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# Method to Foster Intelligent Processes Automation into an Organization

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Dissertation presented as a partial requirement for the degree of Master of Information Management

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by

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# ABSTRACT

*The present dissertation introduces a framework for process automation with the purpose of making them intelligent, in order to increase consistency, optimize execution-time and free workers from low value-added tasks.*

*Foster Intelligent Processes Automation into an Organization is a topic that remains underdeveloped today. Being a relatively recent topic, intelligent process automation may be known as an extension of automated processes "on steroids".*

*The main objective of this project is to propose a method to find and promote Intelligent Automation to a target process, providing a walkthrough guideline, so organizations can identify, assess, and design a process of converting current processes into intelligent automated processes.*

*In order to evaluate the proposed framework, a case study is presented, and a set of interviews was carried out with two groups: an academic group and a group of agents who manage processes in an organization.*

# KEYWORDS

Automation; Workflow; Robotic Process Automation; Artificial Intelligence; Intelligent Process Automation; Cognitive Technology

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# 1 INTRODUCTION

## 1.1 Framework

Nowadays, we can see a high technological evolution, as well as the presence of information systems in today's organization, has increased significantly. Therefore, for a long time, almost 50 percent of organizations' capital investment has been in information technology (Westland & Clark, 1999). Indeed, the market for business process development is expected to further grow from an estimated USD 8.8 thousand million in 2020 to USD 14.4 thousand million by 2025 (Markets & Markets, 2020).

The constant evolution of ITs and the emergence of new products and opportunities (Vedder & Guynes, 2016), along with the investment in technology leads to organizational changes. When changes are introduced in an organization, it yields an array of reactions due to the inherent uncertainty or to the motivations that alter human behavioural patterns. The resistance occurs because it threatens the status quo or increases fear and the anxiety of real or imagined consequences, including threats to personal security and confidence in an ability to perform (Ford, Ford, & McNamara, 2002).

If organizations weren't continually adapting to changes, their performance could not be effective or improved. Nevertheless, owing to a growing increase in products and services for organizations, change is increasingly vital (Rieley & Clarkson, 2001).

For employees to become more effective, productive and improve their performance when implementing new processes, the creation of processes and routines is essential (Luecke, 2003).

These end up becoming workflows that once automated, organizations can start to make the most of it, since productivity, efficiency, and reliability are the research area of automation (Goldberg, 2012).

According to Workflow Management Coalition, a workflow is an automation of a business process to exchange information, tasks or files between participants, according to a set of rules (Workflow Management Coalition, 1999).

In organizations, nor all the business processes are automated, and to address the repetitive and often tedious tasks that require low mental effort, companies have included in their portfolios Workflow Automation and Robotic Process Automation (RPA) technologies (Forrester Research Inc., 2014; Leopold, van der Aa & Reijers, 2018).

RPA is a software-based solution (Willcocks, Lacity, & Craig, 2015) and when applied in business activities, for instance, it is able to support the collecting and pre-processing of information (Hofmann, Samp, & Urbach, 2020), such as processing sales and financial transactions, managing data, communicating between different systems, and access management, as well as monitoring and reporting (Seasongood, 2017). In addition to this matter, and according to Deloitte University Press publication, "by interacting with applications just as a human

being would, software robots can open email attachments, complete e-forms, record and re-key data, and perform other tasks that mimic human action" (Schatsky, Muraskin, & Iyengar, 2016).

Most RPA systems can only perform automation within predefined procedures which are rule-based, not ready for exception handling, and programmed in advance. (Aguirre & Rodriguez, 2017). While Ernst & Young suggests that 30 to 50 percent of RPA projects initially fail not only due to common mistakes of implementation and ongoing support (Lamberton, 2016) but also because of technical limitations with this technology. Usually, it interacts with user interfaces (UI) and a minor change to those interfaces can lead to broken processes, since RPA cannot auto-adjust their behaviour the same way a human being would. RPA works best when it is necessary to automate repetitive screen tasks, but it is not suitable for complex end-to-end business process automation that with the ongoing environmental changes must be adapted (Khalaf, 2017; Murphy, 2018).

By integrating RPA with cognitive technologies, it is enabled the possibility to judge or provide perception within automated processes. By adding natural language processing, speech recognition and computer vision technology, the information can be automatically extracted from documents to the following step in the process (Schatsky et al., 2016).

Having said that, people are still responsible for the correct functionality of processes, evaluate if its results are according to the business needs, therefore, with a correct implementation of RPA, human workers would be focused on the evaluation of results and dedicate their time to innovation and creative thinking (Lacity & Willcocks, 2016; Willcocks & Craig, 2015), i.e., by automating tasks, workers would be freer to engage in higher-value tasks involving reasoning, creativity, or interpersonal skill. As Don Norman stated, in an article from 2017: "We need to think less about human-machine interfaces and more about human-machine teamwork... The human mind is far more powerful when coupled with the smart tool" (Norman, 2017).

Despite the enormous evolution of technology and computational power, human beings still have better performance than machines in solving difficult computational problems, including concept learning, scene understanding, language acquisition, language understanding, speech recognition, and so on. Furthermore, there are other human cognitive skills that remained a challenge to understand computationally, such as creativity, common sense, and general-purpose reasoning. Machines today are not yet capable of being totally creative and, therefore, this should be the way to which human beings should apply their daily efforts (Lake et al., 2017).

Current RPA technology still has its own limitations with unstructured data/ processes and with ever-changing processes and use cases, requiring continuous configuration/ customization of the business rules. In order to address and overcome the limitations of RPA, artificial intelligence (AI), in particular, machine learning, by being able to learn based on historical decisions that were made, decide quickly which decision should be taken, making less necessary the human hand in the loop so improving efficiency and costs in processes (Devarajan, 2019).

## 1.2 Motivation/ Justification

There is no clear idea how AI, in particular, machine learning technology can be conjugated with automation systems, how organizations can make the most of this connection so that it becomes a symbiosis between RPA and Machine Learning. There are many theories on how to apply machine learning in RPAs, which in fact gave rise to different concepts as Cognitive RPA, Intelligent RPA or Autonomous RPA (Gupta, Rani & Dixit, 2019).

Therefore, some of the principal research and advisory companies suggest this new sophistication of automation where the automation has the ability to discover, analyse, design, automate, measure and monitor will provide a new level of automation, an Intelligent Automation.

It is the overall umbrella of technologies that by leveraging the combination of RPA and AI will enable the transformation and automation of business processes (International, 2019).


*Figure 1 – Intelligent Automation adapted from Anywhere (n.d.).*

#### *1.2.1.1 Hyperautomation by Gartner*

According to Gartner, "Hyperautomation deals with the application of advanced technologies, including artificial intelligence (AI) and machine learning (ML), to increasingly automate processes and augment human beings. Hyperautomation extends across a range of tools that can be automated, but also refers to the sophistication of the automation (i.e., discover, measure, monitor, reassess)" (Panetta, 2019).

It has the goal of increasing AI-driven decision making by involving a set of technologies as RPA, intelligent business management software (iBPMS) and AI.

#### *1.2.1.2 Hyperautomation by Deloitte*

A report from Deloitte also defines this new level of automation – "Hyperautomation refers to a combination of complementary sets of tools that can integrate functional and process silos to automate and augment business processes. Hyperautomation brings together several components of process automation, integrating tools and technologies that amplify the overall ability to automate business processes. It starts with RPA at its core and expands the automation horizon with AI, process mining, analytics, and other advanced tools" (Agrawal, 2020).

#### *1.2.1.3 IDC – Intelligent Process Automation*

Augmenting human beings' capacities using technology has revealed many challenges, not only emerged from business changes and technological limitations, but also related to the practice of planning, designing, and implementing an enterprise analysis (Lacity & Willcocks, 2016; Lamberton, 2016).

## 1.3 Objectives

Having the motivations set, it was defined the research goal: to propose a method to foster Intelligent Processes Automation into an organization.

In order to achieve this goal, the following intermediate objectives were defined:

- Study the main workflow and process automation technologies available.
- Identify the most important enterprises areas and processes that are suitable to be automated.
- Build a method for finding and promoting Intelligent Automation to organizations.
- Validate the purposed method.

# 2 LITERATURE REVIEW

Before starting to introduce the problem behind this study, there was the need for a theoretical background to understand how process automation concepts evolved until current days. To investigate the works that had already been done on this topic and what kind of concepts are needed to explore how to identify intelligent automation processes and implement it in organizations.

To be more familiar with all these concepts, we started by studying a bit further the main topics behind this master's thesis.

## 2.1 Workflow automation concepts

This research starts by introducing the basic concepts of workflow, based on the Workflow Management Coalition (Workflow Management Coalition, 1999). Many authors and workflow vendors use their own terminology, the following definitions are fairly standard.

A business process is a sequence of activities, with distinct inputs and outputs, serving a significant purpose within an organization or between organizations.

An activity is a discrete process step, consisting of one or more tasks, executed either by a machine or a human agent.

From a wide perspective and according to the Workflow Management Coalition, a workflow is "the automation of a business process, in whole or part, during which documents, information or tasks are passed from one participant to another for action, according to a set of procedural rules" (Workflow Management Coalition, 1999). It is a defined and repeatable pattern or systematic organization of activities designed to achieve a certain transformation of data (Talia, 2013).

Actually, the concept of workflow exists since industrialization, typically separating work activities into well-defined tasks, roles, rules, and procedures that regulate most of the work in manufacturing and the office. Usually, business process management is referred as a specification of a process, software that complements and automates a process, or software that supports the coordination and collaboration of people that implement a process (Georgakopoulos, Hornick & Sheth, 1995).

Some vendors that produce workflow products defines:

- Monday says that "a workflow is simply the set series of tasks or actions required to get things done, the literal flow of the work" (Berger, 2019).
- Pipefy defines workflow as "an organized series of tasks that must be completed in order to achieve a specific goal" (Pipefy, 2018).
- Processmaker applies the same definition of Workflow Management Coalition, "the flow of a process in an organization, during which documents, information or tasks are passed from one participant to

another for action, according to a set of procedural rules. Participants in the process can be either a human being, machines or computer systems." (Processmaker, n.d.; Workflow Management Coalition, 1999).

Workflow is a concept committed to reengineer and automate business and information processes in an organization, able to capture information process tasks at a level that describes the process requirements for information system functionality and human skills. In different circumstances, to understand, evaluate and redesign business processes, it may describe tasks at a conceptual level. The workflow term is also often used to describe both perspective of the business and information systems perspectives (Georgakopoulos et al., 1995).

Whereas workflow refers in a generic way to multiple related processes, workflow automation is characterized as a set of rules that are required to achieve a particular objective, provided to certain software to be able to automatically route tasks through the process to each subsequent step, all the way to the completion of that goal, so that no one needs to do them manually in a first place.

### 2.1.1 Workflow automation history

According to Michael Lim, a Program Director in IBM, the history of workflow can be briefly stated in three stages, (i) early 1990s, when the earliest workflow automation software solutions emerged, based on workflow engines. With this, software solutions companies enabled the replacement of paper-based tasks routing activities with automated electronic-form processes, (ii) late 1990s, when the describing of business processes, analyses, modelling were enhanced due to the forthcoming of new features in modelling tools and (iii) after 2005, with the introduction of business process management (BPM) methodology and tools (Lim, 2018).

Although the primary developments been during the 1990s, the term Robotic Process Automation (RPA) only emerged in the early 2000s, with the same aim of workflow automation – removing manual and repetitive work.

From the first version of RPA – RPA 1.0 or Assisted RPA – until the current sophistication of automation, able to discover, analyse, design, automate, measure and monitor, the concept has been evolving alongside technology as illustrated in Figure 2 and explained in more detail in Chapter 2.3.

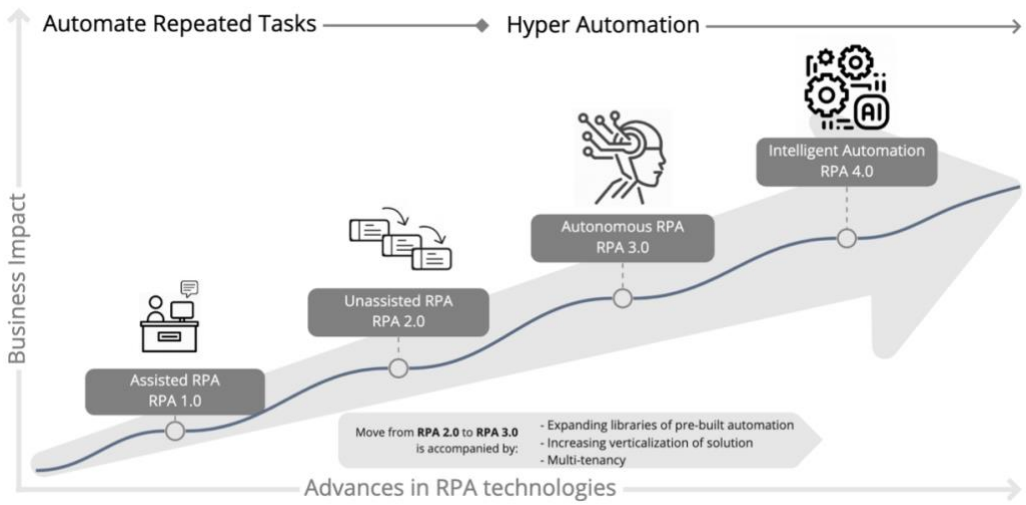


*Figure 2 – Automation Process Evolution,*

*adapted from [https://rpaconferences.com/assets/pdfs/Tejus-Venkatesh.pdf](https://rpaconferences.com/assets/pdfs/Tejus-Venkatesh.pdf).*

## 2.2 Process Intelligence

### 2.2.1 Concepts

In order to achieve this new level of sophistication of automation where it is possible to discover, analyse, design, automate, measure and monitor autonomously, there are three key technologies that must be aligned and implemented in an interconnected manner within organizations:

- Business Process Management.
- Robotic Process Automation.
- Artificial Intelligence.

Having all the above technologies in place working seamlessly in organizations, this research will refer to this new level of automation as Intelligent Process Automation (IPA), as IDC supports, taking into account that there are other terms used by entities such as "Hyper Automation" by Gartner which however refer to this same level of technology. Gartner's goes further in this definition stating that "anything that can be automated in an organization should be automated".

### 2.2.2 Challenges

During this research development, it was identified some barriers that Intelligent Automations faces when being implemented, mostly related to workers' mindset, and understanding of how useful and powerful intelligent automation can be by augmenting their capacities, lack of leadership, technology, and operating model through to data and how to address with automation each business process.

