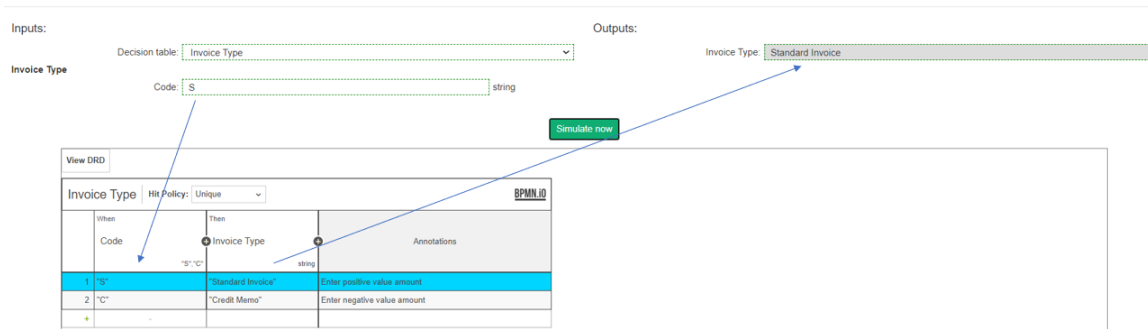


Figure 87. DMN simulator for "Check Invoice Type" DMN

The activities to be done by AP specialist can be described in the table:

Activity	Owner	System
Identify the Invoice type	Payables Specialist	AP dpt
Choose the correct type in the DMN rule	Payables Specialist	Camunda

Table 4. Activities for DMN “Check Invoice Type”

The Key considerations about this flow are the followings:

- No payables transactions can be loaded without a transaction type

The second DMN includes the calculation of the taxes on the invoice.

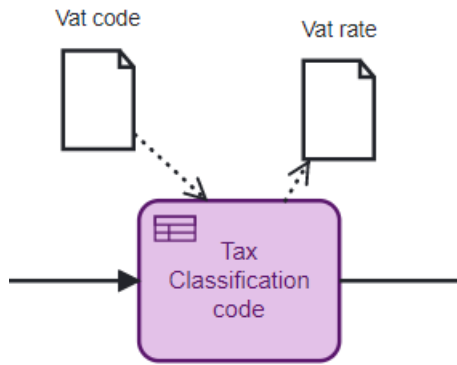


Figure 88. BPMN linked to DMN "Tax Classification Code"

User needs to provide tax code related information on the invoice line level of the form when there is the manual creation of the invoice in place, then check those taxes and perform the calculation of the rate based on the DMN table. The default tax derivation rules are:

Tax Calculation | Hit Policy: Unique			
	When	Then	
	VatCode	+	Rate
	"STD";"RED";"ExtraRED";"ExEU"		double
1	"STD"	0.24	Standard vat rate
2	"RED"	0.13	Reduced vat rate
3	"ExtraRED"	0.06	Super-reduced vat rate
4	"ExEU"	0.00	Non European vat rate
+	-		

Figure 89. DRD and DMN rules for "Tax Calculation Code" DMN

The "Hit Policy" is also unique. For example, in case the tax code is "STD" then the related rate is 0.24. This can be identified as the standard vat rate.

In the DRD, it is clear that we expect as an input value the tax code and we have always to take into consideration the vat policies in order to compose the rules for the different taxes.

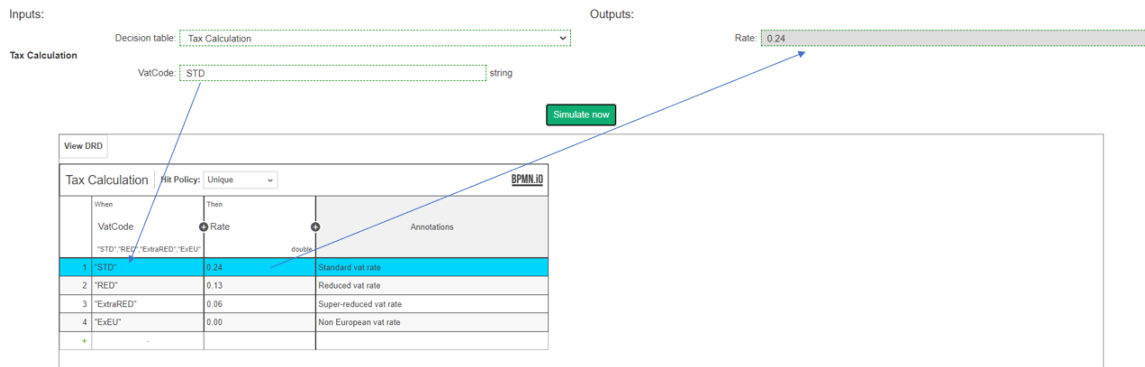


Figure 90. DMN simulator for "Tax Classification Code" DMN

Once the assignee chooses the vat code, the vat rate will be automatically populated and as an output, the DMN will calculate the tax amount.

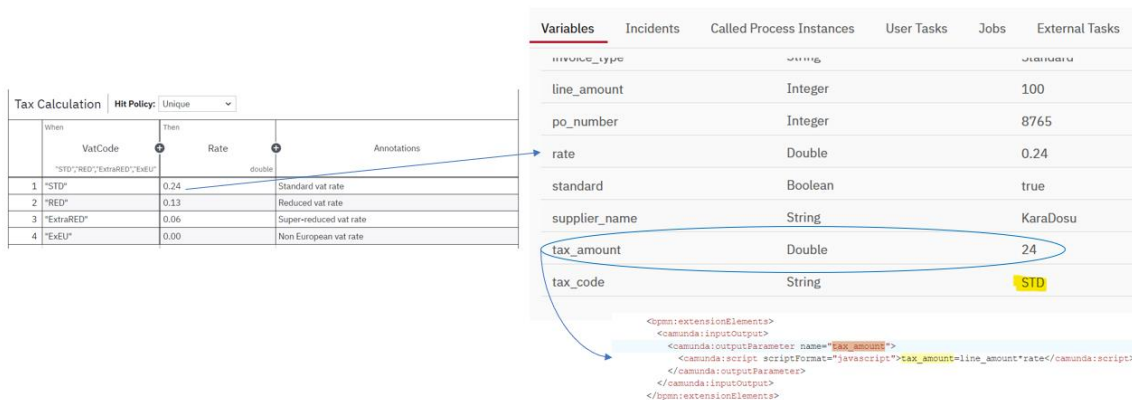


Figure 91. "Tax Classification Code" DMN output "Tax amount" calculation

The activities to be done by AP specialist can be described in the table:

Activity	Owner	System
Identify the tax code	Payables Specialist	AP dpt
Choose the correct tax code in the DMN rule	Payables Specialist	Camunda

Table 5. Activities for DMN "Tax Classification Code"

The Key considerations about this flow are the followings:

- No payables transactions can be loaded without a tax

4.3 Create Forms to “Invoice Creation” process using Camunda

The Camunda Forms feature gives the possibility to design forms and connect them to a user task or start event to implement a task form in the application. The tasks linked to Camunda Forms are presented below:

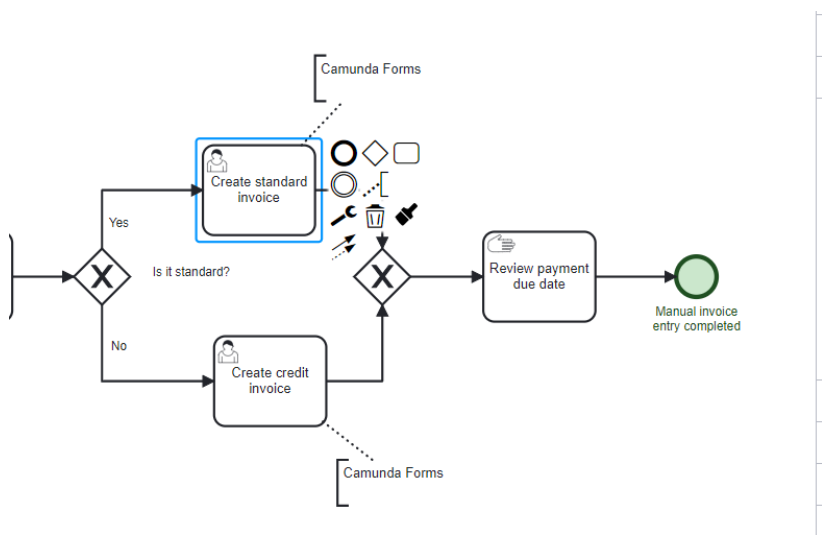


Figure 92. "Create standard invoice with Camunda Form" task

In the “Manual Invoice Entry” subprocess, there are two forms, one is for standard and one for credit invoices.

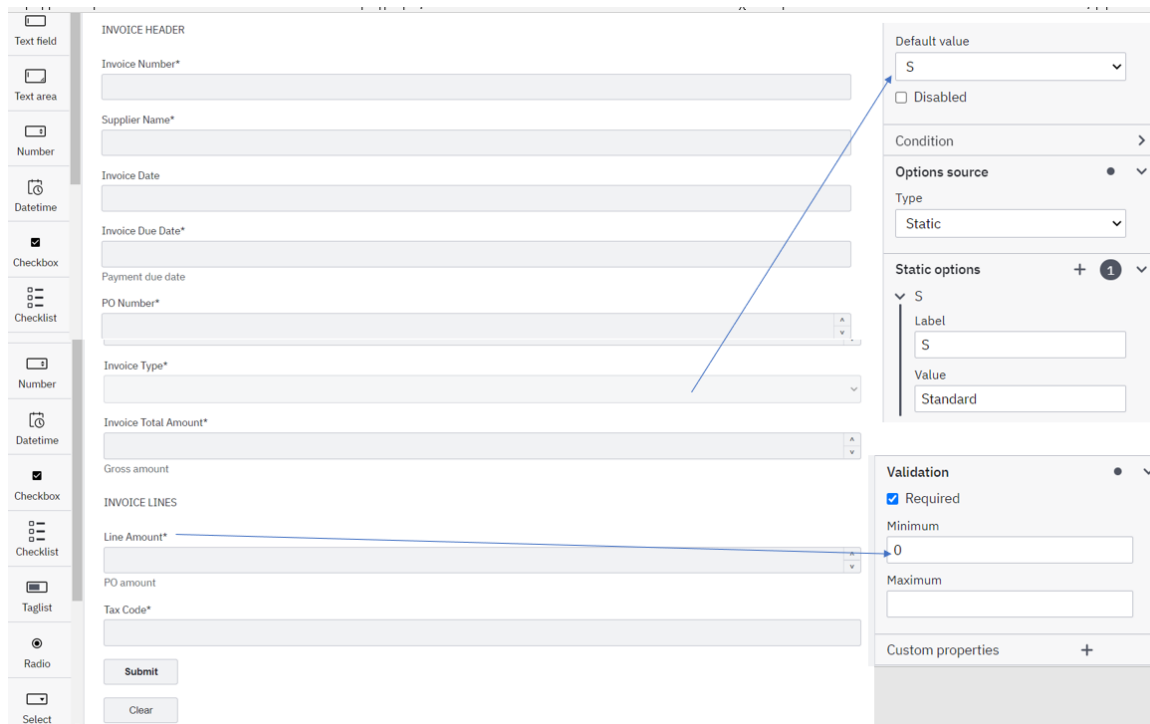


Figure 93. Camunda forms "Standard Invoice Form"

In order to modify and/or add elements there is the palette on the left side. This palette contains text fields, numerical values, checkboxes, radio elements, selection menus, text components, and buttons. There is the option to make field as "Required" or to insert validations or default values from details panel.

Since this form is only for standard invoice, the invoice type field is predefined and set as default value the value "S". Once the AP specialist fills the fields and click on "Submit" the output form is generated:

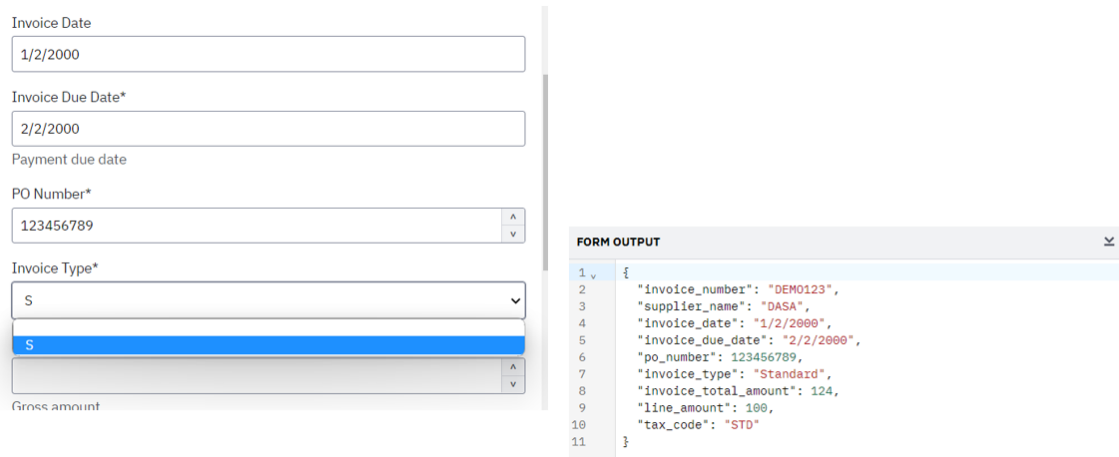


Figure 94. Output form for "Standard Invoice form"

Once the assignee chooses the invoice type, the corresponding form will be populated in the tasklist in order to be filled by the assignee. The logic is presented below:

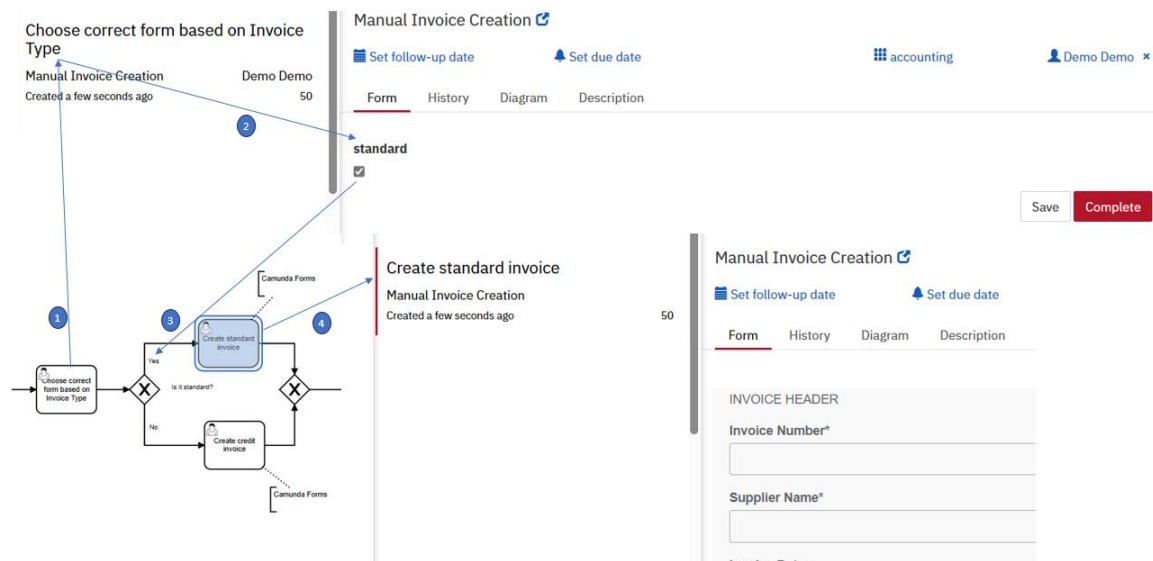


Figure 95. Camunda Forms linked to Camunda BPMN logic

The second form for credit invoices is more or less the same with three exceptions:

- The default value is "C" for invoice type
- The amount is negative
- There is no tax code

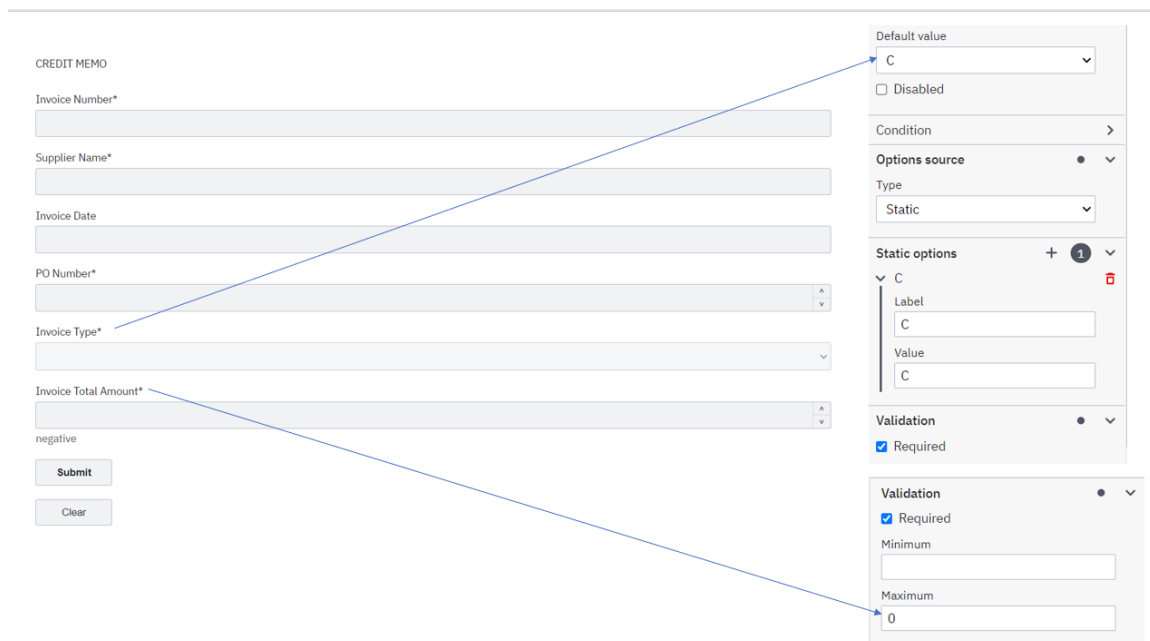


Figure 96. Camunda Form "Credit Invoice form"

4.4 Summary

In this chapter was presented the creation of the business process "Invoice creation" using BPMN. The end-to-end invoice creation was consisted of different types of activities and events in order to illustrate the usage of Camunda Modeler's advanced tools. The approval tasks were the most important since the need for validation in such processes is high. Furthermore, the decisions were presented with the use of DMN and the related DRD. It was highlighted the meaning and the use of the DMN since the proper and valid implementation is a crucial part, otherwise, if the rules won't be identified correctly, the entire flow can be affected since one wrong rule will drive to wrong calculation which means a wrong path. Additionally, the use of Camunda Forms and Camunda Connectors was presented. Connectors can connect easily a business process with external channels and provide quickly feedback and assistance when it comes to communication within the team or with external parties. Forms on the other hand are user-friendly and can make a user task much easier and can also clarify the task with the proper and not complex illustration.

CHAPETR 5: Apply Robotic Process Automation in Case Study: “Invoice Creation”

5.1 Integrate RPA into Camunda using UiPath

To orchestrate RPA bots and the tasks that they automate, it is needed to create a UiPath package that contains the scripts that the RPA bots should execute. In UiPath, these scripts are called “Process”. UiPath studio provides the possibility to configure the scripts. These are the IN parameters. The RPA Bridge will then pass the Camunda task input parameters via the UiPath Orchestrator into the UiPath Robot. The OUT parameters of UiPath will be returned back into the Camunda engine as task output parameters. The names of these IN and OUT arguments will be used in the Cawemo Catalog. Since the UiPath script works properly, it should be deployed in the UiPath Orchestrator as a new package. The name of this package will be used in the Cawemo Catalog.

The high-level RPA Orchestration – Architecture overview is illustrated below:

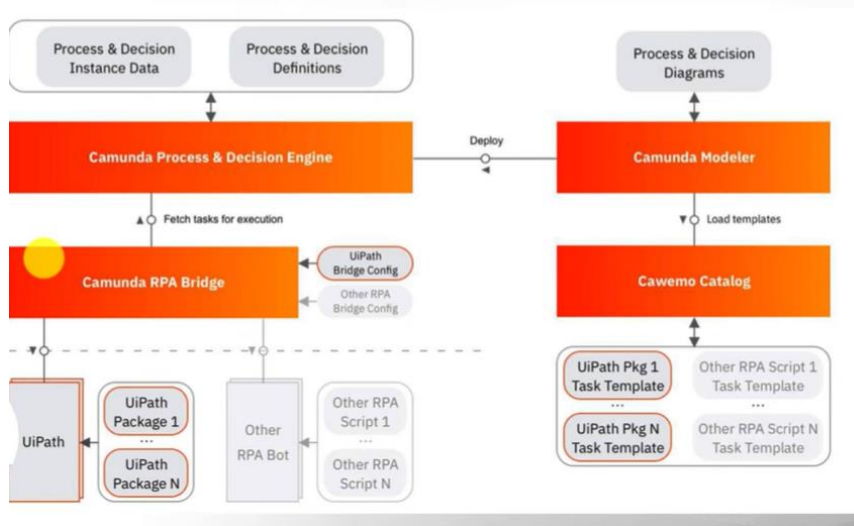


Figure 97. RPA and Camunda integration [8]

UiPath enables the web developers to perform activities, such as data extraction, application transfer, report generation, and website testing. UiPath can be integrated with Artificial Intelligence (AI), BPM, and Enterprise Resource Planning

(ERP). UiPath's end-to-end solutions enable users to automate redundant tasks using Visual Basic (VB) programming language.

The following are the components of UiPath:

- UiPath Studio. In UiPath Studio users can compose their diagrams and flowcharts to design automation processes. It also involves the coding and sequencing of these processes. It consists of Graphical User Interface (GUI) buttons, drag and drop features, and pre-built templates.
- UiPath Robot. UiPath Robots are deployed to execute the automation processes using pre-defined rules.
- UiPath Orchestrator. The web-based orchestrator schedules, deploys, and manages processes. In the orchestrator the user creates the machines and the robots and link them with the process that has been created in Studio.

The steps that are taking place between Camunda and UiPath tool can be summarized in the image below which are basically the call from the Camunda task to UiPath Orchestrator where the AI project has been published through UiPath Studio and then the UiPath Robot is called to complete the job.

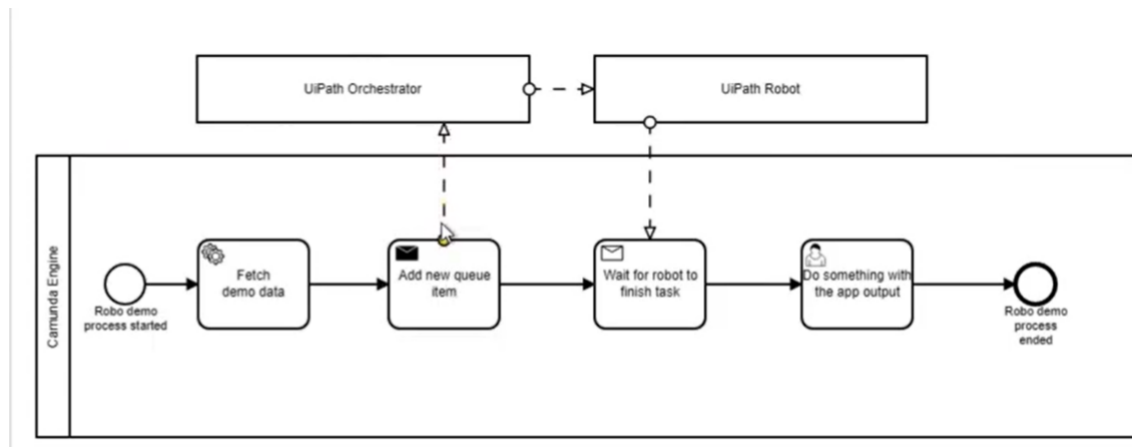


Figure 98. UiPath and Camunda integration overview

5.2 RPA: Invoice Creation Business Process

5.2.1 UiPath Studio

The activities to be done by AP specialist are basically to review the invoices that has been arrived. Since we are referring to a non-PO invoice, the spreadsheets must be uploaded in the correct path in cloud so that the robot can extract the information needed.

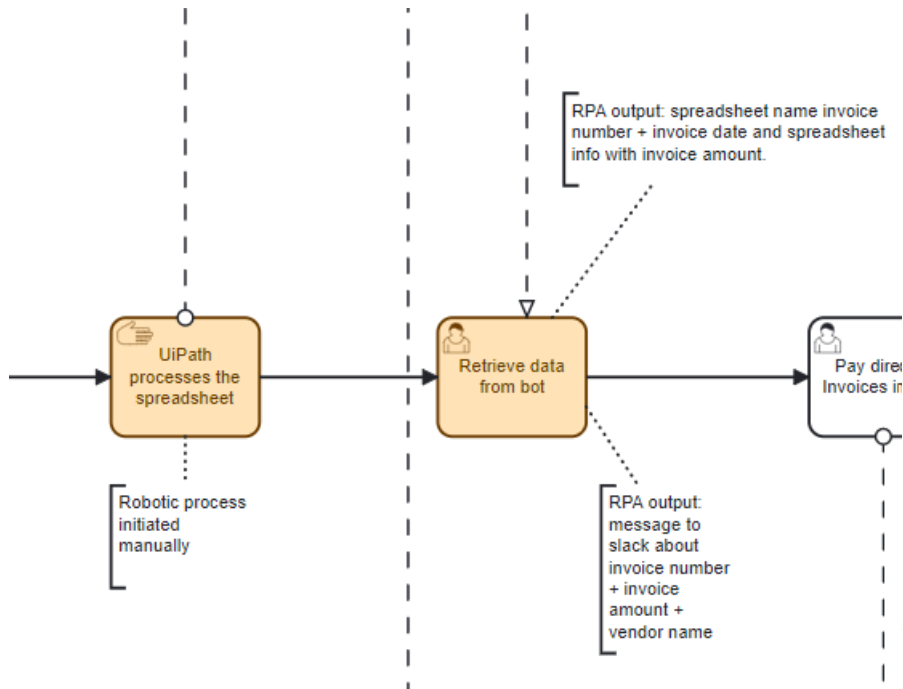


Figure 99. Tasks in "Invoice creation" process that can be replaced with UiPath

The manual tasks indicated the manual trigger of the UiPath Studio, which will trigger the bot to process the spreadsheets. The user task indicates the confirmation that the spreadsheets have been populated and the message in Slack has arrived by the bot. These two tasks can be replaced with the connection between Camunda modeler and UiPath connector. The tasks can be reformed as below:

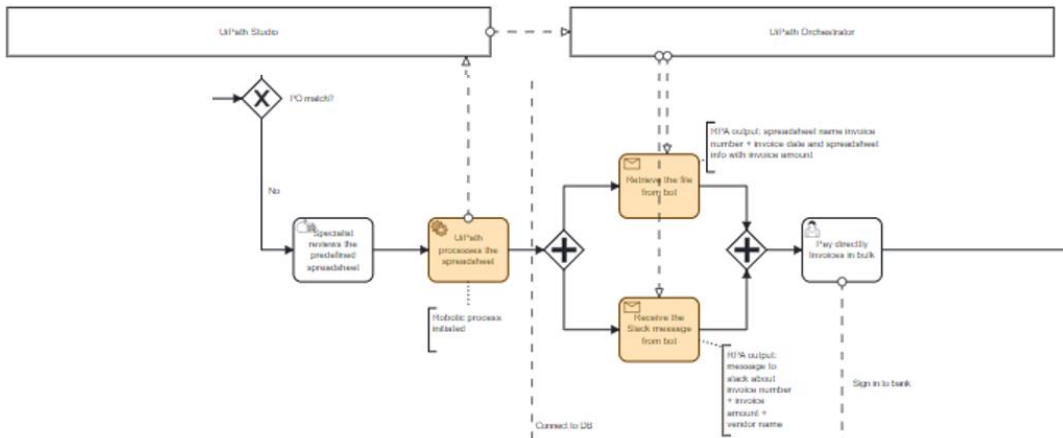


Figure 100. Connected BPMN activities with UiPath

The Key considerations about this flow are the followings:

- The invoice doesn't have a PO

The predefined information includes the below columns:

- invoice number
- invoice date
- vendor number
- vendor name
- invoice amount
- line amount
- account
- tax rate
- tax amount

In this scenario the AP users receives from the supplier (vendor) the spreadsheet with the mandatory information. In the next image a spreadsheet example is presented:

	A	B	C	D	E	F	G	H	I
1	INVOICE NUMBER	INVOICE DATE	VENDOR NUMBER	VENDOR NAME	INVOICE AMOUNT	LINE AMOUNT	ACCOUNT	TAX RATE	TAX AMOUNT
2	123456	11012023	123456789	SONOVA	99,2	80	5100001	0,24	19,2
3	123457	12012023	123456790	GN	99,2	80	5100001	0,24	19,2
4	123458	11012023	123456791	COSMOTE	99,2	80	5100001	0,24	19,2
5	123459	11012023	123456792	KARADOSUS	99,2	80	5100001	0,24	19,2
6	123460	11022023	123456793	SIGNIA	99,2	80	5100001	0,24	19,2
7	123461	15012023	123456794	ING	99,2	80	5100001	0,24	19,2

Figure 101. Invoice Creation Spreadsheet overview

The vendor can send more than one invoice and the UiPath studio can process all these invoices at once directly from Cloud. The aim is to collect and extract the invoice amount to be paid. For this reason, the bot will extract from this spreadsheet only the column "INVOICE_AMOUNT". For each of the invoices the robot will create a separate spreadsheet with the naming convention as "INVOICE_NUM" + "INVOICE_DATE" and each spreadsheet will contain only the invoice amount to be paid.