According to a KPMG report (International, 2019), the resistance comes from the workforce as well as from managers who may naturally resist and feel threatened by the change, where their positions can be replaced

by robots resulting in job loss, change in positions or unknown operating models, usually due to the lack of change management strategies and plans that are typically inadequate. There must be a concern about employees' impact and someone accountable for driving the agenda to get positive feedback promoting a unifying leadership.

Another challenge while implementing IA solutions is the uncoordinated and unintegrated effort applied when implementing this technology across the organizations, resulting from the lack of knowledge or incorrect effort prioritization.

Being machine learning and artificial intelligence new technologies, organizations usually don't have adequate skilled employees or resources to undertake IPA efforts and management, therefore, they must be realistic about what resources should be leveraged via outsourcing.

The lack of budget, assigned to the acquisition of skilled resources or infrastructure to support IPA, and lack orchestrated approach together with unclear business objectives is also a challenge for organizations, leading to more scaling up difficulties on the implementation of IPA technologies across departments and business functions.

To understand why most businesses are not taking full advantage of IPA and its return are not being so great as expected is usually associated with three key factors, as mentioned in KPGM report: (i) who is in charge of leading the initiative, (ii) how integrated IPA is within the business, (iii) and how best practices are picked up and learned (International, 2019).

In this same document and as stated by Anoop Aggarwal, Vice President, Finance, Digital & Staff Officer at Mars Global, it is, in fact, possible to implement a successful IPA technology when everyone adopts it and accepts – "We have been able to achieve scale by cultivating strong understanding with senior leadership. We did this by kicking off our IA journey with an immersion program that addressed what transformation would mean in finance in terms of human beings, technology, culture and business. We worked through this for six months and included senior leadership. Our finance group is way ahead of groups that did not do this. Scale comes from adoption and acceptance".

This statement confirms Accenture's "fundamental shift" idea, wherein this new era of human-machine collaboration, automation should be handled as a cultural change that brings people, process, and technology together to build a sustainable enterprise model (Accenture, 2019).

Accenture has also identified five principles that must be embraced to implement a successful IPA project referred to as MELDS – Mindset, Experimentation, Leadership, Data, and Skills:

1. Reimagine what is possible by adapting the mindset.
2. Experiment and compare results – Champion experimentation.
3. The leader must be active on setting strategy and goals.
4. Data must be specific, selected as part of artificial intelligence strategy.

5. Increased employee responsibilities stimulate skills development.

## 2.3 Business Process Management

### 2.3.1 Concepts

Since the core of businesses are processes, business process management refers to get the work done. Being present in every department and teams, processes are key factor to the outcome of operations, since it defines the flow of tasks and activities that guides each business function. However, developing and ensuring that these pathways are followed is not always easy, requiring time, resources and planning, being this the role of BPM.

BPM is defined as "*a body of methods, techniques and tools to discover, analyze, redesign, execute and monitor business processes"* (Dumas et al., 2013). With this definition, we can say that it is a methodology that can help companies and business improving their processes and if executed in the correct way, it will lead to a continual improvement.

BPM is often misunderstood as workflow automation, yet it considers the end-to-end process and is focused on achieving goals, such as increased efficiency or process improvement.

### 2.3.2 Benefits

Combining practices centred on driving organizational value through a process-improvement culture, by adhering to BPM, means that there are several benefits that companies can take advantage of, as simple as quickly start to get their processes defined, that provides an easier way of looking into areas with gaps available to be improved, along with other benefits such as:

- Cost efficiency – By removing bottlenecks, reducing duplicative efforts and streamlining operations and collaborations.
- Increased productivity and agility – By having an overview of the entire workflows, reusing stages, customizing them or eliminating redundant steps, enables processes to become more responsible, providing insights into the effects that process modifications have and reducing waste.
- Employee satisfaction – With BPM repetitive work is mitigated and information is made available for everyone, resulting in happier workforce and increased productivity.
- Customer focus – By compressing and removing repetitiveness tasks, employees can focus their time in customer relationship and in activities that provides more value to business and customer.

### 2.3.3 Lifecycle

The lifecycle of business processes consists in many phases, each one with its own methods, techniques and tools, operating in a continuous cycle. We will be referring to the lifecycle proposed by the book *Fundamentals of Business Process Management* (Dumas et al., 2013).

As illustrated on Figure 3, the business process lifecycle phases are process identification, process discovery, process analysis, process redesign, process implementation and process monitoring and controlling (Dumas et al., 2013). We will not go into in-depth detail for each of the phases, rather we will do a brief explanation of each one and its relevance in the lifecycle, since process implementation phase and the monitoring and control phase will not be analysed in the context of this research.

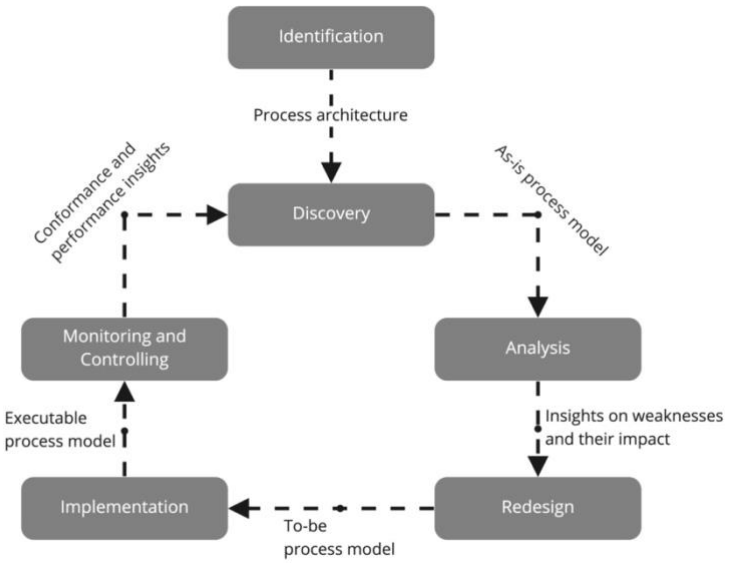


*Figure 3 – BPM lifecycle adapted from Dumas et al. (2013).*

#### *2.3.3.1 Process identification*

In this phase is raised a business problem, where the processes relevant to the problem that is being addressed are identified, delimited and related. As outcome it is expected a process architecture that provides an overview of the relationship between processes within the organization.

#### *2.3.3.2 Process discovery*

Defined by being the phase where the as-is process model is built, each process relevant to the businesss problem is documented.

#### *2.3.3.3 Process analysis*

The purpose of this phase is to collect a structured list of issues related to the as-is process. They are typically prioritized according to the impact they have and also to the estimated effort required to solve it.

#### *2.3.3.4 Process redesign*

Finding the changes that can be applied to solve the issues identified in the previous phase is the goal of this phase. Multiple options to address the issues are analysed and compared using performance measures.

Used as the base of implementation phase, the outcome of process redesign is typically a to-be process model.

#### *2.3.3.5 Process implementation*

The execution of the change is made at this phase, where changes of moving from as-is to a to-be model are prepared and performed. It must cover two principal aspects, organizational change management, and process automation. The first aspect refers to the activities required to adapt the participants involved in the process with the new model. On the other hand, process automation refers to the set of activities on the IT side regarding systems development and deployment.

#### *2.3.3.6 Process monitoring and controlling*

Tracking the process is a key factor to determine how well is the process performing. Collecting relevant data from the process allows to find bottlenecks and flag areas that are underperforming and then apply corrective actions. The cycle must be repeated on a continuous basis as new issues may arise in the same or in other processes.

## 2.4 Process automation technologies

### 2.4.1 Robotic Process Automation

During the last years we have been assisting to an increasing interest in Information Systems, to control and monitor business processes. As stated in a paper by Stoilova and Stoilov, “to implement automation in the business processes it is necessary to apply modeling techniques for the non-technical, organizational systems”. Therefore, some information systems, software, were developed to treat specific areas as Enterprise Resource Planning (ERP), Customer Relationship Management (CRM), and Workflow Management (Stoilova & Stoilov, 2004).

In organizations, in order to execute business processes, workers spent their time dealing with ERP, CRM, spreadsheet, and legacy systems in manual repetitive tasks as copy and pasting, extracting, and merging data from documents or between systems.

Considering a process based on these structured, routine, and manual tasks, it is evident that when adding a robot in replacement of the knowledge worker from executing it, this last would be able to focus his time on value-added tasks. This is the purpose of Robotic Process Automation (RPA) which aims to automate tasks on a rules-based business process (Aguirre and Rodriguez, 2017).

As defined by Suri, “the concept of using a software platform of virtual robots to manipulate existing application software in the same way that a human being does to a process or transaction” (Suri, Elia, & van Hillegersberg, 2017), meaning that RPA is using software robots to replicate step-by-step repetitive tasks that

would be performed by human beings, whereas the case of Telefónica O2, each robot is assign to one software license (Lacity, Willcocks, & Craig, 2015).

Human beings do not interact on just one system, they interact with multiple systems and for RPA be able to perform such tasks in various systems graphical user interfaces (GUI) are used (Cewe, Koch, & Mertens, 2018). In this way, the robots can interact with the systems front-end as human beings would do.

Since companies have increasingly adopted RPA and collecting its benefits, to have a successful RPA implementation, companies must establish guidelines. This is the main challenge, to identify business processes suitable for RPA automation (Leopold et al., 2018).

Once the business processes are well-defined, organizations became more able to comprehend how can they start to take advantage of RPA.

Forrest reinforces that while BPM has a legacy with long and complex implementations with unclear business cases (Le Clair, 2017), on the other hand, RPA aims the opposite, with quick wins and low investments.

Beyond cost reduction, according to Deloitte, by adhering to RPA, organizations benefit in decreasing cycle times and improved throughput, flexibility and scalability, improved accuracy, improved employee morale by enabling them to add more value, allows time to innovate and focus on customer satisfaction and detailed data capture (Wright, Witherick, & Gordeeva, 2017).

To summarize, since robotics systems can perform efficiently repeated, algorithmized and labor-intensive tasks, RPA technology purpose serves to reduce or eliminate the need of operators to perform large routine tasks, reducing costs and freeing up human resources and allocate them to more significant business processes (Uskenbayeva et al., 2019).

#### *2.4.1.1 Assisted RPA – RPA 1.0*

Assisted RPA, also known as RPA 1.0 (AIMDek Technologies, 2018), is a term for RPA tools that operate on the employee's workstation (computer) as a human being would do. Unlike traditional workflow technology, RPA does not apply changes to information systems since they only replace the human actions. In fact, they follow "[if, then, else] statements on structured data, based on user's interface interactions, or by connecting to APIs to drive client servers, mainframes or HTML code. An RPA tool operates by mapping a process in the RPA tool language for the software robot to follow, with runtime allocated to execute the script by a control dashboard" (Tornbohm & Dunie, 2017). Assisted RPA is very useful when real-time human-system communication is needed, since they are effective in minimizing the handling times, resulting in improvements in savings and customer experience. With the implementation of assisted RPA software, the typos, or mistakes that could occur due to employees' distraction/ lack of attention while handling processes are considerably reduced, carrying out their responsibilities in an efficient manner. The operators are only called to intervene when it is necessary to perform specific decision-making tasks (AIMDek Technologies, 2018; Anon, 2020; Gupta et al., 2019).

While business operations had a significant improvement with assisted RPA, on the other hand it still has its own boundaries regarding unstructured data or processes. With the constant change of processes and use cases, it is necessary to maintain continuous configurations of the business rules. When they are not adapted to business changes, these inconsistencies end up causing the automations to fail.

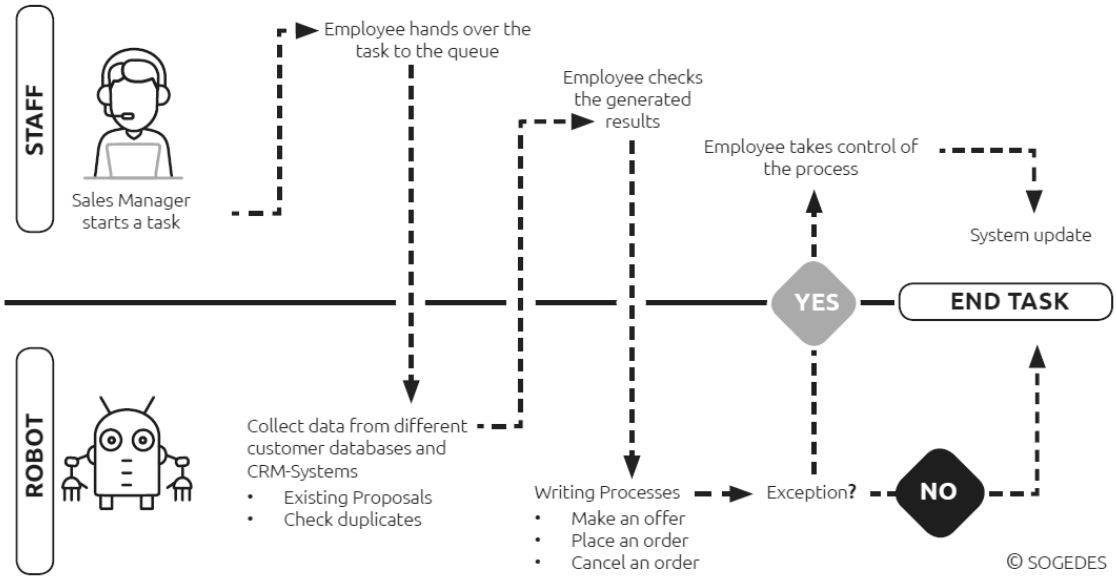


*Figure 4 – Assisted RPA – RPA 1.0 (Col, 2017).*

#### *2.4.1.2 Unassisted RPA – RPA 2.0*

While assisted automation tools are deployed in a particular workstation and requires user intervention, unassisted automation tools do not require human interaction. Hence, they are built on top of several machines. In short, robots run autonomously in a virtual environment. Deployed in this way, it extracts, processes and manages data between systems in order to produce new data by injecting it into other applications through user interfaces (UIs) or application programming interfaces (APIs) (Col, 2017).

Unassisted/ Unattended RPA or RPA 2.0 are processes performed by robots in the background, where it is not necessary user intervention unless for scheduling and managing the automation workload and exceptions, i.e. when the bot meets conditions it does not understand how to proceed (Taulli, 2019).

In the following figure, it is illustrated an RPA 2.0 example, where the robot performs tasks in the background, processing and managing data between systems, so that in the final of the process, and if necessary, the human being can make the decision.

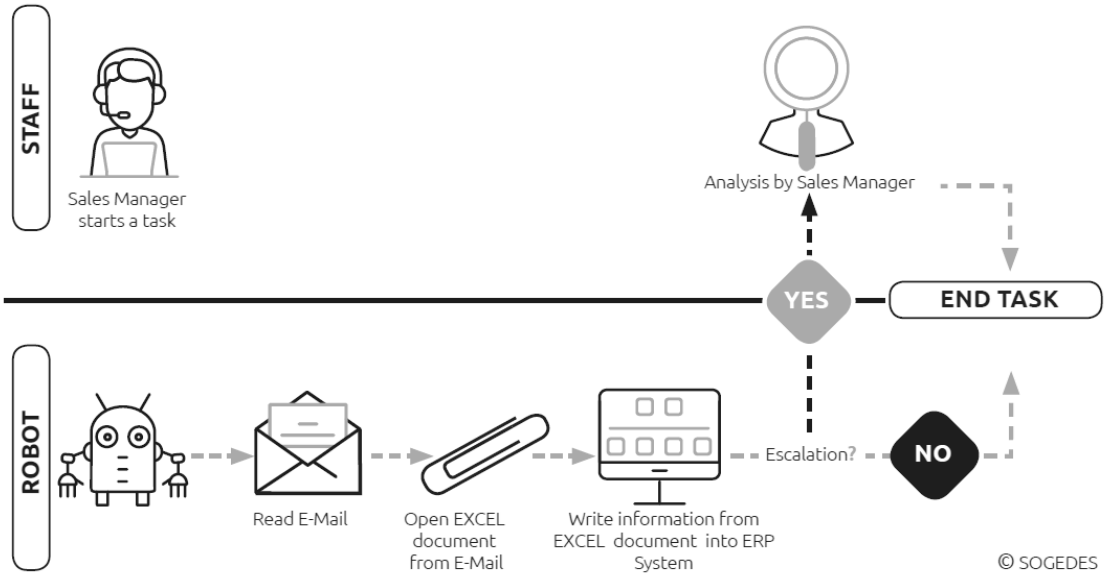


*Figure 5 – Unassisted RPA – RPA 2.0 (Col, 2017).*

#### *2.4.1.3 Autonomous RPA – RPA 3.0*

Autonomous RPA solutions – RPA 3.0 – are an evolution of unassisted RPA, where more complex rule-based processes can be in place, with built-in decision making, as for instance to handle change of priority to achieve a workload balancing (Khan, 2018).

According to UiPath, autonomous automation is also related to robots managing other robots, with the capability of monitor and handle attended or unattended RPA in a collaborative way, optimizing end-to-end processes and centralizing the work in queues (UiPath, n.d.).

This technology has also the objective of providing a scalable and flexible virtual workforce. It is usually deployed in the cloud/ SaaS providing RPA with features as auto-scaling, dynamic load balancing, context awareness and advanced analytics and workflows. The move to RPA 3.0 is accompanied by expanding libraries of pre-build automations, increasing verticalization of solution and multi-tenancy.

Since at this level of automation the cognitive technology was not yet introduced, a limitation of this technology is the type of data that is processed, where unstructured data is not yet supported (Venkatesh, 2018).

### 2.4.2 Artificial Intelligence

The field of artificial intelligence (AI) is quite vast, in short, it is based on the fact that machines have some intelligence, not the same that human beings or animals have, but an intelligence that using methods and calculations according to the environment where they are inserted and whom decides which actions to take according to the result that are as close as possible to the right in order to achieve the objectives. AI must essentially comprehend the world around it, and it can only be achieved by identifying, learning and

unscramble the principal factors that are hidden in the environment of low-level sensory data (Bengio, Courville, & Vincent, 2013).

The term is also used to describe an intelligence similar to human beings, where the cognitive functions mostly associated are learning and problem solving. Furthermore, the four disciplines that compose most of AI are natural language processing (NLP), so computers can process the communication as human language, knowledge representation to store the processed data, automated reasoning to formulate answers and design new conclusions, machine learning to learn how to adapt to new exceptions and find new opportunities in patterns (Russell & Norvig, 2020).

In short, the connection between AI-based technologies and business automation has enabled systems interactions based on natural language and speech, thus, perhaps it enhances the most transformational because it marks a shift in how people and automated systems interact (Calkins et al., 2020).

### 2.4.3 Cognitive Technologies

We should first start by defining what cognitive technologies are and then explain how they can make the most of business process automation. As mention before, cognitive technologies belong to the field of artificial intelligence, therefore, it is the technology that allows machines to perform tasks that only human beings were able to do. Cognitive technologies include computer vision, machine learning, natural language processing, speech recognition and robotics (Schatsky, Muraskin, & Gurumurthy, 2015).

Business process automation benefits from cognitive technologies in two principal ways. The first is that employees will be augmented, meaning that workers would be helped doing their tasks in a better or faster way, where human beings mostly make decisions if necessary. For instance, relying on IBM Watson, an intelligent assistant with cognitive learning capabilities was developed by Royal Bank of Scotland, to support the handling of 5,000 queries in a single day (Gallagher, 2018). The bank became able to analyze customer grievance data and create a list of common questions and answers related to specific subject matters (FAQ). In this way, not only the assistant has analysed queries but has also provided different responses and understand customer intents, where bank employees were only asked to intervene when the query was too complex to be handle by the machine.

As second is that it can also provide automation to specific tasks and replace employee, and when it takes responsibility over all tasks, it can eliminate jobs and let human workers free to use their distinctively human skills (such as interpretation, communication, judgment, and empathy) to less-routine tasks, as well as to explore new problems and opportunities (Hagel, Brown, & Wooll, 2019). Let's look at the of Rio Tinto's driverless mining trucks (RioTinto, n.d.). The company runs more than 130 autonomous trucks that are operated by a supervisory system and a central controller, rather than a driver. Autonomous trucks were developed to reduce risks to human drivers and cut labor costs. Rio Tinto says that as result of using automated

system, working is also safer and the reliance on technology brings many other benefits, where employees can work remotely closer to home rather than spending time away from their families (Gray, 2019).

### 2.4.4 Machine Learning

The main difference between human beings and computers has been since long time ago the ability for human beings to learn to improve their way of tackling problems. Human beings are constantly learning from previous experiences and solving problems by avoiding previous experienced mistakes as well by trying new options. Traditional apps and computer programs are not able to evaluate their outcome and for that reason they are not able to improve their performance automatically. Machine learning field is here to address exactly this problem, by augmenting software where it became able to learn and improve its working process, collecting more data and knowledge. Actually, the first computer program which could learn as it ran, i.e., self-learning, was created by A. Samuel in 1952, one that would improve its expertise at playing the game checkers with the number of games played (Martin et al., 2011).

Years later, in 1967, an algorithm used to map routes and, in particular, one of the first algorithms aiming to find the most efficient route for traveling salespersons emerged, the nearest neighbor algorithm (Cover & Hart, 1967), marking the beginning of basic pattern recognition.

According to Carbonell, Michalski and Mitchell (1983), "Learning processes include the acquisition of new declarative knowledge, the development of motor and cognitive skills through instruction or practice, the organization of new knowledge into general, effective representations, and the discovery of new facts and theories through observation and experimentation". Therefore, machine learning has been grown based on the following primary research lines:

- Task-Oriented Studies, that is the development of learning systems to improve performance in a predetermined set of tasks.
- Cognitive Simulation, specifically the investigation and computer simulation of human learning processes.
- Theoretical Analysis, i.e., the theoretical investigation of possible learning methods and algorithms, independently of application domain.

Briefly, we can say that machine learning means that an application is able to perform a task without being programmed for that specific task. It executes simple tasks through an algorithm program, guiding the machine to perform all required steps based on previous execution results and self-adjustments (Kenge, 2020).

### 2.4.5 Intelligent Process Automation

In the current knowledge of process automation, the core of process automation relies on data, decision-making and flexibility. Going back the literature review regarding RPA, it is possible to label a process as suitable to automate using RPA when one complies with the following aspects (International, 2019; Wellmann et al., 2020):

i. Manages structured data.

ii. Ruled by well-defined rules.

iii. Based on fixed routines.

Intelligent process automation enhances RPA to manage semi-structured and unstructured data, since it combines RPA technology with artificial intelligence, surrounding them with an understanding of processes and challenges, offering a new range of opportunities for improving processes performance and make employees better skilled. We are toward an intelligent automation process when combining automation tools with machine learning (ML) and software used to delivery work (Agrawal, 2020).

Intelligent automation is the catch-all phrase for disruptive technologies and empowers organizations to automate more complex business rules and decisions that require added judgment. By taking advantage of AI technologies, in particular the cognitive one, such as NLP and ML, unstructured data becomes a type of data to be considered as input, bringing IA a greater scale and insight to enterprise operations (APQC, 2019; Burlton & Lyke-Ho-Gland, 2016; Lyke-Ho-Gland, 2015; Paresh, 2018).

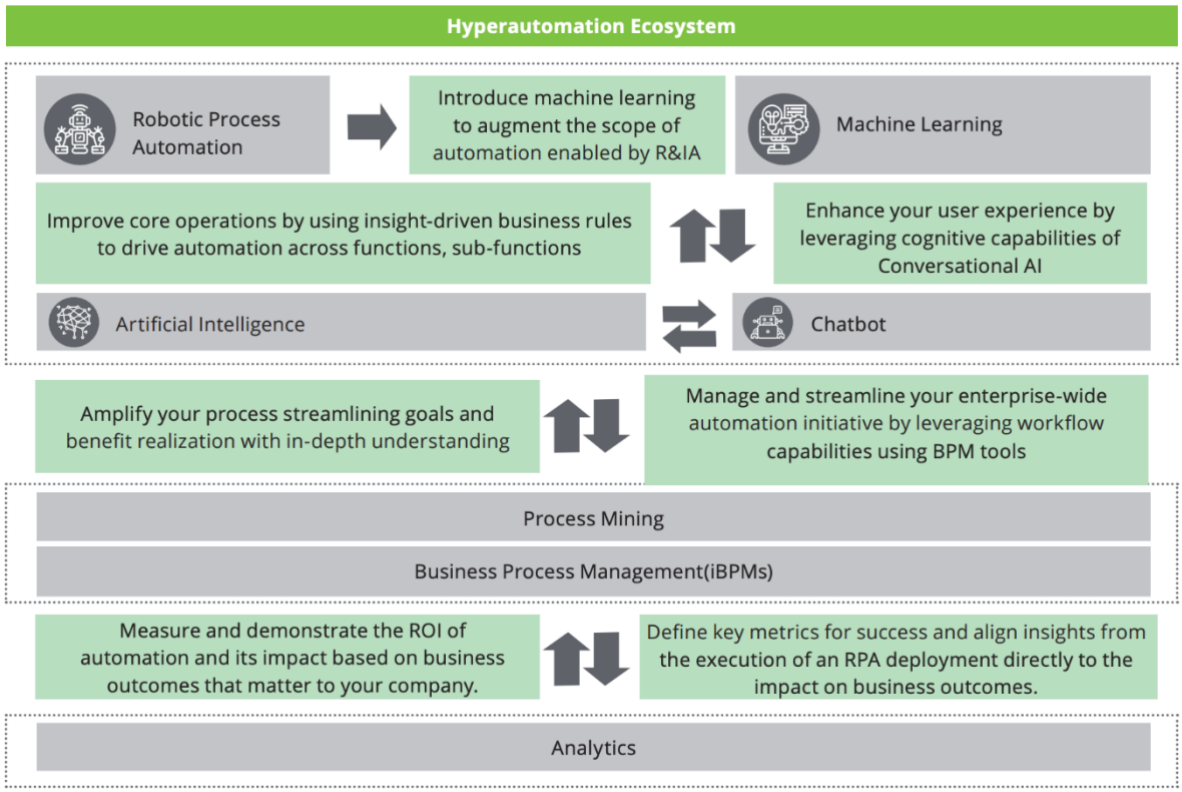


*Figure 6 – Hyperautomation ecosystem by Deloitte (Agrawal, 2020).*

Considering IPA as a product of convergence of AI and related technologies with RPA, Intelligence Automation is here to boost process automation in a way that human beings would become free from tasks that only human beings were able to accomplish.

Companies expect RPA to improve work quality, increase employee performance and reduce/ eliminate the issues caused by human beings (Fernandez & Aman, 2018), eliminating the amount of time managing information systems and transferring data (Syed et al., 2020). However, as previously mentioned, RPA has its limitations, as per instance the fact of being dependent on the rule-based processing of structured data.

Bearing in mind the typical operations team daily basis on a large company, most processes or tasks would be handling semi-structured and unstructured data such as purchase orders, invoices, agreements, emails or even meeting records. Enhanced digitization as Forrester (Le Clair et al., 2015) refers to, is not feasible for automation using RPA due to the different nature of invoices and purchase orders formats. To address this, RPA vendors lead to enhance their robots with learning capabilities of handling and process semi-structured data. The robots are now trained by the operations team through a more user-friendly interface, in order to teach robots, the various options and input data format the robots will manage.

Taking the case of new invoice formats, first, the robot will try to identify the key data, using a pre-configuration set. Then, the result will be validated by the operations team. Over time and feeding on all the learning the team will provide the robot, the rate of accuracy in learning new formats will be increasingly better, in order to reach a scenario of 100% automated invoice processing. By extending intelligence to these types of processes, teams that previously performed the tasks now begin to supervise them, seeing the focus of their work on analyzing the quality of execution.

The intelligent mail assistant deployed in Crédit Mutuel (IBM, 2016) together with IBM's Watson Assistant, was a successful intelligent automation implementation case. The bank had a growing volume of online inquiries of 23% a year becoming very difficult for the bank to maintain the quality of client relationship without losing their competitive advantage or reinventing the role of client advisor. After diagnosing the customer management team's daily routines, the bank found that part of the work involved answering simple and sometimes repetitive questions. Taking this into account, the bank together with IBM sought a solution that would automatically accelerate the treatment of these inquiries, leaving customer advisors free to dedicate themselves to the most complex issues. The introduction of robots in the routine of client managers made them question the fact that they could be replaced by artificial intelligence, making this a challenge for the project's management team, where they had to convince them how robots were tools to do their work even better and not to replace them. In fact, after the implementation one customer adviser said: "*Watson is my assistant. He's a time-saver and lets me know my client better*". The implemented robots learned to handle requests through other virtual assistants analyzing emails, the vocabulary used in the banking industry, building 50,000 lines of dialogue. The bank was gradually releasing the solutions developed for the different lines of business. Watson started to assist 20,000 customers advisors, strengthening its client relationship in 5,000 branches. Since its adoption, managers have been able to answer questions 60% faster. The Watson learning process has not ended in its implementation, it continues to be trained by business experts according to the various requests from customers who continue to enter the system.