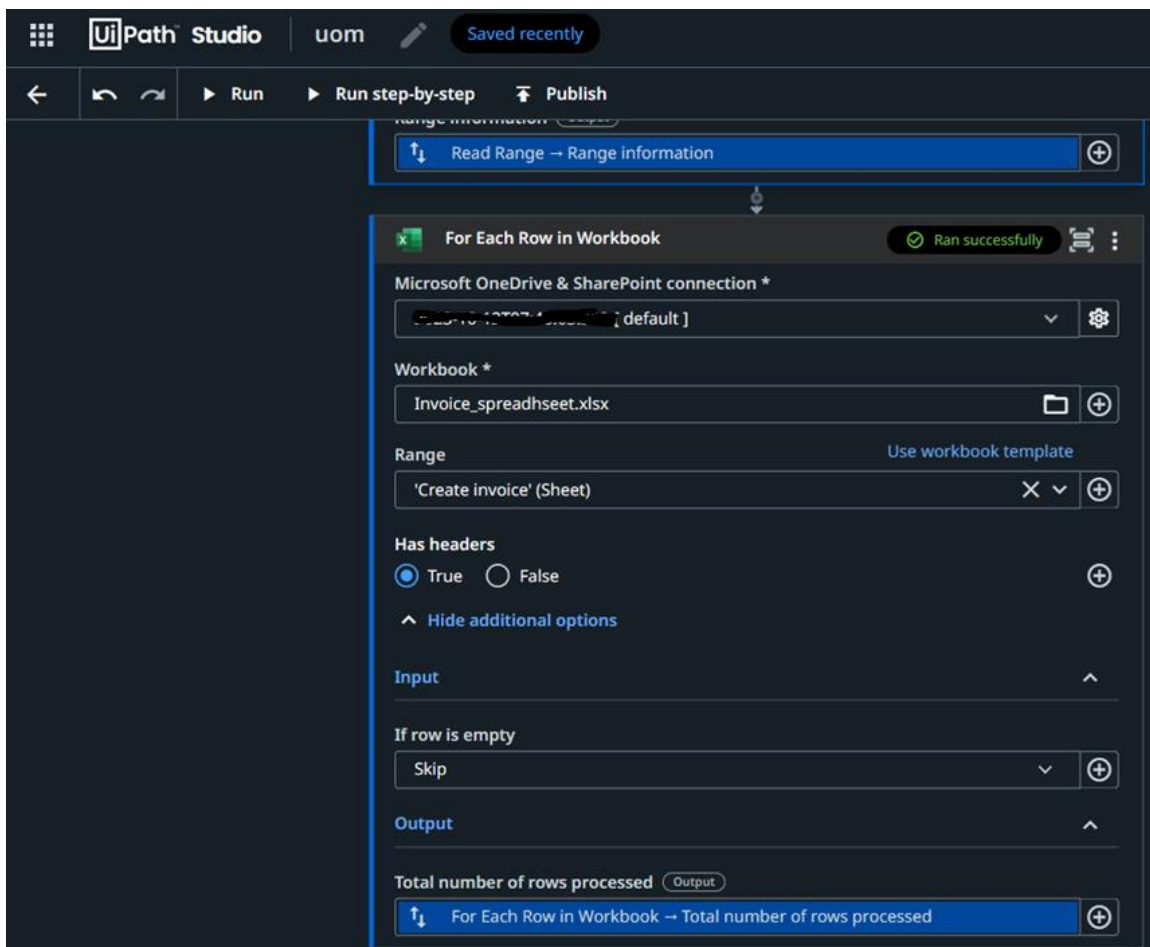
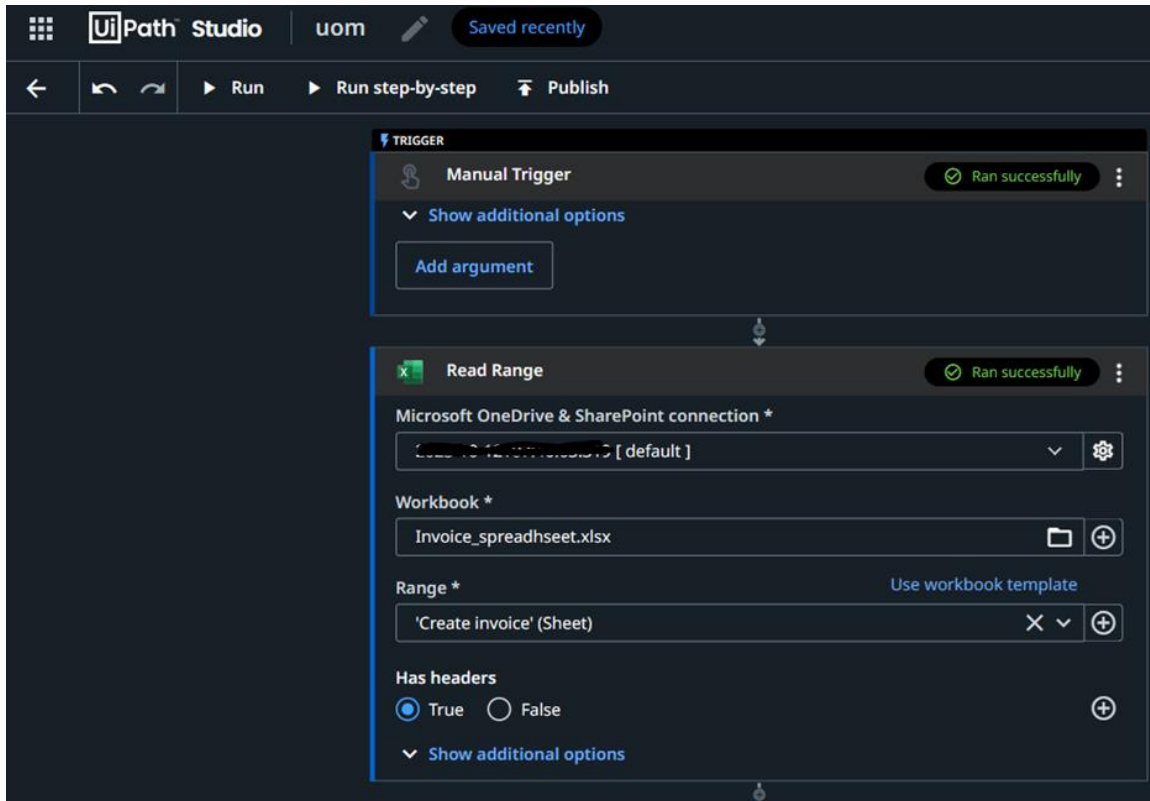
Workbook name:

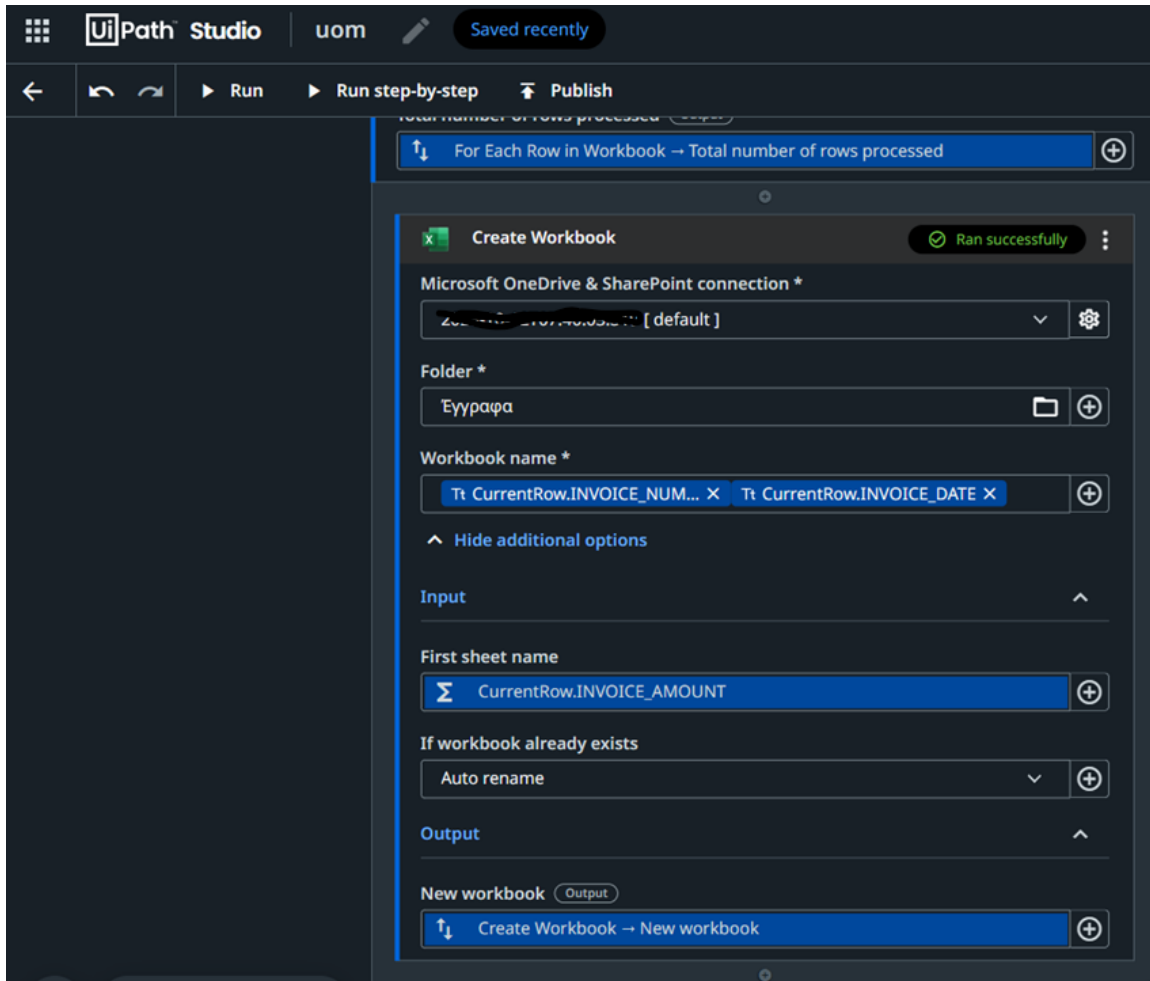
```
string.Format("{0}{1}", CurrentRow.INVOICE_NUMBER, CurrentRow.INVOICE_DATE)
```

Input:

```
CurrentRow.INVOICE_AMOUNT
```

The diagram in the UiPath Studio for the specific scenario is illustrated in the next images:





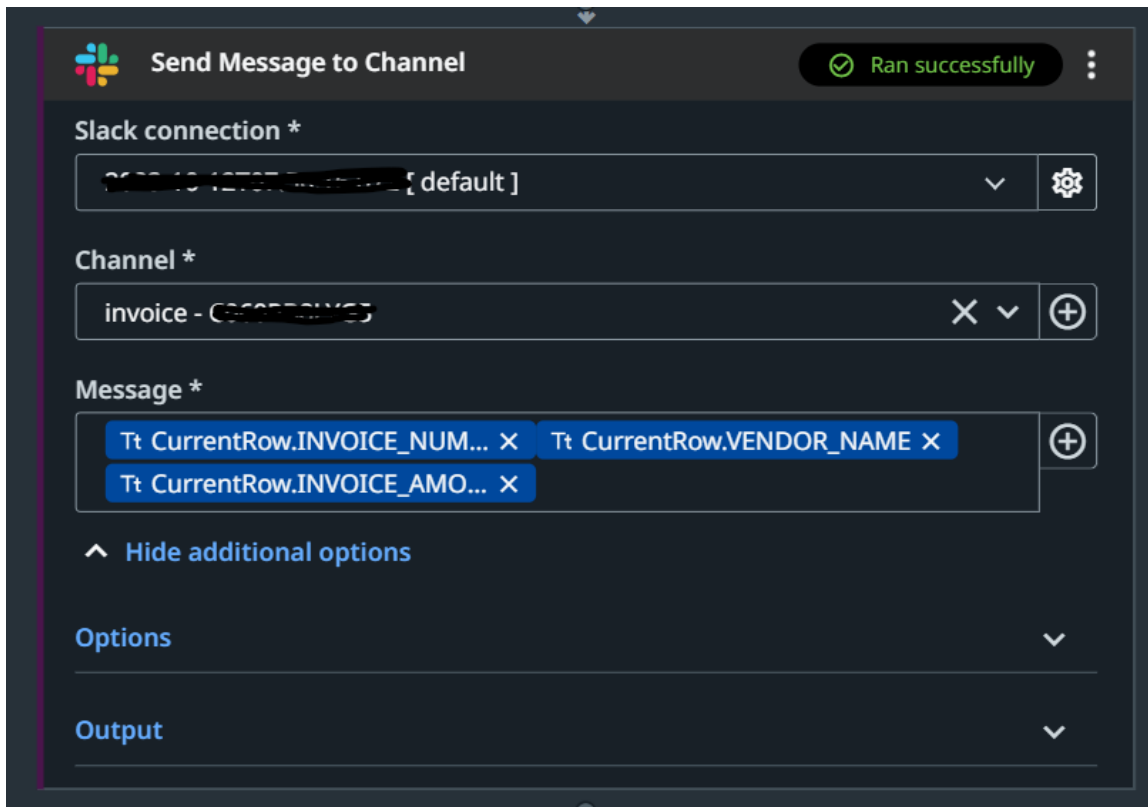


Figure 102. UiPath Studio diagram for process "Invoice creation from spreadsheet"

UiPath supports the activity to upload excel files, csv etc from a specific path. In case the path and/or the sheet name is modified, the first activity should be modified (path) and the also all the activities that extracts the specific excel or the sheet of the excel must be modified as well i.e., the to “DO” activity, which is the “Read Range” must be also modified in order to contain the correct sheet name, i.e., “Create invoice”.

As a last step, UiPath Robot will send a message to a specify channel in Slack. The channel name is #invoice and the participants are the AP users in charge for the payment. The message will contain the “INVOICE_NUMBER” + “VENDOR_NAME” + “INVOICE_AMOUNT”.