## 2.5 Enterprise Areas/ Categories

### 2.5.1 Process Framework

When looking for a process to automate in an organization, it is first necessary to question where does processes fits in terms of categories, as functional areas, as well as which of them are suitable or not to be automated.

Having in mind the usefulness of automation processes, as a fundamental part of this research, it is first necessary to identify organizations processes. Organizations rely on frameworks, process frameworks, as reference guide to support the steps involved in end-to-end process architecture methodology. A process framework is a manner of grouping processes into related categories and usually use the concept of value chains as the basis of these categories. The reason behind using process frameworks is to provide a clear understanding of processes, and group them in a classified structure way, so it can be easily understood how they make things getting done and how related to each other they are (APQC, 2019; Burlton & Lyke-Ho-Gland, 2016; Lyke-Ho-Gland, 2015).

There are several process frameworks available that enhance organizations to recognize and improve their processes, as Enhanced Telecommunications Operations Map (eTOM), Information Technology Infrastructure Library (ITIL), Supply Chain Operations Reference (SCOR) and Process Classification Framework (PCF).

Process classification framework common terminology can be used by organizations to organize, name, and map their processes and used as helpful tool to explain a business in terms of horizontal processes, being this the framework chosen as the basis for this research, in particular the one made available by the American Productivity & Quality Center's Cross Industry (PCF).

APQC's Cross Industry (PCF) presents us a clear overview of existent processes in organizations. It displays the hierarchy between Categories (Level 1 – 1.0), Process Groups (Level 2 – 1.1), Processes (Level 3 – 1.1.5), Activity (Level 4 – 1.1.5.3) and Task (Level 5 – 1.1.5.3.1).

This research will not go into detail at all levels of the APQC PCF hierarchy, instead, it will be focused down to the third level of the hierarchy, Processes, noting that these are composed of tasks, but that they will not be detailed.

### 2.5.2 Process automation classification

As part of identify which processes are candidates to be automated, first, it is necessary to understand the existing opportunities for automation within organization and how deep should a process be automated, if the whole end-to-end process or if organizations should just focus on automating part of the process.

Therefore, processes can only be automated according to the depth of knowledge and understanding within a specific problem domain, where the depth required is the one able to design automations that fits. Mechanisms can only be in place on those that are already highly specialized within the system itself. As stated

in the book (Nof, 2009), "*It is possible to make a mechanical payroll program but impossible to make a mechanical company that responds to dynamic market forces and makes a profit. The result of this is that any mechanization requires specific understanding of some particular specialization within some particular system*".

But it is needed a general principle to have a clear understanding of what can be automated and not. The same book refers to a principle that is too blunt, "*You cannot automate what you cannot do manually, but the converse it is not true, since you cannot always automate everything you can do manually*", and defends a principle of designing, where "(…) *anything that can be reduced to an algorithm or computational process can be automated, but that some things, like human thought and most functions of complex adaptive systems, are not reducible to a logical algorithm or a computational process and therefore cannot be automated".*

As already mentioned in the literature review, chapter 2.1, a process consists of a set of tasks, and it is from this concept that we can then proceed to an analysis and comparison between fully and partially automated processes.

When referring to the different levels of automation, it is related to task planning and performance interaction maintained between a human operator and computer in controlling a complex system (Billings, 1991; Kaber & Endsley, 2004).

The adaptation of automation, according to the commitment between machine and human beings, has come to be called the level of automation (LOA). Sheridan, Verplank and Brooks (1978) proposes one such scale:

1) A human being must take all decisions and actions.
2) Machines offers a set of decision or action alternatives.
3) Machines narrows the selection of alternatives.
4) Machines suggests one alternative.
5) Machines executes that suggestion if approved by a human being.
6) Allows the human being a restricted time to veto before automatic execution.
7) Machine executes automatically and, if necessary, informs the human being.
8) Machine only informs the human being if asked.
9) Machine only Informs the human being if it decides to.
10) Machine acts autonomously and decides everything (the human being is not considered).

Years later, Endsley(1987) discriminated the five LOA levels:

1) Manual control with no assistance from the system.
2) Decision support by the operator with input in the form of recommendations provided by the system.
3) Consensual artificial intelligence (AI) by the system with the consent of the operator required to carry out actions.
4) Monitored AI by the system to be automatically implemented unless vetoed by the operator.

5) Full automation with no operator interaction.

Process automation does not only consist of all or nothing but can vary across a range of levels, from the lowest level of automation, where everything is fully manual, to the highest level of full automation, where, according to the proposed by Parasuraman, Sheridan and Wickens, (2000), automation can be applied to four classes of functions, namely:

1) Acquisition of information needed to do the task.
2) Analysis of that information.
3) Decision of what action to take.
4) Execution of that action.

This research will not get focused in detail on which level of automation each process is categorized because it raises several complex supplementary questions, the discussion of which would take us far afield from the main purpose of this research, however, we will reflect on the processes to identify its level as: full automated, partial automated, or non-automated.

#### *2.5.2.1 Full automated processes*

When referring to full automated processes, Endsley and Kiris (1995) identified that operators should not interact with the processes, meaning that they do not act in any task function. It is also defended by Kaber and Endsley (2004) that the level of full automation is in place when the system is the one who carries out all actions and human beings are out of the control loop, and do not intervene.

A process is said to be fully automated when all of your tasks can be automated, meaning that full automation deals with machines that completely replace human work (Growiec, 2020).

Summarizing, it results in a system automation where human processing is no longer demanded.

#### *2.5.2.2 Partial automated processes*

But since nor all the processes can be fully automated, there are different levels of automation as identified in 2.4.2. Apart from the evolution of process automation, there are still occasions when workflows must be manually accepted, rejected or reevaluated only by human beings.

Those processes that have some tasks in their scope that cannot be automated are characterized as a partially automated process. Partial automation is the combination of people and machines where one compliments the other in order to achieve the goal of that process (Growiec, 2020).

The final delivery of a product or service is an example of a process that still require human attention. Machines can in fact work on automated testing, but when it comes to ensure the quality of the final product, human input is critical, since the user experience cannot be truly appreciated by a machine in the same way a human being would.

Therefore, it can be assumed then that a process can be considered as partial automated when one is composed by at least one automated task and one not automated task. These processes are placed in a level of automation between full automation and full manual (non-automated) processes.

#### *2.5.2.3 Non-automated processes*

In this research, it is considered that all processes composed by tasks that are exclusively handled by human beings, leveled as non-automated processes. These processes are full manual processes when there is no space available for automation due to its nature.

### 2.5.3 APQC Cross Industry PCF

From the wide list of processes available in the APQC framework, this research first identifies the ones suitable for automation.

To be able to perform this selection, it was necessary to understand what makes a process suitable for robot process automation or intelligent process automation and the difference between both concepts.

According to IEEE Guide for Terms and Concepts in Intelligent Process Automation, both concepts lead to building a preconfigured software instance based on business rules with the goal to complete an autonomous execution of human tasks, activities in one or more unrelated software systems to deliver a result or service, in which for RPA scenarios the data handled is exclusively structured data and human beings will be managing exceptions, while IPA it is designed to have the minimal or no human intervention, by being itself able to determine logic and decision criteria, based on structured or unstructured data (Peffers et al., 2007). The unstructured data is managed by cognitive technologies in order to deliver data that can be used as a source for software systems.

Having these concepts in mind and after analyzing the APQC's PCF, it was identified the main enterprise areas where do exist processes suitable to be automated:

**Operating Processes**

1. Develop Vision and Strategy (10002).

3. Market and Sell Products and Services (10004).

4. Deliver Physical Products (20022).

6. Manage Customer Service (20085).

**Management and Support Processes**

7. Develop and Manage Human Capital (10007).

8. Manage Information Technology (IT) (20607).

9. Manage Financial Resources (17058).

13. Develop and Manage Business Capabilities (10013).

### 2.5.4 Findings on Enterprise Areas

While looking in detail for processes in APQC's Cross Industry PCFs, it became clear which type of data and information areas have in common.

These areas tend to have processes requiring information management and standardization from several applications and systems. Most of them are rule-based requiring great speed and accuracy performance where the data that is managed is most of the time structured documents and data.

For most of the processes, simple RPA solutions seems the appropriated to be implemented, however, to complement the simple automation of RPA, the inclusion of Machine Learning, more specifically, cognitive services, allowed these processes to become more evolved, allowing to an introduction of Intelligent Automation (Peffers et al., 2007).

### 2.5.5 APQC Processes

To present the list of identified processes suitable for intelligent automation, it was reduced the scope of detail of APQC PCF processes and focusing on the third level, the detailed description of each process was analysed. In this way, according to the literature review, each process was identified as suitable or not suitable to be a process composed of automation as follows in **Annex I – APQC's Process Framework – Cross Industry (Adapted)**.

In order to simplify the identification of suitable processes for intelligent automation, the table below (Table 1 – Selected processes suitable for automation) presents only those identified as suitable for automation according to the literature review.

| PCF ID | Hierarchy ID | Name |
|---|---|---|
| 10002 | 1.0 | Develop vision and strategy |
| 17040 | 1.1 | Define the business concept and long-term vision |
| 10018 | 1.1.2 | Survey market and determine customer needs and wants |
| 10004 | 3.0 | Market and sell products and services |

| | | |
|---|---|---|
| 10101 | 3.1 | Understand markets, customers, and capabilities |
| 10106 | 3.1.1 | Perform customer and market intelligence analysis |
| 10102 | 3.2 | Develop marketing strategy |
| 16848 | 3.2.5 | Develop marketing communication strategy |
| 18924 | 3.2.6 | Design and manage customer loyalty program |
| 20008 | 3.3 | Develop and manage marketing plans |
| 10153 | 3.3.5 | Track customer management measures |
| 16613 | 3.3.6 | Analyze and respond to customer insight |
| 10185 | 3.5.4 | Manage sales orders |
| 20022 | 4.0 | Deliver physical products |
| 10215 | 4.1 | Plan for and align supply chain resources |
| 10222 | 4.1.2 | Manage demand for products |
| 10216 | 4.2 | Procure materials and services |
| 10278 | 4.2.3 | Select suppliers and develop/ maintain contracts |
| 10279 | 4.2.4 | Order materials and services |
| 10280 | 4.2.5 | Manage suppliers |
| 10217 | 4.3 | Produce/ assemble/ test product |
| 10303 | 4.3.1 | Schedule production |
| 10304 | 4.3.2 | Produce/ assemble product |
| 10369 | 4.3.3 | Perform quality testing |
| 10370 | 4.3.4 | Maintain production records and manage lot traceability |
| 20085 | 6.0 | Manage customer service |
| 10379 | 6.2 | Plan and manage customer service contacts |
| 10388 | 6.2.2 | Manage customer service problems, requests, and inquiries |
| 10389 | 6.2.3 | Manage customer complaints |

| | | |
|---|---|---|
| 12840 | 6.2.5 | Report incidents and risks to regulatory bodies |
| 12658 | 6.3 | Service products after sales |
| 20605 | 6.3.1 | Register products |
| 12669 | 6.3.2 | Process warranty claims |
| 20110 | 6.4 | Manage product recalls and regulatory audits |
| 20112 | 6.4.2 | Assess the likelihood and consequences of occurrence of any hazards |
| 20113 | 6.4.3 | Manage recall related communications |
| 20115 | 6.4.5 | Monitor and audit recall effectiveness |
| 20116 | 6.4.6 | Manage recall termination |
| 20595 | 6.5 | Evaluate customer service operations and customer satisfaction |
| 10401 | 6.5.1 | Measure customer satisfaction with customer problems, requests, and inquiries handling |
| 10402 | 6.5.2 | Measure customer satisfaction with customer complaint handling and resolution |
| 10403 | 6.5.3 | Measure customer satisfaction with products and services |
| 12672 | 6.5.4 | Evaluate and manage warranty performance |
| 20121 | 6.5.5 | Evaluate recall performance |
| 10007 | 7.0 | Develop and manage human capital |
| 10410 | 7.2 | Recruit, source, and select employees |
| 20123 | 7.2.3 | Screen and select candidates |
| 20599 | 7.3 | Manage employee on boarding, development, and training |
| 10473 | 7.3.4 | Develop and train employees |
| 17056 | 7.7 | Manage employee information and analytics |
| 10524 | 7.7.3 | Manage and maintain employee data |
| 17057 | 7.8 | Manage employee communication |
| 16944 | 7.8.2 | Conduct employee engagement surveys |
| 20607 | 8.0 | Manage Information Technology (IT) |

| | | |
|---|---|---|
| 20608 | 8.1 | Develop and manage IT customer relationships |
| 20648 | 8.1.7 | Analyze service performance |
| 20652 | 8.2 | Develop and manage IT business strategy |
| 20682 | 8.2.5 | Control IT management system |
| 20706 | 8.3 | Develop and manage IT resilience and risk |
| 20721 | 8.3.3 | Control IT risk, compliance and security |
| 20866 | 8.7 | Create and manage support services/ solutions |
| 20914 | 8.7.7 | Manage infrastructure resource administration |
| 20921 | 8.7.8 | Operate IT user support |
| 17058 | 9.0 | Manage financial resources |
| 10728 | 9.1 | Perform planning and management accounting |
| 10741 | 9.1.4 | Evaluate and manage financial performance |
| 10729 | 9.2 | Perform revenue accounting |
| 10743 | 9.2.2 | Invoice customer |
| 10744 | 9.2.3 | Process accounts receivable (AR) |
| 10730 | 9.3 | Perform general accounting and reporting |
| 10748 | 9.3.2 | Perform general accounting |
| 10749 | 9.3.3 | Perform fixed-asset accounting |
| 10750 | 9.3.4 | Perform financial reporting |
| 10731 | 9.4 | Manage fixed-asset project accounting |
| 10751 | 9.4.1 | Perform capital planning and project approval |
| 10752 | 9.4.2 | Perform capital project accounting |
| 10732 | 9.5 | Process payroll |
| 10753 | 9.5.1 | Report time |
| 10754 | 9.5.2 | Manage pay |

| | | |
|---|---|---|
| 10755 | 9.5.3 | Manage and process payroll taxes |
| 10733 | 9.6 | Process accounts payable and expense reimbursements |
| 10756 | 9.6.1 | Process accounts payable (AP) |
| 10757 | 9.6.2 | Process expense reimbursements |
| 10737 | 9.10 | Manage international funds/ consolidation |
| 10767 | 9.10.1 | Monitor international rates |
| 10769 | 9.10.3 | Monitor currency exposure/ hedge currency |
| 10770 | 9.10.4 | Report results |
| 17059 | 9.11 | Perform global trade services |
| 14092 | 9.11.3 | Classify products |
| 19593 | 9.11.4 | Perform currency conversion |
| 14093 | 9.11.5 | Calculate duty |
| 14095 | 9.11.7 | Document trade |
| 10013 | 13.0 | Develop and manage business capabilities |
| 11179 | 13.7 | Manage environmental health and safety (EHS) |
| 11182 | 13.7.3 | Train and educate functional employees |
| 20959 | 13.8 | Develop, manage, and deliver analytics |
| 20961 | 13.8.2 | Collect data |
| 20962 | 13.8.3 | Analyze data |
| 20963 | 13.8.4 | Report on data |
| 20964 | 13.8.5 | Identify remedial actions |

*Table 1 – Selected processes suitable for automation (adapted from APQC's PCF – Cross Industry).*

# 3 METHODOLOGY

After some reflection and research, following the design science research (DSR) methodology seems to be best solution to reach the goal to design the process of implementation an intelligent automation to a target process.