After the diagram is debugged and run, the diagram is published to UiPath Orchestrator. Once the robots complete the activity, the output is generated. Once the output is generated, it can be also sent as a file in order to upload it to an ERP or share it for any kind of purposes such as intrenal use for assistance to the payments in bank system.

5.2.2 UiPath Orchestrator

Once the UiPath studio is linked with the UiPath Orchestrator, the idea is to manage the processes and the robots, review which are in queue, which are running and generally monitor the RPA process that has been created in UiPath studio. There is the possibility to schedule the robots in order to run automatically in a specific frequency. The orchestration includes all the workspaces assign to the administrator, the robots, the machines, the possibility to manage the access and add or remove users.

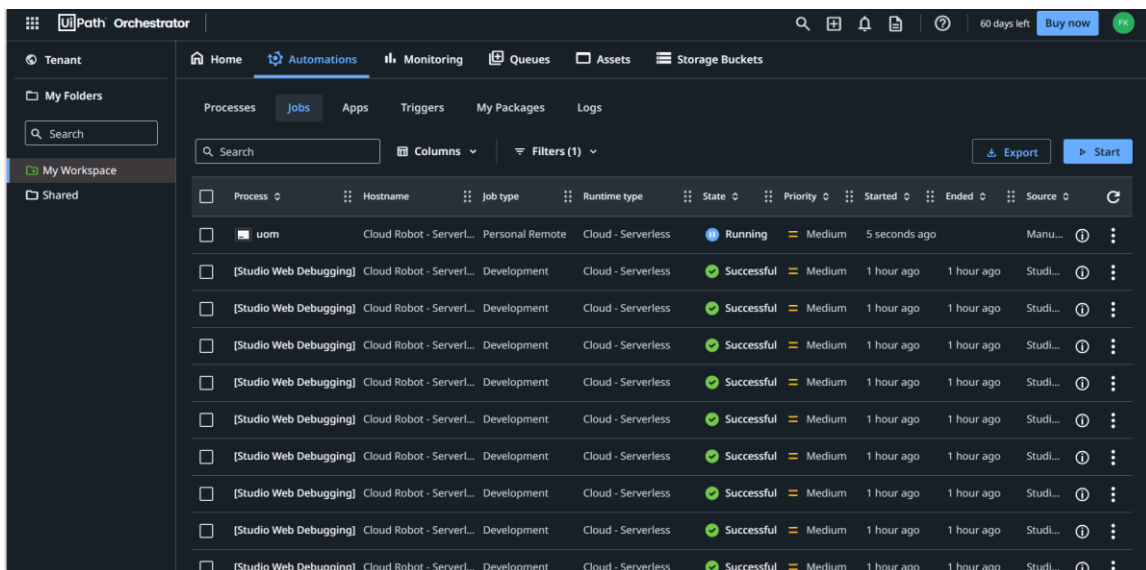


Figure 103. UiPath Orchestrator overview the automated processes that are running



Figure 104. UiPath Orchestrator overview analytics

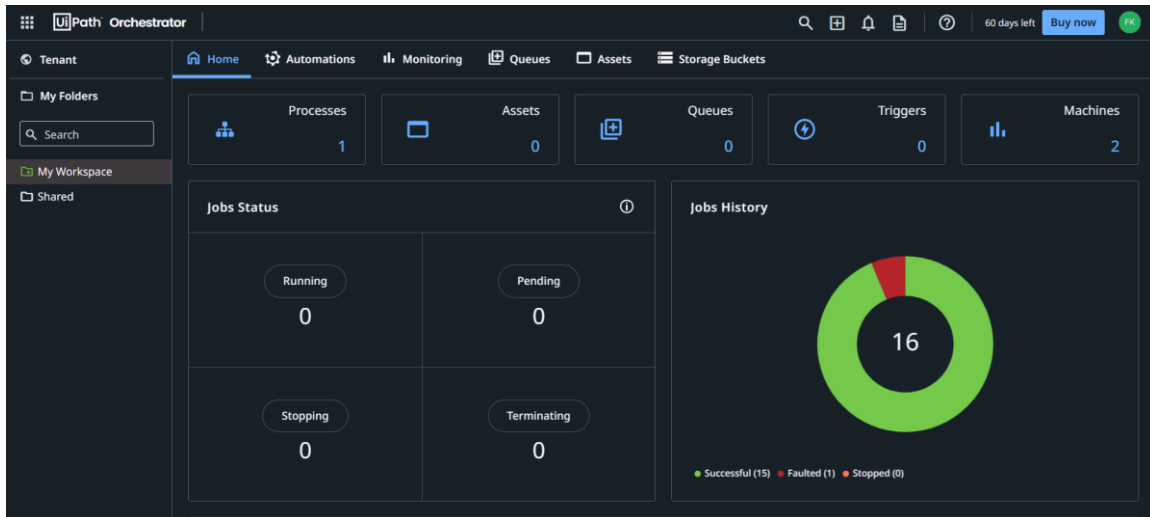


Figure 105. UiPath Orchestrator overview dashboard

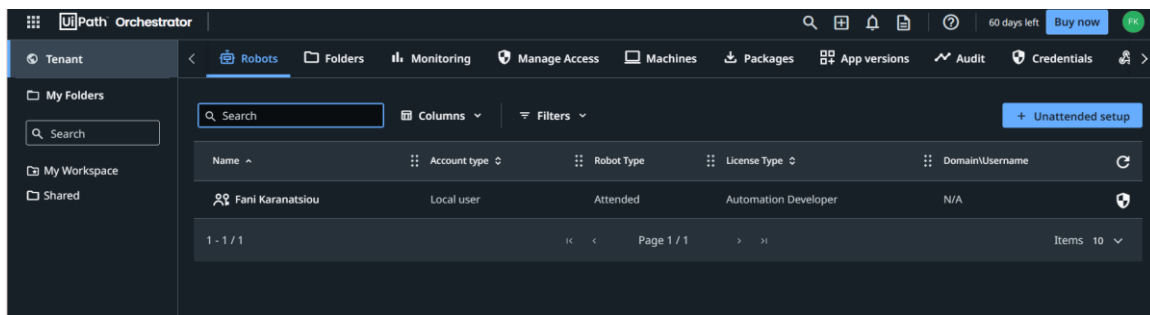


Figure 106. UiPath Orchestrator robots

Each of the workspaces that are linked to the administrator can be reviewed, as well as the job statuses of each workspace, the users that are assigned to this job and the machines. Each time that a job runs, the administrator can monitor them by reviewing this dashboard.

Once the job is completed the new spreadsheets are created. The original one is the “Invoice_spreadsheet” and the rest of the spreadsheets are created automatically with the help of the bot. The naming convention is predefined and in case the name is the same then the bot chooses to rename it, as it is shown in the next image. Each spreadsheet contains as a sheet name the invoice amount (“INVOICE_AMOUNT”) to be paid.

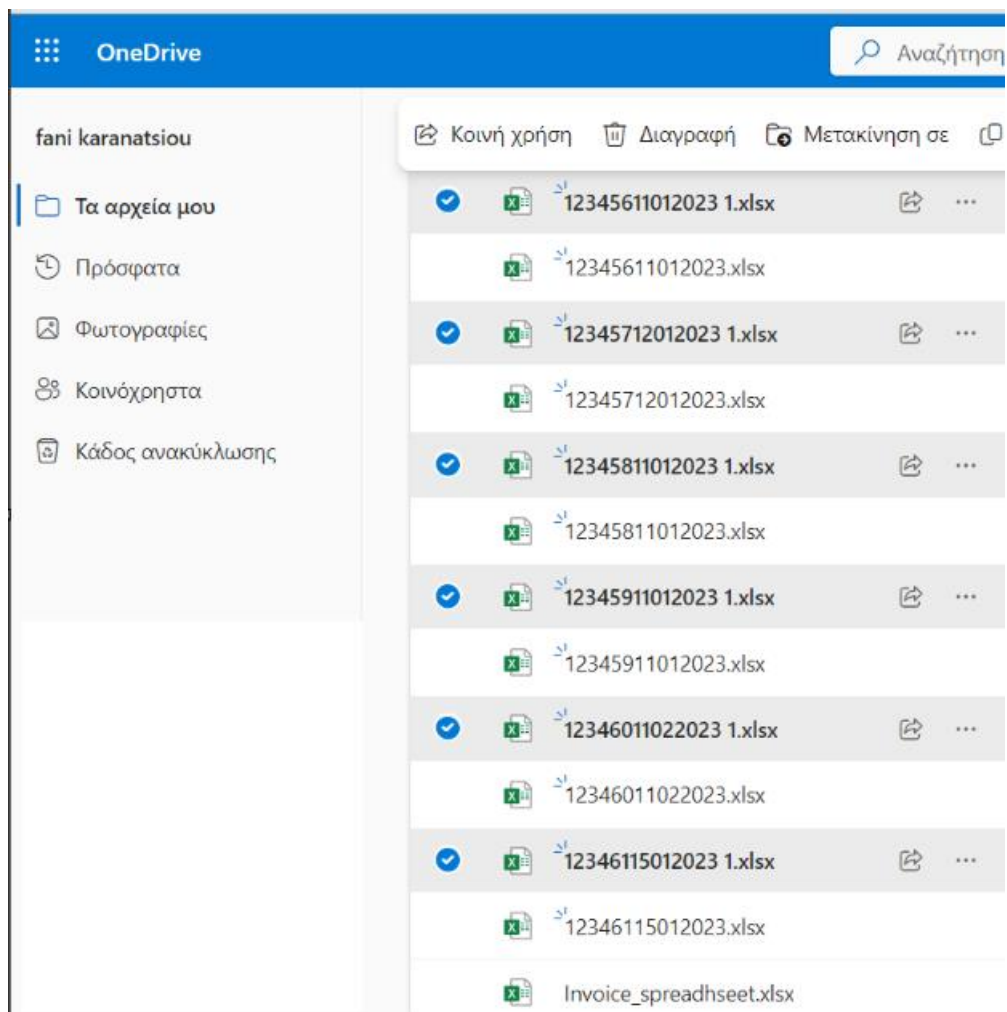


Figure 107. Robot creates automatically the spreadsheet in cloud

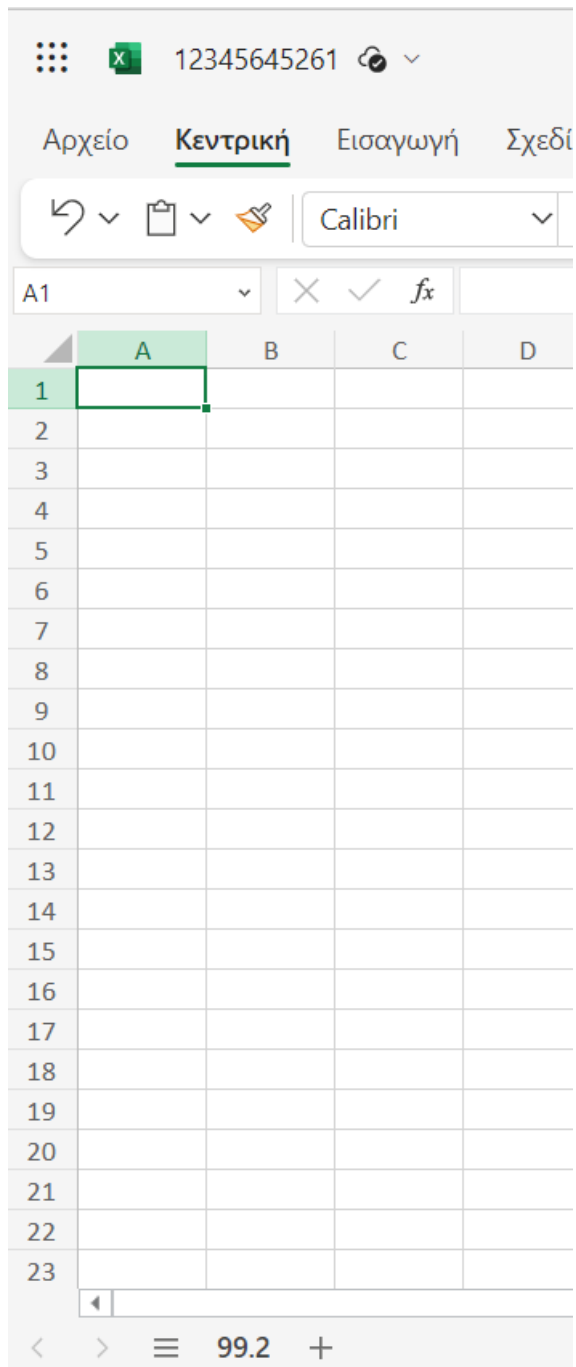


Figure 108. Spreadsheet created by robot and contains the invoice amount

After that a message will be sent to the specific channel by the UiPath Robot. Each message will contain the invoice number, vendor name and invoice amount of the invoices included in the predefined spreadsheet.