The choice of DSR for this research took into account some of the characteristics that were revealed during the analysis of the research types, among them, and the main one, the method of basing the combination of a summary brought by the fundamentals of design with the point of view analytical background from the scientific background (Baskerville, Kaul, & Storey, 2015).

## 3.1 Research methodology

The beginnings of interest in DSR go back to the 1990s (March & Smith, 1995; Nunamaker, Chen, & Purdin, 1990; Walls, Widmeyer, & el Sawy, 1992), when three papers published this methodology (March & Smith, 1995; Nunamaker et al., 1990; Walls et al., 1992).

The purpose of DSR is to deal with building and evaluating artifacts designed to fit a business need (Hevner et al., 2004), building and evaluating means-ends relations and not focused in finding the truth, by exploring and validating cause-effect relations (Winter, 2008). The purpose is also to reach a "to-be" conception and then according to the defined model building the system, having in consideration restrictions and limitations (Österle et al., 2011).

Since DSR is a problem-solving paradigm that tries to generate an artefact or final solution designed for a specific problem, it first identifies business needs and therefore the finding of a solution to organizational problems (Hevner et al., 2004).

DSR being one of the approaches currently used in the study and investigation in the field of information systems (Hevner et al., 2004), describes the importance of DSR in this domain. Thus, using this research methodology, this research intends to build an artifact, flux gram, that support organizations finding and promoting IPA solutions.

DSR project has the potential to make different types and levels of research contributions depending on its starting points in terms of problem maturity and solution maturity.

## 3.2 Design Science Research

Having always taking into consideration that *"nothing is really 'new'. Everything is made out of something else or build on some previous idea"*, as mentioned in Gregor and Hevner (2013), to figure out how this research process can take advantage of DSR, it was first necessary to place this research in one of the quadrants of Figure 7.

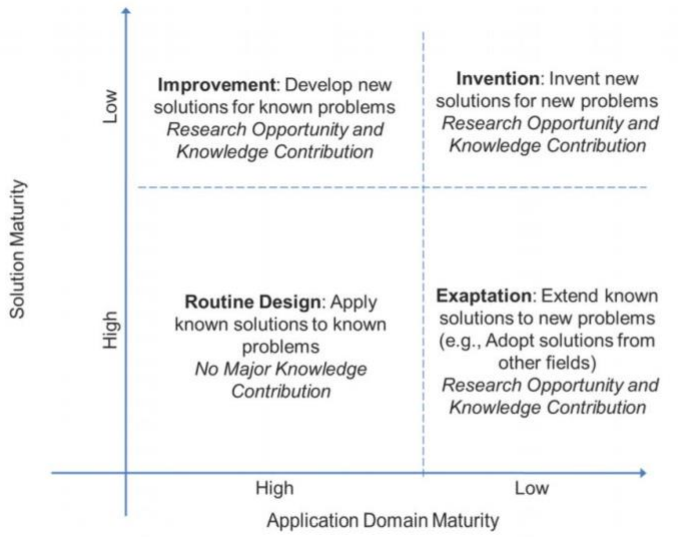


*Figure 7 – DSR knowledge contribution framework (Gregor & Hevner, 2013).*

Given the fact that a given individual can experience different disciplines, the combination of these different disciplinary experiences can result in the expropriation of artifacts from a given field in order to solve problems in other fields. By this it means that by adapting existing solutions in other fields in a new context with different characteristics (Gregor & Hevner, 2013), we are in agreement with what is intended in this master's thesis, i.e., an output artifact that, taking into account the processes and automation definitions together with the advances of new cognitive technologies, can fit these into the RPA processes so that they become intelligent processes.

Based on a problem solver approach, this research method relies on creating/ improving in an innovative way, that comes from a specific problem (Hevner et al., 2004), which, in the scope of this research, is "what should organization do to implement an intelligent automation process successfully".

Also considering that the search for a solution through an exhaustive scientific research, thus ensures consistency and credibility to the artifact that is proposed in the research. The final step that should always be in place is communication, ensuring that the final result is communicated not only to a technical-oriented audience but also to management-oriented audiences (Hevner et al., 2004).

As illustrated in Figure 8, and in order to clarify the main steps of the DSR methodology, based on the fact that it is only during the construction and application of the artifact that the design problem, as well as its solution, is known and understood, each step is further explained as Peffers et al. (2007) suggests:

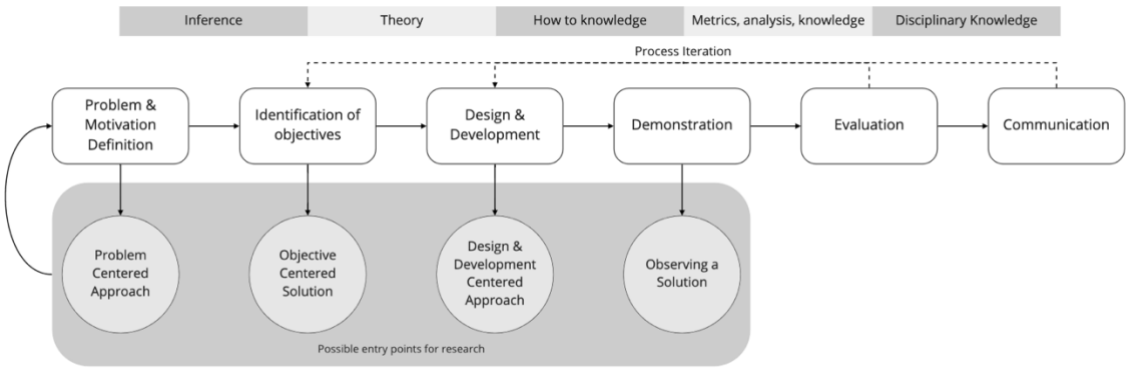


*Figure 8 – DSR method adaptation (Peffers et al., 2007).*

### 3.2.1 Problem and motivation definition

In this step, is defined a specific research problem to be addressed, usually raised by a research question and justified by its foundations. Based on the problem definition an artifact will be developed, so that it can be effectively provided a valuable solution for the stakeholders.

It is also necessary to understand the current state of the art of the topic addressed by the research.

### 3.2.2 Identification of objectives

Then, it is necessary to define/ identify the objectives, which can be qualitative or quantitative. This identification will set the core for the solution based on a problem definition. To do so, it is necessary to have the knowledge of the current state of problems and solutions, as well as their effectiveness.

### 3.2.3 Design & Development

In this step, the artifact will be created. This activity includes determining the artifact's desired functionality and its architecture and then creating the actual artifact. Conceptually, a design research artifact can result in a design of any object, as long as the research design contributes to its development.

### 3.2.4 Demonstration

Once the artifact is developed, it is necessary to demonstrate that it can provide a solution for the identified problem. The artifact should be used in an experimentation, use case, or other appropriate activity as a way of demonstrating the effective knowledge it provides.

### 3.2.5 Evaluation

Once the demonstration is completed, it should be analysed and evaluated the artifact efficiency by observing and measuring how well the artifact supports a solution to the problem. The resource for evaluation is the knowledge of selecting relevant metrics and analysis techniques that are appropriated to that specific problem, where, depending on problem nature, evaluation can be made differently.

After the evaluation, the researchers can decide if the artifact is ready to be communicated, leaving further improvements to subsequent projects, or if a new iteration is necessary, returning back to the design and development stage, where more efforts will be put in place to try to achieve improvements to the artifact's effectiveness.

### 3.2.6 Communication

The last but not least stage is communication. In fact, it ends by being one important step where research results are explained, not only to the technical audience, as well as for the management audience, so that presentation of the result is as effective as possible and understood by all research readers.

The activities described above regarding DSR methodology may follow a different order from the one presented, and in some cases may be carried out more than once according to the needs that arise. In fact, researchers can start the process at any of the stages and move outward.

## 3.3 Research Strategy

According to the framework of the DSR methodology, presented above, the following figure shows how each stage of the research strategy that supports this study was carried out:


*Figure 9 – Research strategy.*

- **Problem Awareness** – The literature review made around process automation and the area of artificial intelligence that influences this theme, enhanced us to gather information on the main factors covered by the literature to date. The main objective of the literature review is to gather as much information already available around the topic under study and, from there, to support the study and knowledge acquired throughout this chapter.
- **Development** – Based on the content from the literature review, a method was built to identify processes and promote intelligent automation according to their characteristics.
- **Demonstration** – To demonstrate that this model fits its purpose, a use case was presented.
- **Evaluation** – To evaluate this model specialist interviews were carried out grounded on literature review.
- **Discussion** – Discussion about the feedback obtained in the interviews carried out.

# 4 METHOD TO FOSTER INTELLIGENT PROCESSES AUTOMATION INTO AN ORGANIZATION

After studying the main areas and concepts of workflow automation, as well as the evolution of process automation technologies, and how companies are struggling when adapting to them, in particular to intelligent process automation, it was possible to have a clear understanding of what must be included in the definition of the main concept behind this master's thesis: finding and promoting implementation of intelligent automation processes.

Implementing IPA is a key factor that boosts company's operational processes, and as consequence, the quality of the service provided to the customer, since the goal of an intelligent process is to optimize, accelerate and free human beings from low-value tasks added, being these dedicated to more complex tasks.

Since these initiatives passes by connecting to workers to collect feedback from the process, it promotes better information flow between company and workers, that is crucial for a successful implementation. Listening to their explanations and convey that their knowledge is valuable, understanding their routines and tasks repetitiveness, typifying processes, find out software and data involved is also a must to design a suitable intelligent automation process.

In general, intelligent process automation must improve the way people interacts with the whole business process, not only company workers as well as customers.

## 4.1 Assumptions

Based on what was studied in the literature review, about workflow and process automation, process intelligence and automation technologies available, as well as how organizations interact with it was defined that a method for finding and promoting implementation of intelligent automation to a target process should take in account the following:

- A process is composed by tasks/ activities with distinct inputs and outputs, serving a significative purpose within an organization or between organizations (Workflow Management Coalition, 1999).
- Tasks can be executed either by human beings or machines (Workflow Management Coalition, 1999).
- The processes can be classified according to different frameworks. One the most complete and recognized framework is PCF from APQC.
- Workflow automation is characterized as an execution of a set of tasks in an automated way through software, guided by the set of rules previously established (Workflow Management Coalition, 1999).
- Most failures in workflow automation implementations are due to a lack of knowledge on the topic or prioritization of the effort (International, 2019).
- There are three key factors for a successfully implementation (International, 2019), based on identifying:

    - Who oversees the initiative?
    - How are processes integrated within the business?
    - How best practices are picked up and learned?
- Workers have to be aligned with change for them to adopt and accept it (International, 2019).
- RPA aims to automate tasks on rules-based business processes (Aguirre & Rodriguez, 2017).
- Human beings must be freed from large repetitive and low-added value tasks, being those replaced by RPA (Uskenbayeva et al., 2019).
- In addition to the evident reduction in costs and lead times, by adhering to the "RPA", companies can focus their resources on managing and improving customer satisfaction (Wright, Witherick, & Gordeeva, 2017).
- Human beings should be allocated to more significant business processes (Uskenbayeva et al., 2019).
- Human beings' augmentation bases on the fact that they will have their tasks performed in a faster and improved way, where decision making becomes the focus (Gallagher, 2018).
- To fill the gap of just being able to manage data structured and defined by rules, these automated processes must become intelligent (Agrawal, 2020), so that unstructured data can be also included in the type of data managed by automation processes.
- The field of artificial intelligence is an aggregator of a set of technologies that aims mirroring the functioning of the human mind as a problem solver, by making decisions through calculations and analysis of results, opting for the one that is closest to the most correct to achieve the objectives (Bengio, Courville, & Vincent, 2013).
- Cognitive technologies belong to the field of AI, that includes computer vision, machine learning, natural language speech recognition and robotics (Schatsky, Muraskin, & Gurumurthy, 2015).
- Natural language processing (NLP) refers to computers being able to process the communication as human language (Russell & Norvig, 2020).
- Knowledge representation to store the processed data (Russell & Norvig, 2020);
- Automated reasoning to formulate answers and design new conclusions (Russell & Norvig, 2020);
- Machine learning to learn how to adapt to new exceptions and find new opportunities in patterns (Russell & Norvig, 2020).

## 4.2 Method

Finding a way to find and promote intelligent processes as a walkthrough diagram that any company can use as guide, is proposing a workflow diagram with possible paths and depending on each company's reality. This research will not enter in the details of implementing the process, because it would requires a detailed investigation under that area and lead to a discussion which would take us far afield from the main purpose of this research.

At the scope of this study, a workflow diagram to find and promote an implementation of intelligent automation was proposed, so that companies became able to find within their processes which can be enhanced, by being converted into an intelligent process, and according to the assumptions described above, it was proposed the following conceptual framework.

Taking the proposed diagram as a reference, below, in Figure 10, we can verify that, as the first step of BPM lifecycle, it is necessary to carry out a survey of existing processes to identify the existing processes as it is proposed on step 1. Identify current business processes.

Following by step 2, it is performed a validation of the processes according to the APQC framework. The processes that are not found in the selected processes presented in this framework are excluded, and only those that match are the ones chosen for the continuity of the flow.

The step 3 is dedicated to the analyse of the processes, by identifying their tasks and their repetition. Here, the purpose is to understand later, according to step 4, if they can all be automated or if only a few are chosen for automation, since in step 4, the tools and software used are surveyed as well as the type of data that is managed.

The objective of step 4 is to understand whether structured or unstructured data is managed and how it is integrated between systems. Reflecting on the results of steps 3 and 4, we were able, according to the criteria studied by the IPA, to identify whether we are faced with the need and possibility of automating the process.

Once the possibility of process automation has been validated, moving into step 5, according to the type of data managed, the type of decision making and its flexibility in relation to the changes that the process flow may undergo, it is proposed that if it is identified as a simple process of RPA, this will not be within the scope of this research, but that if it is considered adequate to become an IPA, the flow should continue to identifying what level it is at, whether it is a matter of data transformation or sharing, a matter of making decisions according to the changes in the rules of business or whether it is necessary to capture data from physical documents. In the end, the goal is to identify the AI technology that will be used, so that this process becomes an intelligent process.

According to what was studied, an intelligent automation is proposed when there is the possibility of automating the execution of a task where cognitive technology is included in order to free the human being from the execution of the same, becoming the supervisor and intervening in cases where the machine cannot progress.

Once the level of automation has been defined, it is necessary to assess what is the actual effort involved, in relation to time, cost and quality of execution.

According to the resulting IPA specifications, a survey of the necessary vs. existing resources should be made to understand if there are internal resources available or if it is necessary to resort to external resources. The

assessment of the necessary resources is related to the team and the software to transform the process into an intelligent process.

Finally, a final cost/ investment assessment must be made, step 7, with a decision to go/ not go to the implementation phase.

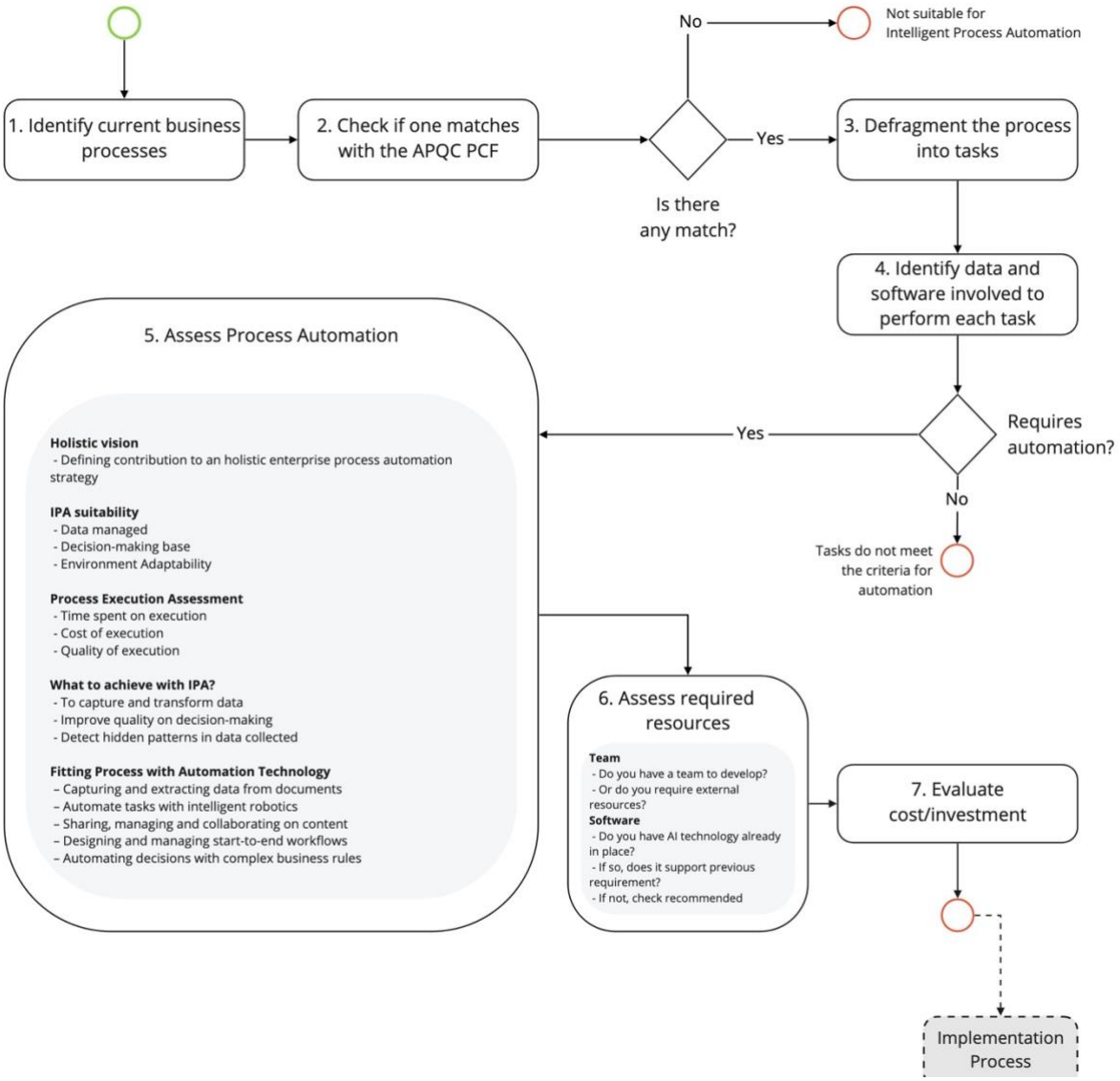


*Figure 10 – Walkthrough guidelines diagram.*

As presented below, it was designed a table for each step from Figure 10, to provide a detailed explanation of each phase. On each table you will find:

- Process ID – Identifies the step.
- Process Name – Identifies the name of the step.
- Description – Describes what is intended with the execution of the step.
- Goal – Defines the objective of the stage.

- Template – Indicates the reference for the model that assists in the execution of the stage.
- Tool – Indicates the tool that assists in the execution of the step.

| Process ID | 1. |
|---|---|
| Process Name | Identify Business Processes |
| Description | In this step, it is expected a survey of companies' existing processes:<br>- Find out processes availabilty and its descriptions<br>- Identified the parts involved<br>- Find why is it important to the business<br>- Identify if there is any known issue to be addressed |
| Goal | Create processes description |
| Template | Process identification form (Annex II) |
| Tool | N/ A |

*Table 2 – Step 1 – Identify business processes.*

As first step, it is necessary to identify the as-is business processes in the company. This process analysis is a process management strategy that identifies and allows the evaluation of business' current processes. It builds a solid foundation on company's processes and without the knowledge of where start from, it will be harder to identify where the company want to be. There are several methods for collecting information, such as research, personal interviews, direct observation, surveys or group meetings. Used as a support to collect the process details, the Process Identification form template is available in the Annexes, Annex 1. The recommendation is made in conjunction with the business stakeholders who perform the business process, and all relevant company processes must be brought together.

In the form template is described the expected data to be collected:

- Process Title – Use of verb noun phrasing.
- Purpose – Process outlining, with its purpose and scope. Should be a short section with 2-4 sentences.
- Entry Criteria – Identify what triggers the process.
- Inputs – Bullet-point list of deliverables that provide data to the process, such as receipts, emails, documents, either in physical or electronic form.
- Workflow Diagram – Create a visual diagram indicating the relationship between activities in the process.
- Tasks and Activity Descriptions – Describe each activity within the process in bullets, together with the roles and responsibilities of the people involved.
- Exceptions – List exceptions and describe them.
- Business Rules – List the business process rules, as, per instance, that an email must be sent after five business days if there is no reply.
- Outputs – Bullet-point list of the deliverables resulting from the completion of the workflow diagram.

- Exit Criteria – Identify what ends the process.
- Metrics – List the metrics for process evaluation.

| Process ID | 2. |
|---|---|
| Process Name | Match BP with APQC PCF processes |
| Description | - Verify if processes from step 1 matches any selected process from APQC PCF<br>- All the processes that are not mapped, should be ignored |
| Goal | Check if Business Processes are on APQC PCF |
| Template | N/ A |
| Tool | APCQ's Process Classification Framework |

*Table 3 – Step 2 – Business processes vs APQC PCF process.*

The goal, on this step 2, is to narrow the selection of the company business processes that are suitable for automation. In this step, the APQC PCF processes previously considered to be suitable for automation should be revisited and the company's processes should be filtered according to that selection, so that only those that match proceeds to the next step.

| Process ID | 3. |
|---|---|
| Process Name | Defragment the process into tasks |
| Description | - Defragment the business process into tasks<br>- Describe the tasks characteristics |
| Goal | Identify Business Process tasks |
| Template | Task identification form (Annex III) excluding data and software rows |
| Tool | N/ A |

*Table 4 – Step 3 – Defragment the process into tasks.*

According to the activities identified on step 2, it is now time to identify the tasks that make up the activities of each process. In this step and in conjunction with step 4, we intend to validate whether the tasks can be automated or not. For this, reflecting on their characteristics, it is necessary to have a description of it and understand how they are executed.

It must also be identified who is the executor of the task and how often it is performed so a repetitive pattern can be designed or not.

Task execution can be typified according to how and who is executing it, leveraging the possibility to identify the process automation level:

- User – When the task is started, executed and completed by a human being.
- System – When the task is started, executed and completed by a robot.
- Mixed – When there is a combination of a human being and a robot, where one compliments the other to achieve the goal of that task.

As an outcome of this step, it is expected a detailed list of tasks, so that, on step 4, it can be assessed the data and software used.

| Process ID | 4. |
|---|---|
| Process Name | Identify data and software involved to perform each task |
| Description | It should be identified:<br>- Task executor<br>- Software involved<br>- Data managed<br>- Task value |
| Goal | Detail the tasks to validate if are suitable for automation |
| Template | Task identification form (Annex III) data and software rows |
| Tool | N/ A |

*Table 5 – Step 4 – Identify data and software involved to perform each task.*

As previously mentioned, step 4 is dedicated to data and software involved to achieve the task goal. Here, the last two rows should be filled in so that it can be analysed together with the data involved and tasks repetitiveness within the process execution. If a task transfers data between two peers, in a repetitive way, following some kind of rules, we can say that it is suitable for automation. Identifying the software involved within tasks is important due to most of the times it already specifies what is being handled by the tasks.

Low added value tasks are usually most suitable for automation, since with automation there is a will of freeing the human being from these tasks. Human beings should focus their efforts on more added value tasks such as evaluating and taking decisions that are not expected or processing data that is not supported by automation processes, actions that robot itself would not be able to handle.

| Process ID | 5. |
|---|---|
| Process Name | Assess Process Automation |
| Description | Defining how intelligent process automation contributes holistically to the enterprise process automation strategy.<br>Finding process characteristics, such as Repetitiveness, Data, Decision and Volatility.<br>Define process As Is – Cost, Time and Quality<br>Automation process level, fully automated or partially automated and its purpose.<br>Identify technology solutions to provide IPA |
| Goal | Identify if process is suitable for IPA |
| Template | Identifying intelligent process automation suitability (Annex IV) |
| Tool | N/ A |

*Table 6 – Step 5 – Identify process automation type.*

With step 5, it will be validated if the selected process is capable of gather automation with intelligence, i.e., if it has the possibility of being more than a simple RPA, where the technologies that support artificial intelligence are considered.

It should be first described the holistic approach for the enterprise process automation strategy. This will serve as a guide when decisions must be taken while developing the proposal.

Once it is defined, the analysis of the process must be done in relation to its:

- Repetitiveness – Executed several times (hourly, daily, week, month).
- Data – Manages structured or unstructured, digital or non-digital data.
- Decision – Rule-based or judgment-based decisions.
- Volatility – Not flexible, always the same or process changing as the environment changes.

Repetitiveness is one of the most important aspects to be considered, where it should be identified how often it is executed, e.g., hourly, daily, weekly or monthly basis. Together with repetitiveness, it should be checked how long does it take to execute, by finding if it is a long “hands on” work, that typically consumes a couple of hours per month.

Then, the identification of the data managed should be assessed. It must be identified if the process works based on multiple legacy systems, or with multiple data files, as spreadsheets, text/ flat files format as inputs, outputs or as interim files. The cost of error with data is also a criterion to be considered, by analysing the amount of data managed and if it is prone to human error or not, due to the complexity or the number of steps in the process, and how it may result in company damage. Intelligent processes will be capable of transforming non-structured data into digital structured data, so it can be exchanged between human beings and software, and with more precision and efficiency.

Looking into the process flow it must be analysed if there are many decisions to be taken, in particular, if these are made based on a business rule or judgment basis. By enhancing processes with intelligence, these can become able to manage judgment-based decisions.

The last item to be verified is the process volatility, i.e., if the process is unstable and changes frequently, it may not be worth for robotic process automation, but suitable for implementing intelligent technologies to guide through the flow. However, if a process is always performed based on the same routine with no changes, the repetition can be automated and can help achieving success, but now it might not require intelligence.

To support the collection of information during the execution of this step 5, please see Annex IV.

It is focused on the identification of suitability for intelligent automation, by first identified what tasks will be automated and the data that will be managed. It is necessary to identify the process transformation needed, if there is a need to convert data into digital format, if it is necessary to have automated decision in place or if there is a need to exchange unstructured data across different systems. With the problem definition we can

then assess what is the technologies to be put in place to get the expected outcome from the IPA implementation.

Assessing the process as-is, regarding its costs, time and quality is also an important part of this step, so that it can be designing an adapted proposal and re-evaluated later, when it became an intelligent process. As part of the process cost assessment, it should be gathering the cost related to the involved resources, such as human work and the required software. For time analysis, it should be measured the time it takes in each task, since the beginning till the end of the process. Regarding process quality, it should be defined by the process responsible, that must provide the quality expectations details.

By having a clear understanding of the desired outcome, it should be identified the required technology to be put in place so that the process became an intelligent process. The technology will be directly linked to the data, since these must be the input or output in the process, and according to the objective of this transformation, a cognitive technology must be chosen, such as:

- Natural language processing, optical character recognition, computer vision/ visual recognition or speech recognition – To capture data.
- Machine Learning – If the data structure is changing from time to time and the system must adapt and learn.

Since IPA ecosystems ends by gathering multiple technologies, the previous technologies are sometimes known as “add-ons” to chatbots and RPAs.

Once the technology is identified, we move on to the next step, where the necessary resources will be analysed.

| Process ID | 6. |
|---|---|
| Process Name | Assess required resources |
| Description | Identify the resources available:<br>- Human resources<br>- Software that supports automation |
| Goal | Assess what resources are necessary |
| Template | N/ A |
| Tool | N/ A |

*Table 7 – Step 6 – Assess required resources for IPA.*

Reaching the final stage of this diagram, in order to perform step 7, an assessment of the resources that the company has, must be made. When we refer to resources, we are referring not only to the available team, but also to the software that the company uses in its processes.

To implement/ develop this intelligent process, human beings are needed, in which case it will be preferable to have an internal team to carry out the implementation, in order to reduce costs, but which, however, must

have the necessary skills. In the event of lack of resources to develop the solution, the possibility of using external solutions should be evaluated.