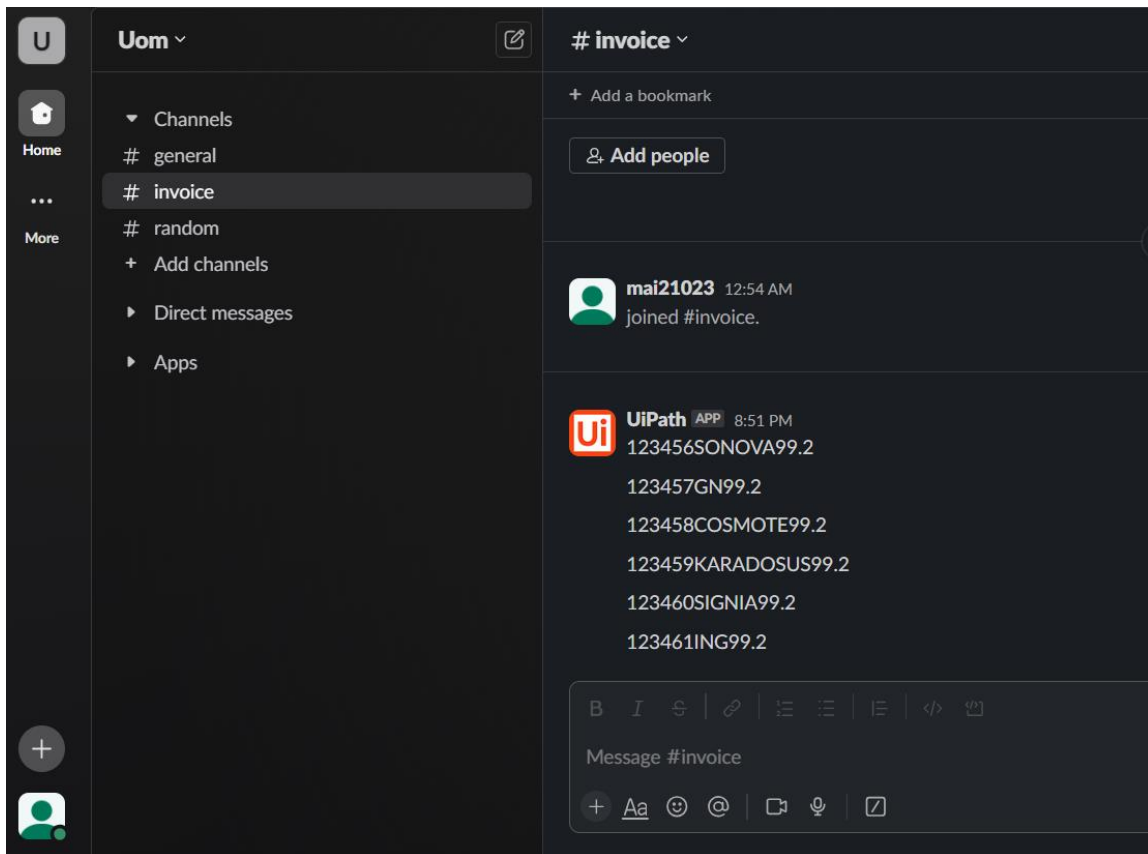


Figure 109. Slack message from UiPath robot

The overall benefits that ensue from this automation can be listed as below:

1. Saves time
2. Saves money
3. Ensures reliability without interruption
4. Ensures consistency since the manual errors or users' neglects are decreased
5. Improves productivity and efficiency since the users are not occupied with low importance manual tasks
6. Leads to growth in profits since the users are occupied with more important tasks
7. Improves the working environment since the users don't deal with tedious work and routine tasks

5.3 Summary

In this chapter was described the integration between BPMN and RPA using UiPath tool. As it was highlighted, the benefits that ensue from this implementation are countless. An organization can decrease the costs with just one bot and also decrease a lot the manual effort. UiPath can provide a lot of automations from a generation of an excel file to an automated message to a specific channel. This can save time and effort specifically to the tasks that needed manual effort in order to extract, analyze and modify data or to communicate with different parties. The tricky part is that all the files or workspaces must not change location or must not be modified. Otherwise, the maintenance and the update of the RPA flow must be covered.

CHAPTER 6: MITOS: Apply Robotic Process Automation in “Electronic submission of APD” procedure

As has already been mentioned, Mitos is the official register of procedures of the Greek Public Sector. Mitos renders the possibility to sign-in and either find necessary documents or implement different procedures. There are different procedure categories for citizens, businesses, legal entities, public bodies etc based on specific purposes, such as audit reasons, certificates, benefits etc. The procedure that is going to be described on this chapter is from the category “Business Activity” with subcategory “Staff employment” and procedure name “Electronic submission of APD”. [41]

6.1 Description of “Electronic submission of APD” procedure

The Detailed Periodic Statement (APD) is a document that should be submitted electronically by the employer on a monthly basis to Ministry of Labor and Social Security and contains detailed information regarding the employees, their salary, their employment time, their class of insurance and the amount of their social security contributions. The due dates of submission are the month following for the private sector and for public enterprises, next but one month after that of the employment. The requirements are: [41]

1. The employer has to be preregistered with the e-EFKA Registry of Joint Venture or Construction and Technical Projects Employers.
2. The employer must have credentials in order to use the Electronic Services.
3. The employer must create the credentials via the certification procedure.
4. The employers who are either natural or legal persons can be registered with the e-EFKA Registry of Joint Venture or Construction and Technical Projects Employers online.

6.2 As-is business process “Electronic submission of APD” modeling using BPMN

In order to complete the electronic submission of APD, there are some steps to be followed. Firstly, the person in charge should log into the application with the credentials. Then the user should select the specific date range and create a submission period based on this date range. After that, the user has to decide between two options, either to complete manually the form or to upload a prepared file. The first submission option is called “Form completion” method and the second “Send file”. In case the user selects the first one, then there are several steps to perform in order to complete the submission. Firstly, the user must create a new entry with blank data. Then, the user should start filling all the necessary information and once everything is filled, the user must select the button “Finalisation”. Once the mode has become final, then the user should check the entries and correct possible errors, and finally, the user should submit the form and check the update of the status which should be “submission”. After the completion of the submission, the submission receipt is available to either review or store it. On the other hand, if the user chooses to upload a prepared file, then the user should select the proper APD document which for example, can be generated by a software for payroll procedures, upload it to the system, check the submission into the system, if for instance there are errors that must be corrected, and lastly, the user should submit the file and check the update of the status which should be “submission”. Then, again the submission receipt is available and ready to be printed. [41]

Below a screenshot of the modeling of the procedure “Electronic submission of APD” using BPMN.

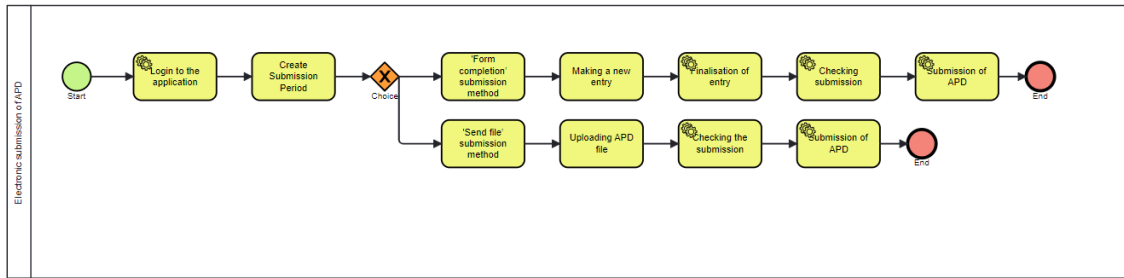


Figure 110. MitoS: As-is business process modeling of the procedure “Electronic submission of APD” using BPMN [41]

6.3 To-be business process “Electronic submission of APD” using automation

The as-is business process modeling for the “Electronic submission of APD” can be improved by adding an automation. Generally, the improvement of each business process is an activity that must be carefully analyzed based on the needs, must be properly designed, developed and deployed. The testing stage is one of the most important stages due to the fact that all the errors or the gaps can be identified before the final launch. If the testing is successful and all the parameters can be satisfied then the automation can be moved to production and then the automation can be monitored in order to ensure the smooth implementation.

In the particular case, the automation that can be implemented without disturbing the normal process or the safety factor, is a Robotic Process Automation. In the XOR gateway the user, as mentioned in the previous paragraph, should choose between manual submission or submission with a file. In the second option, “Send file” method, since the user is using a file, which has already been prepared and checked, a bot can replace not only the manual upload of the APD prepared file but also the log-in to system and the submission of the APD prepared file.

The benefits that ensue from the implementation of this automation are the fact that the bot will eliminate the manual effort, it will save time, it will ensure that the submission won’t be neglected, it will ensure the reliability without interruption and the consistency since the manual errors or users’ neglects are decreased. Furthermore, long-term it will not only save money but also increase the efficiency and the profits since the user in charge of this activity can focus on other activities

that are more meaningful and profitable for the company instead of being occupied with low importance manual tasks. Lastly, it will improve the working environment since the users won't deal with routine tasks.

Undoubtable, there are some focal points that each company needs to take into consideration when a bot is included into a business process. Specifically for this automation, the company must ensure that the credentials are secured, they are not going to change and if they are, they should be updated into the automation setup, the testing phase must take into account all the necessary parameters before to launch the automation to production, the APD prepared file must be correct and always stored to the specific cloud path and the bot must have access to this path. If the path changes, the automation setup must change as well. Generally, the bot's maintenance is the key consideration when it comes to this kind of automations.

6.3.1 "Electronic submission of APD" using BPMN

With the RPA integration into the business process, the business process modeling with BPMN has to be modified in order to include the automation step. Since the automation will take place only on the second part of the gateway which includes the second method, the steps from the task "Send file submission method" to "Submission of APD" can be replaced with a single service task. This service task basically will be the trigger of the bot. Once the bot is triggered, the bot is going to log-in to the system with the credentials, select the prepared file from a specific path, upload the file to the proper area and submit the file.

The BPMN process can be modified as below:

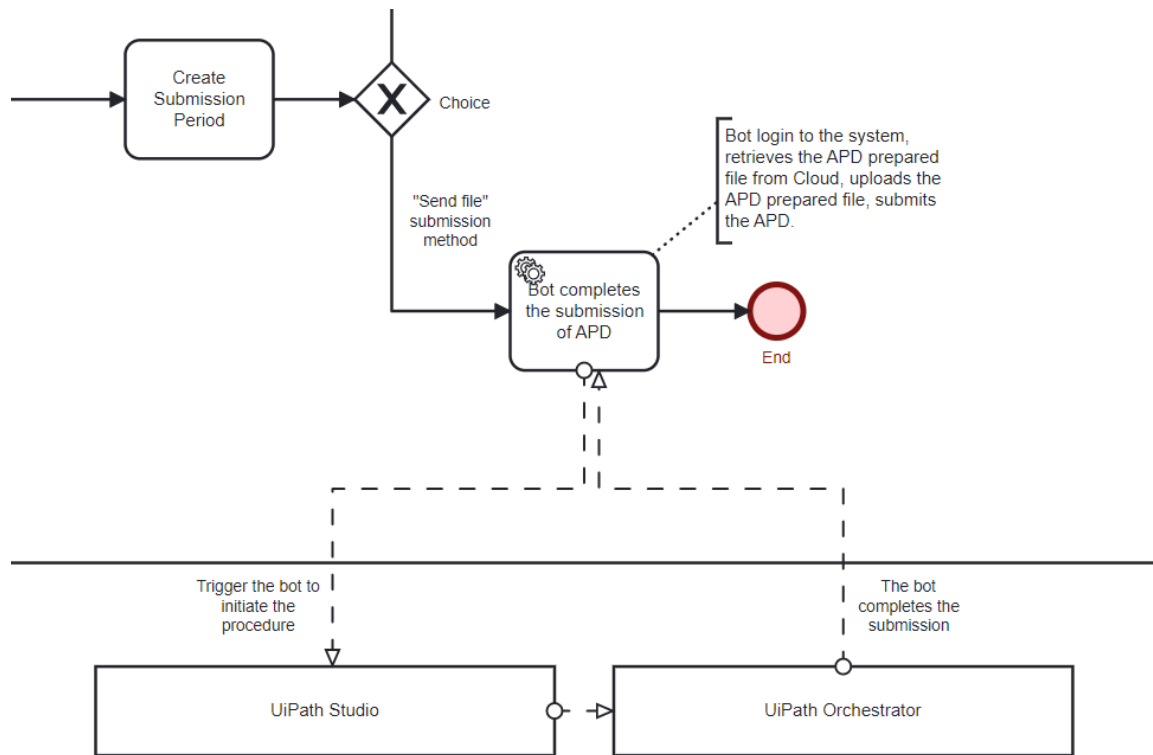


Figure 111. Mitos: To-be business process modeling of the procedure “Electronic submission of APD” using BPMN and automation

6.3.2 “Electronic submission of APD” using UiPath

In order to configure the automation, it is needed to use an automation tool. For the purposes of this thesis, the UiPath is going to be used, as it has been already described as an automation tool. The first step is to ensure that the UiPath Studio includes a specific package which is the UiPath.Credentials.Acitivity package. If it is not existed, it should be added. This package gives the possibility to include the login or/and sign-in to specific URL path. If this package is not installed, the bot cannot perform the first step of the automation activity which is the login to the Mitos system.

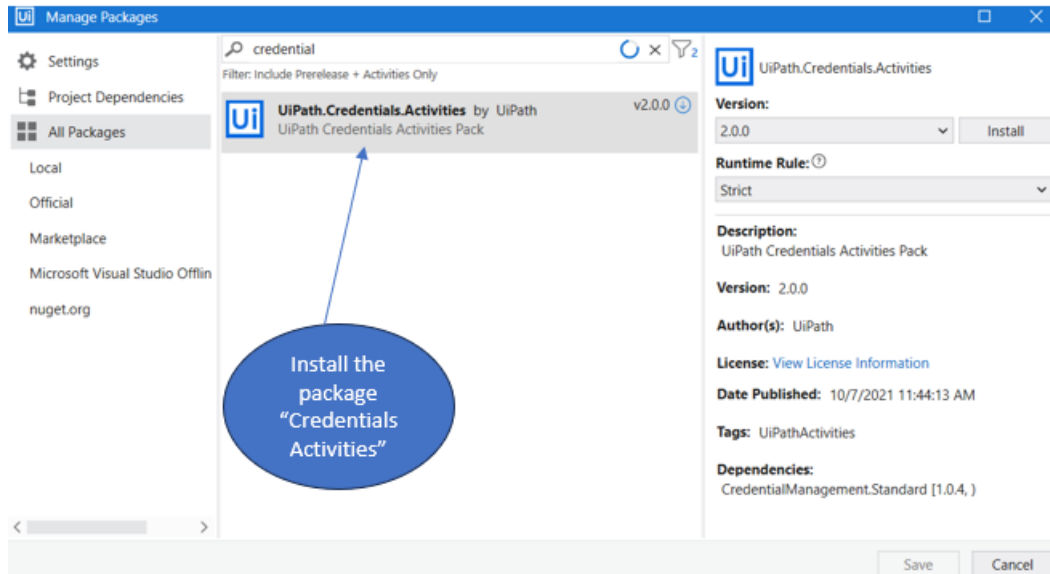


Figure 112. UiPath Studio package installation for the “credentials” activity

Once the package is installed, then the next step is to create an asset. The asset should be created in the UiPath Orchestrator. Assets are basically predefined variables that can be used to give the possibility to the bot to access to specific information. In the specific scenario the asset is going to be the credentials that the bot should use in order to login to Mitos system.

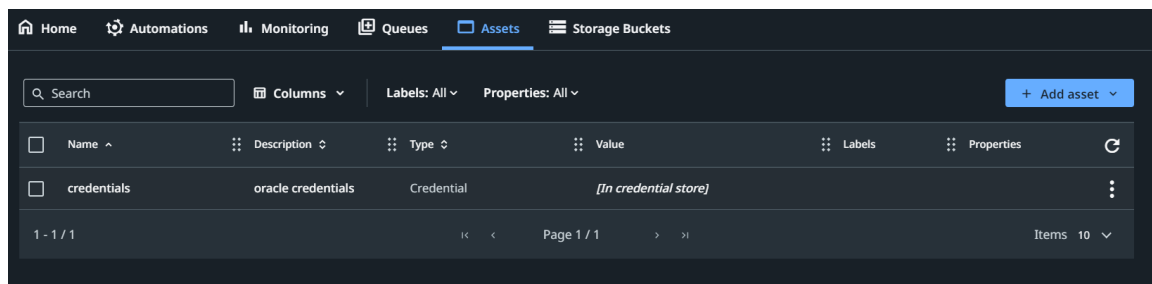


Figure 113. UiPath Orchestrator: Asset creation

Once the asset is created, the automation process can be built using the UiPath Studio app. The implementation of the specific automation process can be described as below:

1. Add the activity “Go to URL” in order to open the URL provided. The URL in this scenario is going to be the URL from Mitos with the path Mitos.gov -> Business Activity -> Staff Employment -> Electronic Submission of APD.

2. The activity “Get credentials” must be added in order to retrieve the credentials for the specific URL. The values for the credentials have been predefined on the asset.
3. The activity “Get File” must be added in order to retrieve the APD prepared file from a specific Cloud path.
4. The activity “Click” must be added to click on a specific UI element. The element in that case should be the button for upload the APD prepared file.
5. The activity “For Each” must be added in order to ensure that all the file will be chosen.
6. The activity “Click” must be added again in order to click on a specific UI element. The element in that case should be the button for the submission of the APD prepared file.

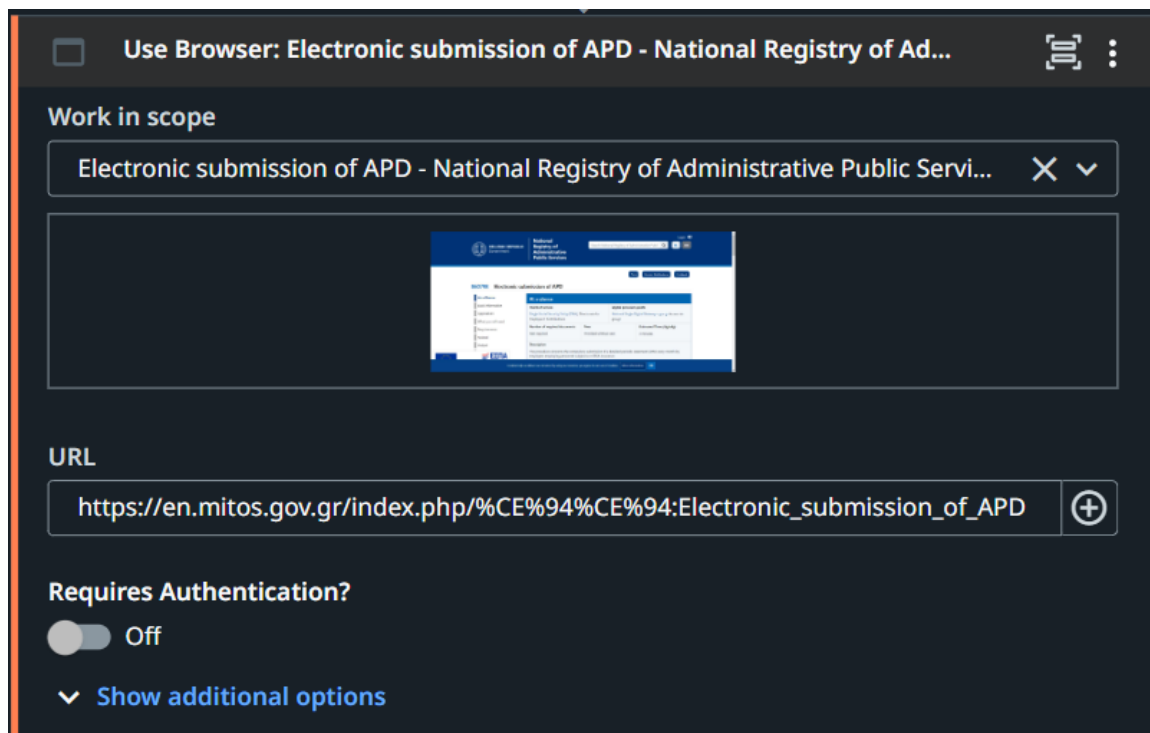
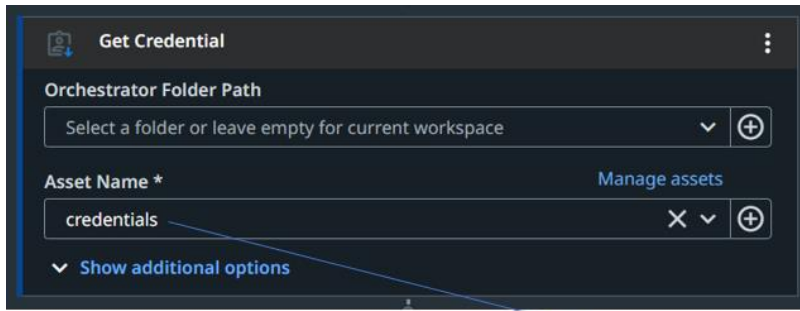


Figure 114. UiPath Studio: “Go to URL” activity



This is from the asset list that has been created earlier in UiPath orchestrator

Figure 115. UiPath Studio: "Get credentials" activity

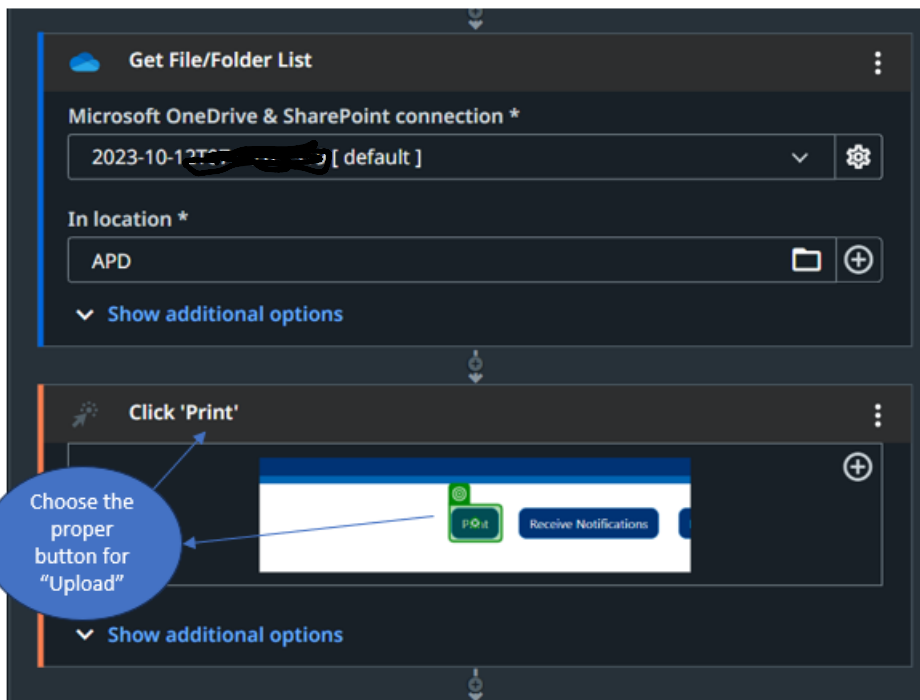


Figure 116. UiPath Studio: "Get File" and "Click" activities

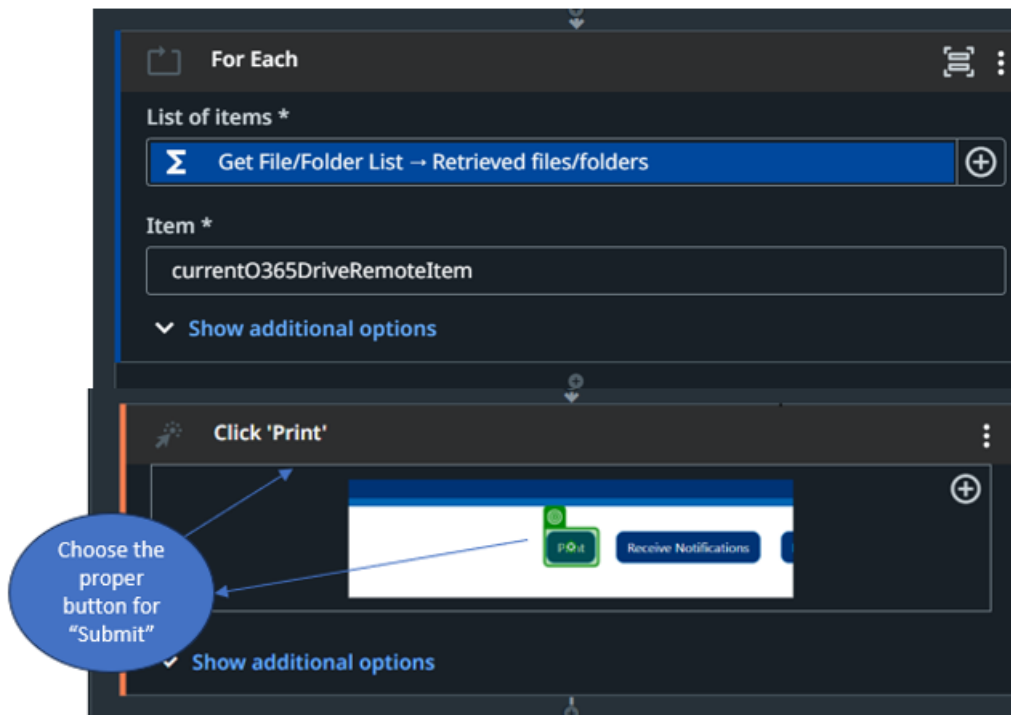


Figure 117. UiPath Studio: "For Each" and "Click" activities

6.4 Summary

On this chapter the Mitos.gov platform was described. Mitos is the official register of procedures of the Greek Public Sector and offers the possibility to sign-in to the platform, find necessary documents and/or implement different procedures. The procedure that was described on this chapter is from the category "Business Activity" with subcategory "Staff employment" and procedure name "Electronic submission of APD". For the particular case, an automation was suggested that was implemented without disturbing the normal process or the safety factor. This automation was the integration of Robotic Process Automation into the second option of the XOR gateway. In the second option, "Send file" method, a bot replaced not only the manual upload of the APD prepared file but also the log-in to system and the submission of the APD prepared file. Additionally, the overall modification of the as-is business process modeling using BPMN was described and the implementation of the automation to the to-be business process was presented using UiPath. Lastly, the benefits and the key considerations for the specific automation were also mentioned.

CHAPTER 7: Discussion and Conclusion

This chapter concludes the thesis, providing an overview of this research, highlighting the contribution to this research, the limitations and the future work that can push forward the research in the area of workflow automation. The chapter aims to provide the main findings and they key observations around the business process and decision automation, based on executable models combined with RPA tools.

7.1 Research Contributions

The overall contribution of this research is to analyze firstly the business process modeling and the associated semantic languages and modeling tools and deep-dive into the Business Process Modeling world. Additionally, the new era of Business Process Automation is described and the associated benefits that this new era can offer to businesses. Business Process Automation in combination with AI can provide a wide range of techniques and tools that businesses can take advantage of, such as Robotic Process Automation. The scope of the research focuses on identifying the ways to model and automate a business process, the capabilities of the existing tools, i.e., BPMN, DMN Forms, Connectors, UiPath, and the way to manage them. The ultimate aim concerns the automation of an end-to-end business process and the ways in place in order to link a business process model to an RPA tool. Additionally, this research aims to present practical examples, the challenges, the problems and the way to combine different tools and platforms in order to achieve a better automation and to monitor this automation. Ultimately, this research can contribute to the already existing academic work around the workflow automation, by providing not only the theoretical concepts behind it, but also by introducing a practical and real example of an invoice creation in the AP department of an organization and presents the ways to automate a workflow and to apply to the business process Robotic Process Automation tools. Considering the lack of practical examples of business processes within the literature, the existing literature on the subject is thoroughly examined in order to better identify the

meaning of RPA in relation to BPMN. Continuing, a variety of cases and scenarios are reviewed regarding the integration of RPA within business processes. In order to accomplish that there is the need to use a standard notation language which is BPMN and a decision model language which is DMN and all the end-to-end process is implemented using Camunda Modeler and Camunda's Platform tools. Furthermore, this thesis targets to explore the full potentials of BPA by combined RPA with BPMN capabilities and propose a methodology which can optimize a business process. When it comes to RPA there is a limit of academic research on theoretical and practical analysis. For this reason, the most common RPA tool has been used, UiPath. With the help of UiPath's tool, the bot integration into BPMN was achieved. As a last applied example, the "Electronic submission of APD" from Mitos platform was described and for the particular case, an automation was suggested that was implemented without disturbing the normal process or the safety factor and by bringing a variety of benefits into the procedure.

7.2 Research Limitations and Future Work

A limitation of the underlying research derives from the fact that real business processes have much more complicated procedures. There is no sufficient literature or training in order to combine all the tools that are mentioned in this thesis. For this reason, the business process in use is a simpler business process and doesn't include all the possible variables. However, considering the fact that real invoice creation process can be applied in the existing model but with some modifications, the ultimate aim is to present the way to achieve a better automation. Additionally, taking into account that BPMN is mainly introduced for modeling purposes within literature, the establishment of its execution semantics in end-to-end processes has yet to be highly adopted within academic works. Furthermore, since there is a plethora of opportunities and research challenges around BPA, the Robotic Process Automation (RPA) is just an example of the possible ways to implement an automation in the BPMN. Also, RPA has a lot of tools to take into consideration and can provide to the business process a high volume of automation.

7.3 Conclusion

In conclusion, this thesis presented the activity of modeling a business process by using graphical notation. In particular, for graphical notation BPMN was used. BPMN provides fundamentals and advanced elements to help businesses to illustrate and model their processes. BPMN has been established as a de facto modeling notation since provides a huge range of elements. Besides the standard modeling, a business process requires also decision model. For this reason, the DMN graphical notation was described. DMN model can provide an assistance and make less complex a BPMN diagram. DMN standard provides a two-level model for decisions: the decision requirements and the decision logic level. The Decision Requirements Diagram (DRD) models in a graphical and hierarchical way the decisions. The set of activities, tasks, events, decisions are illustrated with the use of Camunda Modeler. An introduction to Camunda Modeler, Camunda Platform 8 and all Camunda's tools and Camunda Platform's components were described in order to understand deeply how all these tools can be combined so that an entire complex business process can be presented as a model. Later, the Camunda Forms was described. The Camunda Form creation can be accomplished directly to Camunda Modeler or to Camunda Platform 8 by initiating a Form Project. Additionally, the Camunda Connectors were presented to explain the fact that Camunda Platform 8 is a process orchestrator for every endpoint, means that the connectivity is universal. Then, the possibility to connect Camunda Modeler BPMN models with databases by using Spring Boot was mentioned.