As previously verified, there are already some processes that need software to be able to be executed, and to make it an intelligent process. It is first necessary to confirm whether they support processes automation and then whether they include support for artificial intelligence technologies or, in their absence, analyze how an integration should be done.

| Process ID | 7. |
|---|---|
| Process Name | Evaluate cost/ investment |
| Description | Before starting any implementation, it should be gather all the costs and investments to ensure that all the resources (human beings and techonology) will be available when needed, as well as if the expected result will be profitable. |
| Goal | Assess if the investment will be profitable |
| Template | N/ A |
| Tool | N/ A |

*Table 8 – Evaluate cost/ investment.*

To finalize the execution of the proposed diagram, and before starting any implementation, the last step is to assess the cost/ investment required for the proposal to implement an intelligent process. With this, it is expected that all resources (human beings and technological) will be available when needed. Taking into account the costs versus the results that are expected to be obtained with the implementation of the intelligent process, a decision must be made to proceed or not to proceed to the implementation phase. Note that the implementation phase is not within the scope of this diagram, as previously mentioned.

## 4.3 Usage recommendations

In this chapter, it is presented some recommendation regarding the method usage according to the studied literature review. Therefore, for some steps, applying these recommendations will be crucial.

It was considered that the implementation of the proposed framework should start from a **management decision** that would **delegate the responsibility to a key user**. This key user will be in charge of collecting all required information by reaching out all the necessary departments, teams and resources.

The **kick-off meeting** between management and key user would be crucial to **outline the goals** of this key user, so that he can understand how this strategy meets the company's holistic vision. At this meeting, the **stakeholders should be defined**, however, as this work should be continuous and progressive, these may be subject to change and introduced at those moments. The stakeholders should be responsible to gather information regarding known processes with issues, such as **time-consuming** or **prone to human error** processes.

In order to obtain greater collaboration and generate synergies, the management team must **communicate** to each department, indicating the reasons why this initiative is being taken and what the expectations are.

## 4.4 Demonstration – Use case

To make workers support the change, a communication was prepared that explains all the benefits, as well as moments to clarify doubts and obtain feedback.

Assuming the kick-off meeting was successfully executed, and the stakeholders are already involved, by using the presented method as a guide, the Company XPTO goal is find out if a certain business process – Manage customer complaints – can be transformed into intelligent processes, so it can:

- Improve customer satisfaction.
- Work/ product quality.
- Increase employee performance.
- Reduce/ eliminate the issues caused by human beings.

| | |
|---|---|
| **Process Title** | Manage customer complaints |
| **Purpose** | Obtaining customer complaints online. Direct these complaints to higher-level representatives as appropriate. Resolve them. Respond to customers |
| **Entry Criteria** | New complaint from client on the help desk platform |
| **Inputs** | Electronic form, together with images, that shows how to replicate the complaint |
| **Workflow Diagram** | Visual diagram indicating the relationship between activities in the process |
| **Activity Descriptions** | Support team:<br>1. Assess and tag complaint accordingly to the system modules/ features<br>2. 1st line of support:<br>o Checks for articles in Help Centre platform to solve the complaint<br>o If there are no articles, complaints are forward to the corresponding module/ feature owner<br>3. The feature owner must check the complaint and creates/ updates article to provide feedback to customer<br>4. Support team provides the article to customer<br>5. Customer marks complaint as solved/ not solved:<br>o If solved, ticket is closed<br>o If not solved, then go back to 1 |
| **Exceptions** | N/ A |

| | |
|---|---|
| **Business Rules** | An email must be sent within 1 hour if no response is provided to customer<br>Complaints must be tagged according to their system module/ feature<br>Complaints must be solved with a Help Centre article (create/ update articles) |
| **Outputs** | Help Centre article |
| **Exit Criteria** | Customer closes the ticket/ request and marks complain as solved |
| **Metrics** | Response time. Client satisfaction. Complaint resolution |

*Table 9 – Step 1 & 2 – Identify business process VS APQC PCF (use case).*

According to step 2, it is validated if the process matches one of APQC PCF processes. It is verified that process 6.2.3. matches with the selected business process, meaning that it is suitable for Intelligent Automation.

Then, the process activities must be assessed as part of step 3 and 4:

| | |
|---|---|
| **Task Title** | Assess complaint |
| **Purpose/ Goal** | Identify and tag complaints<br>Collect information to provide feedback to customer |
| **Assign to** | Support team |
| **Periodicity** | Several times a day |
| **Type** | User |
| **Data** | Structured and not structured |
| **Software** | Internal software – Helpdesk |

*Table 10 – Step 3 & 4 – Task 1 (use case).*

| | |
|---|---|
| **Task Title** | Search for articles within Help Centre related to complaint topic |
| **Purpose/ Goal** | Identify possible articles that would provide feedback to customer<br>Reduce the amount of complaint sent to feature owners |
| **Assign to** | Support team |
| **Periodicity** | Several times a day |
| **Type** | User |
| **Data** | Structured |
| **Software** | Internal software<br>1. Helpdesk – software where complaints are raised<br>2. Help Centre – software where articles with complaint resolutions are available |

*Table 11 – Step 3 & 4 – Task 2 (use case).*

| | |
|---|---|
| **Task Title** | Check complaint service level agreement status |
| **Purpose/ Goal** | Identify if feedback was provided to customer<br>If there are no feedback inform that it is still under analysis, ensure that service level agreement is respected |
| **Assign to** | Support team |
| **Periodicity** | Every 2 hours |
| **Type** | User |
| **Data** | Structured |
| **Software** | Internal software<br>1. Helpdesk – software where complaints are raised<br>2. Help Centre – software where articles with complaint resolutions are available |

*Table 12 – Step 3 & 4 – Task 3 (use case).*

| | |
|---|---|
| **Task Title** | Provide feedback to customer |
| **Purpose/ Goal** | Provide the article that solves the complaint |
| **Assign to** | Support team |
| **Periodicity** | Several times a day |
| **Type** | User |
| **Data** | Structured |
| **Software** | Internal software<br>1. Helpdesk – software where complaints are raised<br>2. Help Centre – software where articles with complaint resolutions are available |

*Table 13 – Step 3 & 4 – Task 4 (use case).*

For step 5, the following template was filled in:

| **Questions** | **Answers** |
|---|---|
| **How will this process automation contribute holistically?** | The company's holistic vision, in terms of automation, involves the desire of setting up processes that free human beings from repetitive tasks that lead to human errors, and also to increase human's productivity and customer service responsiveness |
| **How often does the process occur?** | Regularly – Daily |
| **Is the process time-consuming?** | Yes |
| **Is the process prone to human mistakes?** | Yes |
| **Does the process manage data across different systems?** | Yes |

| | | |
|---|---|---|
| **Identify the input and output data involved in the process** | Input | Output |
| | Structured data – Online forms<br>Unstructured data – Screenshots and images | Structured data |
| **How do you describe the process flow?** | Follows a strict set of predefined rules. | |

*Table 14 – Step 5 – Identify process automation type (use case).*

As part of step 5, it was also validated with stakeholders that this process consumes a lot of time and (human) resources, since it is necessary to analyse the text of complaints and customer images and then tag all complaints according to keywords and in a repetitive way. After this tagging, validate if there are articles in the Help Centre software that are common to the terms placed in the tags. If they exist, it is necessary for Support to add to the complaint the link to the article explanation.

Checking complaint Service Level Agreement status is also a very important activity that is currently executed by support team, by going every 2h in the system checking for updates. Once the article is available it should be sent to the customer.

Considering what was described, and according to the literature review, this process could be considered suitable for intelligent automation.

The insertion of cognitive technologies, such as Optical Character Recognition (OCR) may be an option for the interpretation of complaints written by customers, as well as Visual Recognition (VR) for interpretation of the images sent together with the complaints, in order to tag complaints and carry out article searches within the Help Centre so it can be provided back to the customer.

Having the previous information gather, the step 6 is to assess the required resources, and to support it, it was used the Annex V.

| **Questions** | **Answers** |
|---|---|
| **Software** | |
| **Is there already in place any AI technology/ software?** | No |
| **Does the current software support previous AI requirements/ integrations?** | No |
| **Human Resources** | |
| **Is there a development team available to develop/ implement the AI technology?** | No |
| **Do you require external resources?** | Yes |

*Table 15 – Step 6 – Assess resources (use case).*

According to the answers above, it became clear that software development is required as well as human resources to implement it. These should be considered on the cost/ investment assessment of step 7, where outsourcing companies will be contacted to carry out the necessary developments, which should send their respective budgets so that the company can make a decision.

Going forward, the process would be able to work all by itself, with the exception when there are no articles available or the customer does not agree with the final response, where a human being is “called” to intervene.

## 4.5 Validation & Discussion

To validate and assess the usability of the proposed framework, interviews were conducted. The objective of the interviews is to understand if the proposed model is adequate to the real context of process automation in companies, both in terms of business process improvement, as well as to see if the set of actions that allow reaching a certain level of intelligent automation are adequate.

To this end, the set of interviews conducted is focused on two groups: academic group and business group, specialists in process management.

In addition, the questionnaire carried out in the scope of the dissertation also serves as a validation tool for the proposed model, as it allowed us to gather the importance of a set of activities and improvement actions that are proposed in the framework.

In the following subsection, the interview guide used in conducting the interviews is presented, while in Annex V the support material used as well as the links to access the interviews carried out are available.

### 4.5.1 Interviews

To carry out the interviews, it was necessary to understand the stakeholders whose use of this model would positively impact, thus, two groups of people were identified.

The first group corresponds to NOVA IMS professors who teach subjects related to business process management as well as provide consultancy in the same area. By having knowledge on this area, they can be suitable to provide feedback on the proposed framework.

The second group focuses on agents who work in an organization within the area of operations and development, who end up managing processes, in which they can be mentioned as COO and CTO. The interviews with this group aim to understand if the proposed model is feasible to be implemented in a practical and real context.

For this interview process, videoconferencing technologies had to be used due to the worldwide pandemic called Covid-19. All interviewees authorized the recording of their interviews and the respective sharing of their personal data.

Next, the interview model used with all respondents is presented. Before the questions are answered, there is an introductory presentation by the interviewer, in which the research objectives are explained, some basic concepts and, later, the presentation of the proposed framework to find and promote intelligent automation to a target process.

1) Do you consider the proposed framework useful and why? If not, why do you believe it is not?

- NOVA IMS Professor
    - "Although I do not have extensive experience in the automation area within business organizations, but in a more academic context, I consider it a very useful for organization due to the lack of knowledge and guidelines available."
- COO
    - "Yes, the framework is adjusted for a world where human beings are performing the search for automation targets. In a world of AI, it would be great to have an AI model (framework) that looks for potential automation targets."
- CTO
    - "Yes, it is useful as it presents a systematic approach to identify and automate processes."

2) Do you have any criticism towards the proposed framework? Please explain.

- NOVA IMS Professor
    - "I do not have an additional criticism. It is an interesting framework and I consider that it would help organizations when designing process automation and that would provide business improvements within the automation area."
- COO
    - "No. It is a good fit for purpose"
- CTO
    - "The presented framework, although useful to systematically find processes that should be automated with intelligence, does not address two key issues:
        - How to automate the identified processes — probably, in the scope of another framework?
        - How to use AI (or not) to automate those processes?"

3) Would you consider implementing the proposed framework? Please clarify why/ why not.

- NOVA IMS Professor
    - "I would consider using this framework, which is undoubtedly a good methodology for companies and that will help to fill a gap that currently exists in the area."
- COO
    - "Yes, definitely. This is the same approach we have today for other domains. But we should try to move to an AI world that pinpoints the targets, when such solution becomes available."
- CTO

- "Yes, currently in my organisation no formal systematic process is in place to automate processes, so having a framework like this would for sure be great."

4) Do you have any recommendations or suggestions for further improvements of the proposed framework?

- NOVA IMS Professor
  - "The proposed framework is well structured and supported, and as part of recommendations or suggestions for improvements, it could be interesting to introduce process mining topic."
- COO
  - "It seems that it wouldn't be such a big leap to try to approach the problem with AI, taking this framework as a steppingstone."
- CTO
  - "The proposed framework could be augmented or improved in two ways:
    - Employ AI to broaden the number of detected processes beyond what can be perceived by human beings using the proposed decision tree.
    - Extend the framework to allow it to propose automation implementation and the use of AI on the automation process itself."

## 4.6 Discussion

Three analyses will be made in this section, regarding utility, viability of implementation and improvements based on the answers from validation phase. Then, a general evaluation to the proposed framework will be done based on the previous analysis.

Regarding the presented proposed framework and its utility, all interviewees agreed that the proposed framework is very useful.

According to all the participants' experience, although one of them in a more academic perspective, all agree with the fact of existing a lack of knowledge and tools when fostering Intelligent Process Automation. While sometimes companies have few resources dedicated to this type of work, when they decide to move in this direction, the existence of frameworks that help them is indispensable.

Still regarding the proposed framework utility, it was shared the idea that the future of companies passes by adapting to new technologies where machines have a closer relation to human beings. Human beings would be freed from low-added value tasks and allocated to more specialized and humanized tasks that machines cannot perform yet. The sooner this adaptation starts, the sooner they will have a competitive advantage over other companies. Although the framework proposal presents a strategy where human beings look for processes that can be automated in an intelligent path, during the meetings, the possibility of passing this onus to an intelligent system was discussed, which ends up by having an AI model proposing potential IPA solutions.

Regarding criticisms and observations on what was proposed and its viability, all interviewees agreed that it is a good fit for its purpose, filling the existing gap on companies regarding automating processes to became intelligent since it provides a clear overview of what steps should be performed. Although useful to systematically find processes that should be automated, there were two additional points identified regarding on how to automate the processes, and how to implement the AI within the processes, since the framework does not go in-depth detail for each process because it requires a detailed investigation under each process and lead to a discussion of which would take us far afield from the main purpose of this research.

Summarizing, it was considered viable the proposed framework, as it would contribute to defining procedures of designing and promoting intelligent automation.

Regarding the suggestions for improvement, all participants agree that an evaluation would only be possible through a practical application of the proposed framework and appropriate testing. It was also referred by all the interviewees the fact of process identification could take advantage of AI, by per example, adding process mining technology within the framework or take advantage of AI to tend the number of detected processes beyond what can be perceived by human beings using the proposed decision tree, and extending the framework so it could propose automation implementation and the use of AI within the proposed automation processes.

# 5 CONCLUSIONS

The study objective to build a method to foster Intelligent Processes Automation into an organization was achieved.