Besides the above, it was also described one of AI techniques which is Robotic Process Automation (RPA) which is a tool that allows businesses to replace manual low-value single tasks. Using RPA businesses can automate a high variety of manual and recurring tasks and can save time and decrease costs. The benefits that come with a process automation are plenty. Last but not least, this thesis referred to the way of how to include Robotic Process Automation using UiPath. UiPath is the lead vendor when it comes to business digital transformation and has provided a variety of RPA possibilities.

It is necessary to mention that a section was focused on the overview of a specific department, Account Payables. The case study was the invoice creation which is a

business process that is performed by Account Payables department and this case study was analyzed in order to understand how to apply BPMN and RPA. The example presented was the creation of the business process “Invoice creation” using BPMN. The end-to-end invoice creation was consisted of different types of activities and events in order to illustrate the usage of Camunda Modeler’s advanced tools. The approval tasks were the most important since the need for validation in such processes is high. Furthermore, the decisions were presented with the use of DMN and the related DRD. It was highlighted the meaning and the use of the DMN since the proper and valid implementation is a crucial part, otherwise, if the rules won’t be identified correctly, the entire flow can be affected since one wrong rule will drive to wrong calculation which means a wrong path. Additionally, the use of Camunda Forms and Camunda Connectors was presented within the example. In the business process it was also applied UiPath automation and provided the setup to automate the generation of an excel file and an automated message to a Slack channel. This can save time and effort specifically to the tasks that needed manual effort in order to extract, analyze and modify data or to communicate with different parties.

As a last applied example, the “Electronic submission of APD” from Mitos platform was described and for the particular case, an automation was suggested that was implemented without disturbing the normal process or the safety factor and by bringing a variety of benefits into the procedure.

Lastly, to summarize, the benefits that ensue from the automation can be that automation can save time and money, can improve data quality and accuracy, can ensure reliability without interruption and consistency since the manual errors or users’ neglects are decreased. Automation can also decrease the necessity of heavy coding and can minimize the diversion from the rules, but also can improve productivity and efficiency since the users are not occupied with low importance manual tasks. These can lead to growth in profits since the users are occupied with more important tasks and to improvement of the working environment since the users don’t deal with tedious work and routine tasks. The following 3-step framework provides a practical approach to get started:

1. Firstly, the bots should be managed centrally so that users can monitor them better and be able to detect any kind of misalignment and/or bug. This approach will give the opportunity to users to achieve better effectiveness, minimize losses and disruptions and ensure a long-term performance.
2. Secondly, it is better to use the process automation platform to implement the full business process including all RPA bots. This way each bot will be included in the end-to-end process with specific roles.
3. Lastly, by orchestrating the infrastructure based on the above, RPA bots will be replaced in long-term with micro-services that are accessible via API without changing the underlying process.

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Appendix A: Create Maven Project in Eclipse IDE

In order to create a maven project with Eclipse IDE, firstly in the maven archetype catalog, the Camunda catalog file must be added which contains a huge library of dependencies:

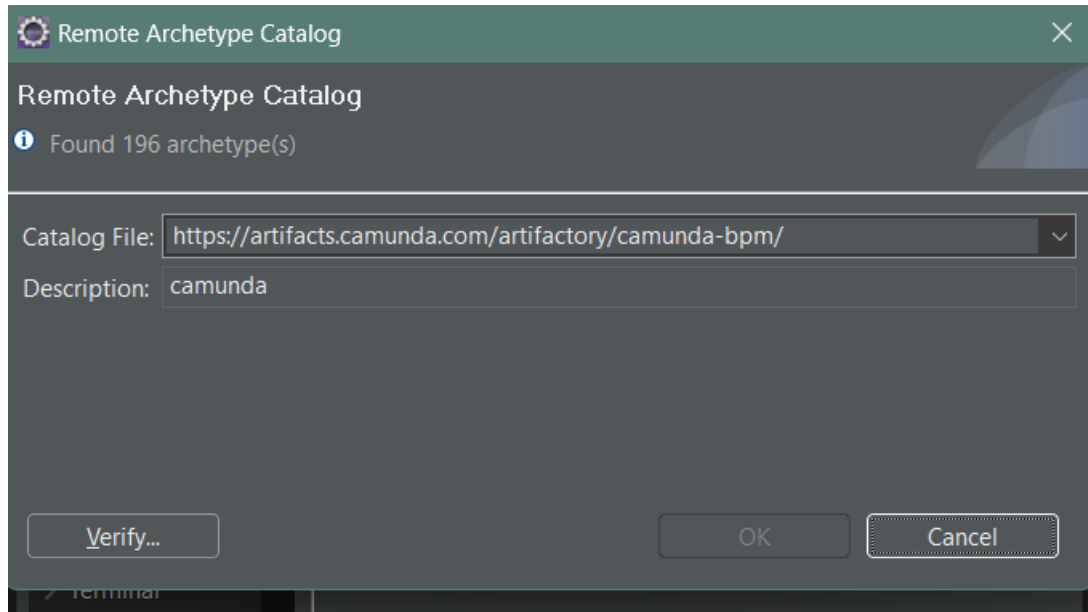


Figure 118. Add remote Archetype Catalog

Then, a new maven project must be initiated with the corresponding Artifact ID which contains all the necessary dependencies for a Spring Boot application:

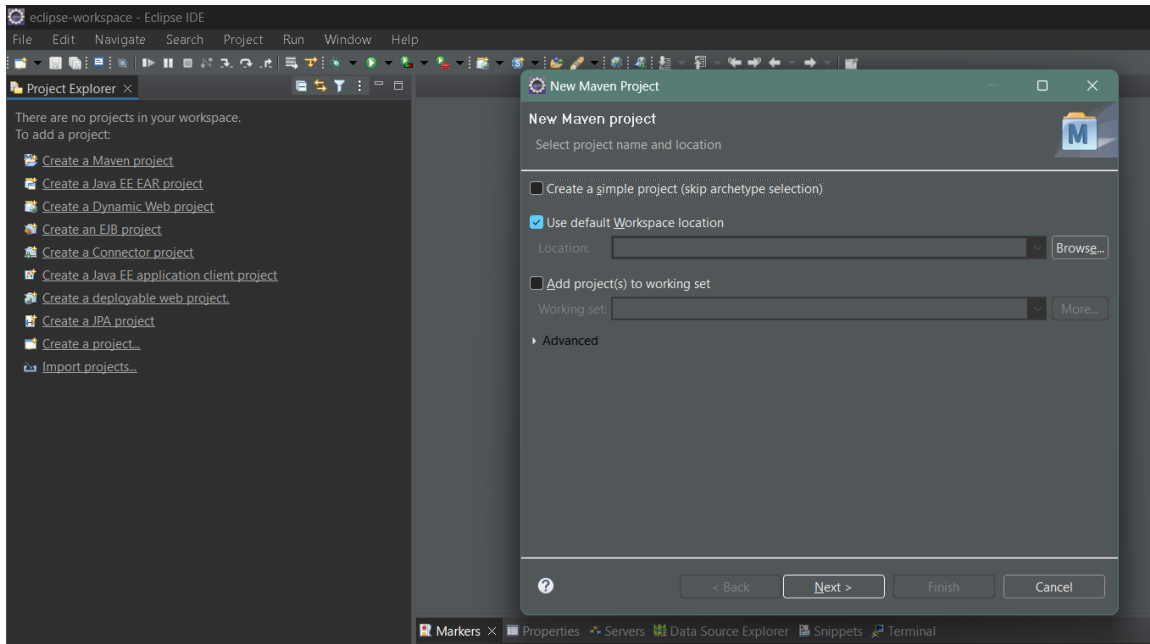


Figure 119. Create new Maven Project

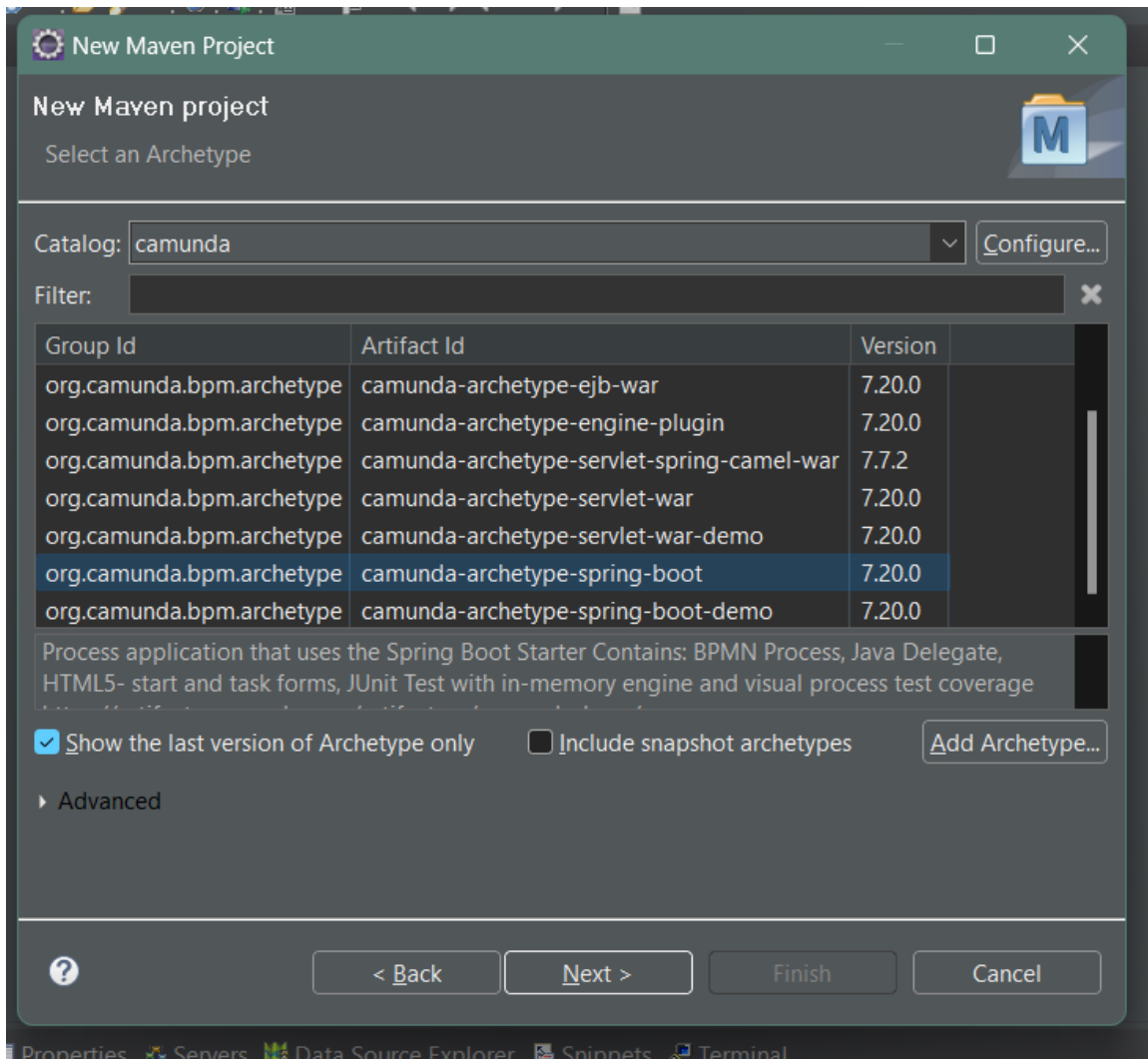


Figure 120. Choose the Artifact ID for Spring Boot

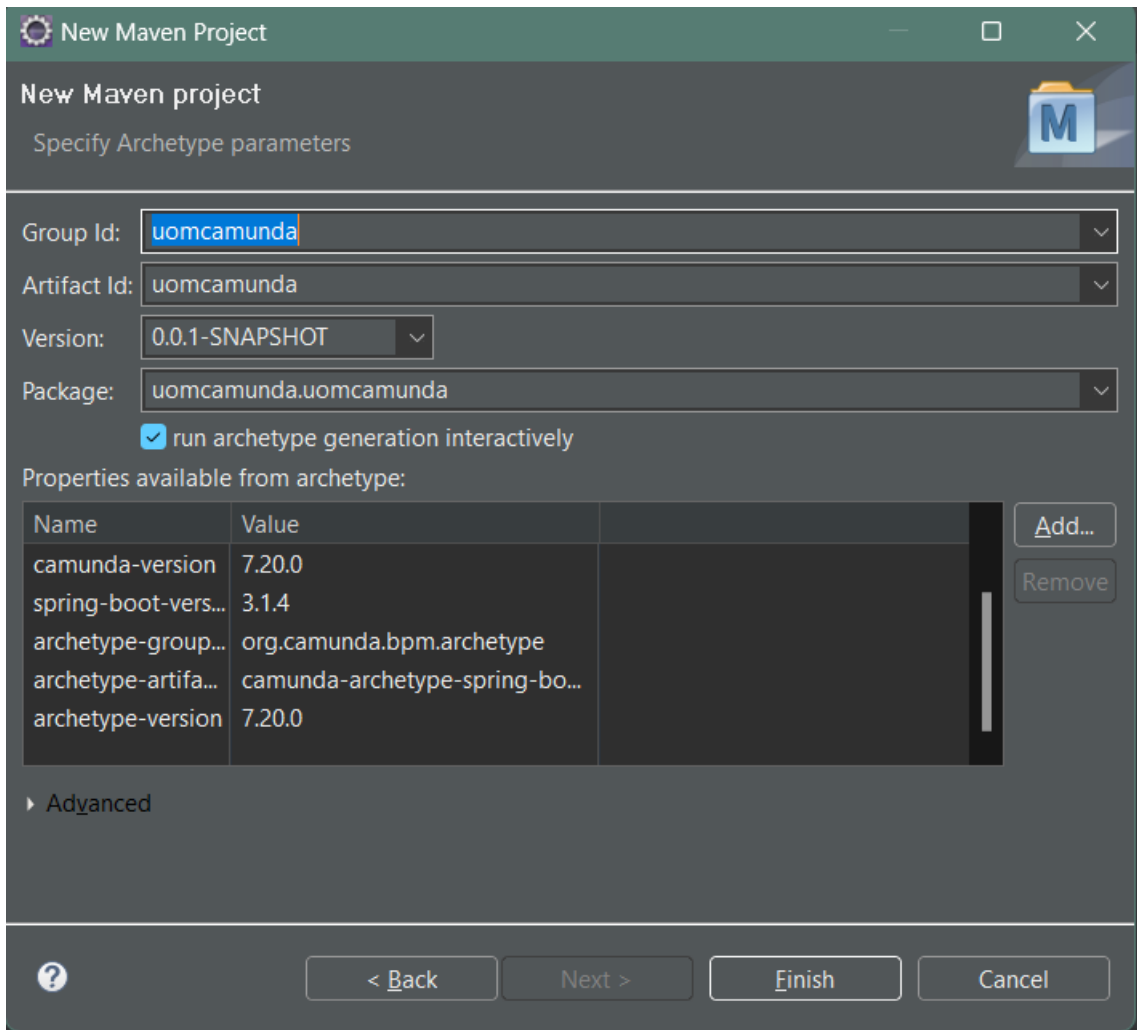


Figure 121. Name the maven project

Once the setup is completed a new project is automatically created in the Project Explorer area:

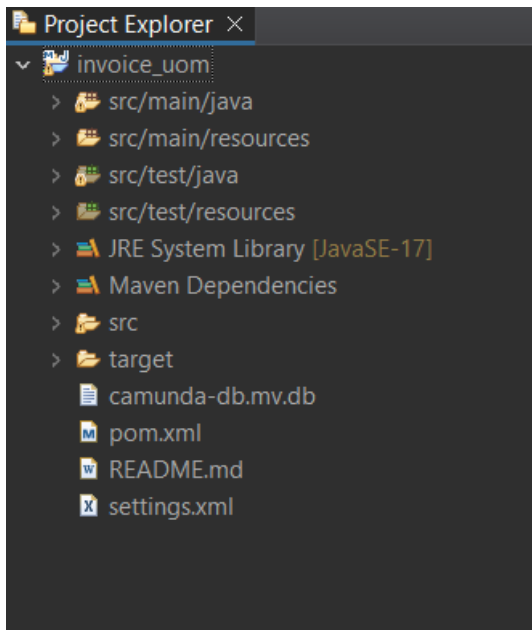


Figure 122. Go to the Project Explorer

Appendix B: Connect the UiPath Studio with UiPath Orchestrator

Firstly, sign in to UiPath Orchestrator. Create a folder and then a machine in UiPath Orchestrator. Then create a Robot. Each time a Robot is registered to Orchestrator, a Robot user is automatically created and is assigned the Robot role. In the Machine Key field, enter the key received from the user who created the Robot in Orchestrator. In the Orchestrator URL field, enter Orchestrator's address.

Then, assign the machine name and the orchestrator URL in the UiPath Assist and connect.

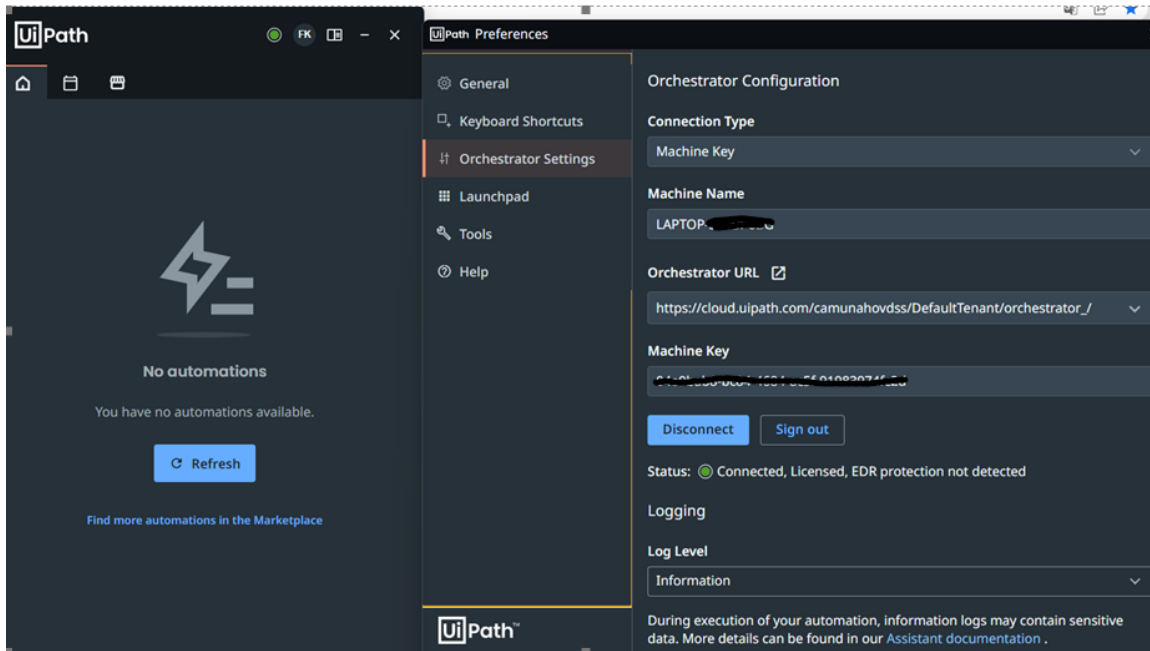


Figure 123. UiPath assistant

Finally, ensure that in the UiPath Studio the location folder will include the correct URL.

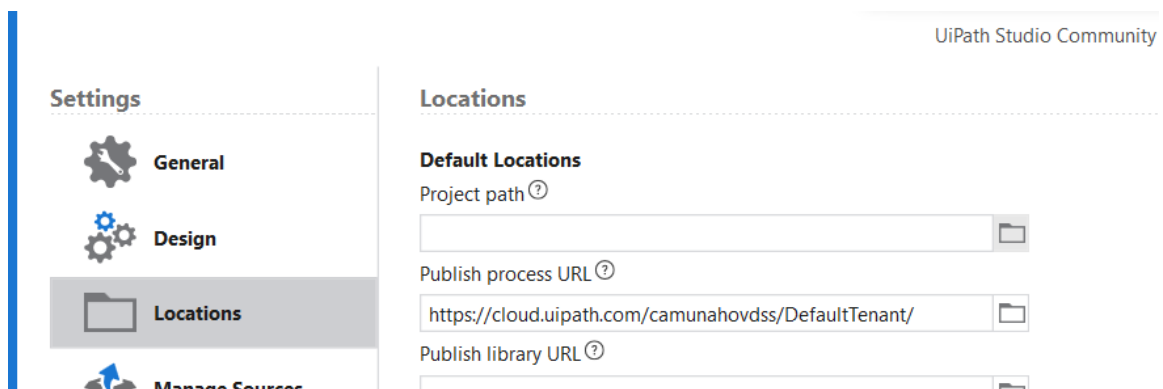


Figure 124. UiPath studio locations

Once the process is created, at the bottom of the page the folder will be activated and it is linked to the UiPath Orchestrator.

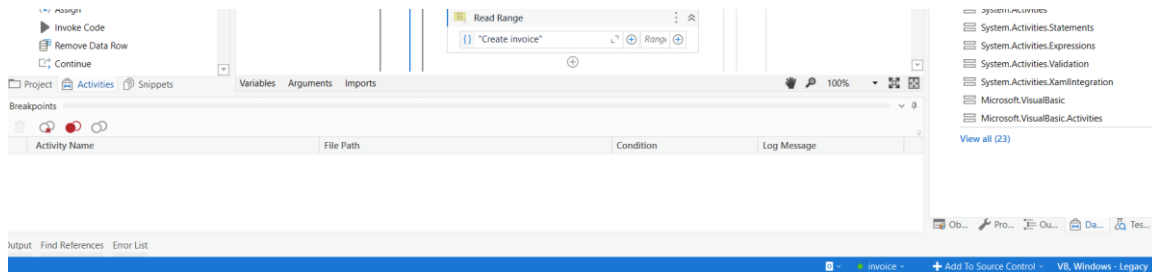


Figure 125. UiPath studio connection

Appendix C: Connect a Database to Camunda using MySQL Workbench 8.0 CE

In order to setup a Spring Boot Project, firstly it is required to setup a Spring Boot application as an Apache Maven Project inside Eclipse. This consists of three steps: [23]

- Create a new Maven Project in Eclipse
- Add the Camunda & Spring Boot dependencies
- Add a main class as an entry point for launching the Spring Boot application.

The screenshot below illustrates the settings of the Eclipse:

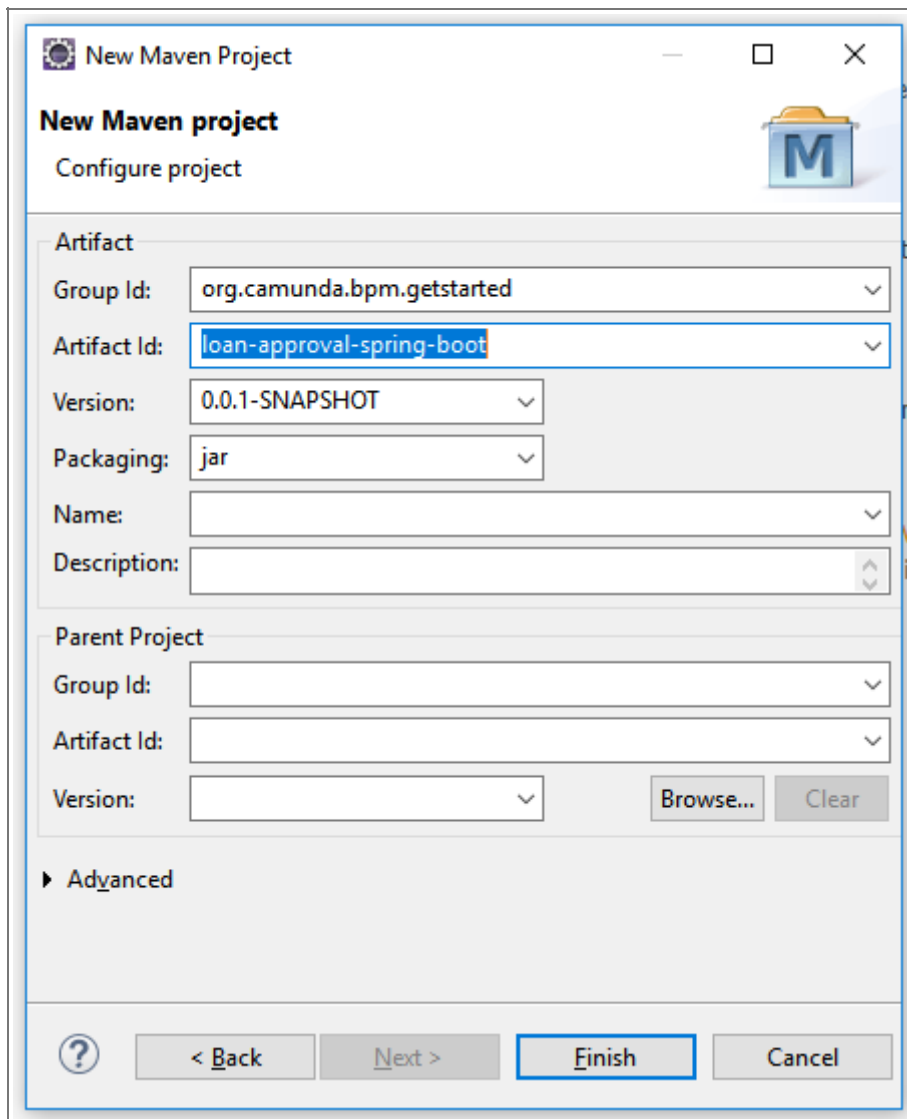


Figure 126. Maven project

The next step consists of setting up the Maven dependencies for the new project. Maven dependencies need to be added to the pom.xml file of the project. The Spring Boot BOM must be added in the “dependency management” section and the Camunda Spring Boot Starter for Webapps, which will automatically include the Camunda engine and webapps in the app. The spring-boot-maven-plugin is also used.

```
<project xmlns="http://maven.apache.org/POM/4.0.0"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xsi:schemaLocation="http://maven.apache.org/POM/4.0.0
http://maven.apache.org/xsd/maven-4.0.0.xsd">
```



```

<modelVersion>4.0.0</modelVersion>
<groupId>org.camunda.bpm.getstarted</groupId>
<artifactId>loan-approval-spring-boot</artifactId>
<version>0.0.1-SNAPSHOT</version>

<properties>
  <camunda.spring-boot.version>7.17.0</camunda.spring-boot.version>
  <spring-boot.version>2.6.6</spring-boot.version>
  <maven.compiler.source>1.8</maven.compiler.source>
  <maven.compiler.target>1.8</maven.compiler.target>
</properties>

<dependencyManagement>
  <dependencies>
    <dependency>
      <groupId>org.springframework.boot</groupId>
      <artifactId>spring-boot-dependencies</artifactId>
      <version>${spring-boot.version}</version>
      <type>pom</type>
      <scope>import</scope>
    </dependency>
  </dependencies>
</dependencyManagement>

<dependencies>
  <dependency>
    <groupId>org.camunda.bpm.springboot</groupId>
    <artifactId>camunda-bpm-spring-boot-starter-webapp</artifactId>
    <version>${camunda.spring-boot.version}</version>
  </dependency>
  <dependency>
    <groupId>com.h2database</groupId>
    <artifactId>h2</artifactId>
  </dependency>

```

```

<dependency>
  <groupId>com.sun.xml.bind</groupId>
  <artifactId>jaxb-impl</artifactId>
  <version>2.3.5</version>
</dependency>
</dependencies>

<build>
  <plugins>
    <plugin>
      <groupId>org.springframework.boot</groupId>
      <artifactId>spring-boot-maven-plugin</artifactId>
      <version>${spring-boot.version}</version>
      <configuration>
        <layout>ZIP</layout>
      </configuration>
      <executions>
        <execution>
          <goals>
            <goal>repackage</goal>
          </goals>
        </execution>
      </executions>
    </plugin>
  </plugins>
</build>

</project>

```

Next, an application class with a main method that will be the entry point for launching the Spring Boot application must be added. The class has the annotation `@SpringBootApplication` on it, which implicitly adds several convenient features.

```
package org.camunda.bpm.getstarted.loanapproval;

import org.springframework.boot.SpringApplication;
import org.springframework.boot.autoconfigure.SpringBootApplication;

@SpringBootApplication
public class WebappExampleProcessApplication {
    public static void main(String... args) {

        SpringApplication.run(WebappExampleProcessApplication.class,
args);
    }
}
```

Then, the first build can be performed. As a result of the build, a JAR-file in the target folder will be created. This JAR is a Spring Boot application, which embeds inside Tomcat as a web container, Camunda engine and Camunda Web applications resources. When started, it will use an in-memory H2 database for Camunda Engine needs. The application can be run by right-clicking on the `WebappExampleProcessApplication` class and selecting Run as/Java application. A similar line will be initiated in the console:

```
Started WebappExampleProcessApplication in 10.584 seconds
```

Finally, the `http://localhost:8080/` must be initiated in the browser.

Another way to run the app is to simply run the JAR-file with a `java -jar` command.