To this end, a method was developed, represented by a workflow diagram. After being confronted with various extrinsic and intrinsic factors, selected based on the literature review, the elected processes and respective steps are evaluated to fit the intelligence technology that best suits their nature.

To validate the purposed method, interviews were carried out with specialists in the area who provided feedback on the method built and the results obtained.

Conclude this study that the topic of intelligent automation processes is a relatively recent topic to most companies, which is identified with the problem of the little existence of methods and practices and, therefore, when interviewing specialists in the area, I felt a great enthusiasm and adherence in responding, participating, and helping to improve the method proposed in this work.

## 5.1 Framework limitations

Regarding the developed framework, it is important to mention that in addition to the attributes outlined, there are also inherent limitations, such as:

- The fact that the framework is based on the APQC process classification, and this is quite extensive, the identification process may be a little laborious, so the presented list of selected processes suitable for automated makes the process list shorten, but this identification may be extendable to a more simplistic and/ or automated form of identification where intelligent process could be put in place.
- In order to be able to make a detailed analysis of the effectiveness of the proposed method, it should have been applied in multiple contexts where later the results should be evaluated. However, in the context of this work, it was not possible to reach it due to the necessary time window.
- So that the companies take greater benefit from this research to promote a process to an intelligent one, the inclusion of tools and techniques to add intelligence to processes as a suggestion could have been made available along with the method. However, it was not possible to include it due to the time window required.
- To obtain more reliable feedback and closer to reality, the interviews could include more specialists and from different areas, however, this work represents only a starting point and can be extended to a deeper study.

## 5.2 Recommendations for future development

As recommendations for future work development, it would be very interesting to improve the process of identification processes that are suitable for automation by exploring the possibility of developing an intelligent automation process, including data mining and machine learning so that would be able to identify organizations processes, as well as adapt and expand the method according to changes that could occur to the process classification framework.

In order the organization could easily adapt, reduce research time spent on process identification, tools and implementation and, in the end, free human beings from non-high value tasks, making them decision makers, the suggestion presented could suffer some mutations and adaptations to become an increasingly effective method that can effectively identify and propose automation of intelligent processes.

# REFERENCES


Accenture. 2019. Intelligent Automation at Scale: what's the hold up?

Agrawal, Nitin. 2020. Hyperautomation – The next Frontier. (https://www2.deloitte.com/content/dam/Deloitte/in/Documents/technology-media-telecommunications/in-hyperautomation-the-next-frontier-noexp.pdf).

Aguirre, S., & Rodriguez, A. 2017. Automation of a Business Process Using Robotic Process Automation (RPA): A Case Study. Applied Computer Sciences in Engineering. WEA 2017. Communications in Computer and Information Science, vol 742. Springer, Cham. 65-71 doi: 10.1007/978-3-319-66963-2_7 .

AIMDek Technologies. 2018. Evolution of Robotic Process Automation (RPA): The Path to Cognitive RPA. *Medium*. Retrieved May 18, 2020 (https://medium.com/@AIMDekTech/evolution-of-robotic-process-automation-the-path-to-cognitive-rpa-c3bd52c8b865).

Anon. 2020. Assisted vs. Unassisted Robotic Process Automation – Winjit. Retrieved May 18, 2020 (https://www.winjit.com/articles/assisted-vs-unassisted-robotic-process-automation/).

Anywhere, Automation. n.d. What Is Intelligent Automation? *Intelligent Automation | Ai Bots | Automation Anywhere*. Retrieved May 30, 2020 (https://www.automationanywhere.com/intelligent-automation).

APQC. 2019. APQC Process Classification Framework (PCF) – Cross Industry – 7.2.1. *APQC*. Retrieved December 5, 2020 (https://www.apqc.org/resource-library/resource-listing/apqc-process-classification-framework-pcf-cross-industry-excel-7).

Baskerville, R. L., Kaul, M., & Storey, V. C. 2015. Genres of Inquiry in Design-Science Research: Justification and Evaluation of Knowledge Production. *MIS Quarterly*, 39 (3): 541-64. doi: 10.25300/MISQ/2015/39.3.02.

Bengio, Y., Courville, A., & Vincent, P. 2013. Representation Learning: A Review and New Perspectives. *IEEE Transactions on Pattern Analysis and Machine Intelligence*, 35 (8): 1798-1828. doi: 10.1109/TPAMI.2013.50.

Berger, B. 2019. Workflow Management: 5 Things You Need to Know. *Monday Teamwork*. Retrieved May 3, 2020 (https://monday.com/blog/teamwork/workflow-management/).

Billings, C. E. 1991. Human-Centered Aircraft Automation: A Concept and Guidelines. *Nasa Technical Memorandum* (February).

Burlton, R., & Lyke-Ho-Gland, H. 2016. Part Three: Frameworks and End-to-End Processes. *BPTrends*. Retrieved December 5, 2020 (https://www.bptrends.com/part-three-frameworks-and-end-to-end-processes/).

Calkins, M., Ward-Dutton, N., Westerman, G., Lakshmi, N., Fernandes, S., Wei, A., Skinner, C., Sacolick, I., Rymer, J., Heneghan, L., Blake, D., Galbraith, R., Tolido, R., & Beckley, M.. 2020. *Hyperautomation*. BookBaby.

Carbonell, J. G., Michalski, R. S., & Mitchell, T. M. 1983. An Overview of Machine Learning. *Machine* Learning, 3-23. Berlin, Heidelberg: Springer Berlin Heidelberg.

Cewe, C., Koch, D., & Mertens, R.. 2018. Minimal Effort Requirements Engineering for Robotic Process Automation with Test Driven Development and Screen Recording. *Business Process Management Workshops. BPM 2017.* 642-48. doi: 10.1007/978-3-319-74030-0_51

Col, P. 2017. Attended on Desktops? Unattended on Servers? RPA Is a Continuum! *Contextor*. Retrieved May 19, 2020 (https://contextor.eu/en/rpa-is-a-continuum/).

Cover, T., & Hart, P.. 1967. Nearest Neighbor Pattern Classification. *IEEE Transactions on Information Theory*, 13 (1): 21-27. doi: 10.1109/TIT.1967.1053964.

Devarajan, Y. 2019. A Review on Intelligent Process Automation. *International Journal of Computer Applications*, 182 (36): 40-44. doi: 10.5120/ijca2019918374.

Dumas, Marlon, Marcello la Rosa, Jan Mendling, and Hajo A. Reijers. 2013. Fundamentals of Business Process Management. Berlin, Heidelberg: Springer Berlin Heidelberg.

Endsley, M. R. 1987. The Application of Human Factors to the Development of Expert Systems for Advanced Cockpits. *Proceedings of the Human Factors Society Annual Meeting*, 31 (12): 1388-92. doi: 10.1177/154193128703101219.

Endsley, M. R., & Kiris, E. O. 1995. The Out-of-the-Loop Performance Problem and Level of Control in Automation. *Human Factors: The Journal of the Human Factors and Ergonomics Society*, 37 (2): 381-94. doi: 10.1518/001872095779064555.

Fernandez, D., & Aman, A. 2018. Impacts of Robotic Process Automation on Global Accounting Services. *Asian Journal of Accounting and Governance*, 9: 123-32. doi: 10.17576/AJAG-2018-09-11.

Ford, J. D., Ford, L. W., & McNamara, R. T. 2002. Resistance and the Background Conversations of Change. *Journal of Organizational Change Management*, 15 (2): 105-21. doi: 10.1108/09534810210422991.

Forrester Research Inc. 2014, February. Building a Center of Expertise to Support Robotic Automation: 1-14. (https://www.blueprism.com/uploads/resources/white-papers/forrester_research_-_building_a_center_of_expertise_for_robotic_automation_-_a_thought_leadership_white_paper.pdf)

Gallagher, R. 2018. RBS Launches Mobile App Messaging Service Using Cora. *Business Insider*. Retrieved January 2, 2021 (https://www.insider.co.uk/news/rbs-cora-ai-messaging-app-12688390).

Georgakopoulos, D., Hornick, M., & Sheth, A. 1995. An Overview of Workflow Management: From Process Modeling to Workflow Automation Infrastructure. *Distributed and Parallel Databases*, 3 (2): 119-53. doi: 10.1007/BF01277643.

Goldberg, K. 2012. What Is Automation? *IEEE Transactions on Automation Science and Engineering*, 9 (1): 1-2. doi: 10.1109/TASE.2011.2178910.

Gray, D. 2019. No One Behind the Wheel: The New Workforce Driving Australia's Mines. *The Sydney Morning Herald*. Retrieved January 2, 2021 (https://www.smh.com.au/business/companies/no-one-behind-the-wheel-the-new-workforce-driving-australia-s-mines-20190411-p51dd2.html).

Gregor, S., & Hevner, A. R. 2013. Positioning and Presenting Design Science Research for Maximum Impact. *MIS Quarterly*, 37 (2): 337-55. doi: 10.25300/MISQ/2013/37.2.01.

Growiec, J. 2020, April. Automation, Partial and Full.

Gupta, S., Rani, S., & Dixit, A. 2019. Recent Trends in Automation – A Study of RPA Development Tools. 159-63 in *2019 3rd International Conference on Recent Developments in Control, Automation & Power Engineering (RDCAPE)*. IEEE.

Hagel, J., Brown, J. S., & Wooll, M. 2019. Skills Change, but Capabilities Endure: Why Fostering Human Capabilities First Might Be More Important than Reskilling in the Future of Work. *Deloitte Insights* , 16.

Hevner, A. R., March, S. T., Park, J., & Ram, S. 2004. Design Science in Information Systems Research. *MIS Quarterly: Management Information Systems*, 28 (1): 75-105. doi: 10.2307/25148625.

Hofmann, P., Samp, C., & Urbach, N. 2020. Robotic Process Automation. *Electronic Markets*, 30 (1): 99-106. doi: 10.1007/s12525-019-00365-8.

IBM. 2016. *Crédit Mutuel*. Vol. Stories. (https://www.ibm.com/watson/stories/creditmutuel)

International, KPMG. 2019. Easing the Pressure Points: The State of Intelligent Automation. *Intelligent Automation and Data & Analytics* (https://assets.kpmg/content/dam/kpmg/xx/pdf/2019/03/easing-pressure-points-the-state-of-intelligent-automation.pdf)

Kaber, D. B., & Endsley, M. R.. 2004. The Effects of Level of Automation and Adaptive Automation on Human Performance, Situation Awareness and Workload in a Dynamic Control Task. *Theoretical Issues in Ergonomics Science*, 5 (2): 113-53. doi: 10.1080/1463922021000054335.

Kenge, R. 2020. Machine Learning, Its Limitations, & Solutions Over IT. *International Journal of Applied Research on Information Technology and Computing*, 11 (2):73. doi: 10.5958/0975-8089.2020.00009.3.

Khalaf, A. 2017. The Benefits (and Limitations) of RPA Implementation. *Accenture Financial Services Blog*. Retrieved May 2, 2020 (https://financialservicesblog.accenture.com/the-benefits-and-limitations-of-rpa-implementation).

Khan, T. 2018. RPA: Is Your Integration Strategy Ready for the Next Emerging Technology? *Boomie*. Retrieved May 31, 2020 (https://resources.boomi.com/blog-dell-boomi/robotic-process-automation-integration-strategy).

Lacity, M. C., & Willcocks, L. P. 2016. A New Approach to Automating Services. *MIT Sloan Management Review*, 58 (1): 41-49.

Lacity, M., Willcocks, L., & Craig, A. 2015. *Robotic Process Automation at Telefónica O2*. ( https://www.blueprism.com/uploads/resources/case-studies/TelefonicaOUWP022015FINALPOSTED.pdf ).

Lake, B. M., Ullman, T. D., Tenenbaum, J. B., & Gershman, S. J. 2017. Building Machines that Learn and Think like People. *Behavioral and Brain Sciences*, 40: e253. doi: 10.1017/S0140525X16001837.

Lamberton, C. 2016. Get Ready for Robots. *Ernst & Young*. ( https://www.ey.com/Publication/vwLUAssets/Get_ready_for_robots/$FILE/ey-get-ready-for-robots.pdf).

Leopold, H., Aa, H. van der, & Reijers, H. A. 2018. Identifying Candidate Tasks for Robotic Process Automation in Textual Process Descriptions. Gulden J., Reinhartz-Berger I., Schmidt R., Guerreiro S., Guédria W., Bera P. (eds) Enterprise, Business-Process and Information Systems Modeling. BPMDS 2018, EMMSAD 2018.67-81. (https://link.springer.com/chapter/10.1007%2F978-3-319-91704-7_5).

Le Clair, C. 2017. Robotic Process Automation: The 12 Providers that Matter Most and How they Stack Up Key Takeaways. Robotic Process Automation. (https://www.forrester.com/report/The-Forrester-Wave-Robotic-Process-Automation-Q1-2017/RES131182).

Le Clair, C., Cullen, A., Richardson, C., Elizabeth, C., & Lynch, D. 2015. The State of Robotic Process Automation. *Forrester Research Inc.*, 1-10. (https://www.forrester.com/report/The+State+Of+Robotic+Process+Automation/-/E-RES129042).

Lim, M. 2018. Workflow Automation: 25 Years of Tried-and-True Success. *IBM – Cloud Computing*. Retrieved May 3, 2020 (https://www.ibm.com/blogs/cloud-computing/2018/12/18/workflow-automation-25-years/).

Luecke, R. 2003. *Managing Change and Transition*. Boston: MA: Harvard Business School Press.

Lyke-Ho-Gland, H. 2015. Back to Basics: Why We Need Process Frameworks. *The APQC Blog*. Retrieved December 5, 2020 (https://www.apqc.org/blog/back-basics-why-we-need-process-frameworks).

March, S. T., & Smith, G. F. 1995. Design and Natural Science Research on Information Technology. *Decision Support Systems*, 15 (4): 251-66. doi: 10.1016/0167-9236(94)00041-2.

MarketsandMarkets. 2020. Business Process Management Market. Retrieved December 8, 2020 (https://www.marketsandmarkets.com/PressReleases/business-process-management.asp).

Martin, E., Kaski, S., Zheng, F., Webb, G. I., Zhu, X., Muslea, I. et al. 2011. Samuel's Checkers Player. *Encyclopedia of Machine Learning*, 881-881. Boston, MA: Springer US.

Murphy, K. L. 2018. Robotic Process Automation and Low-Code. *OutSystems*. Retrieved May 2, 2020 (https://www.outsystems.com/blog/posts/robotic-process-automation-low-code/).

Nof (ed.), S. Y., 2009. *Springer Handbook of Automation*. Berlin, Heidelberg: Springer Berlin Heidelberg.

Norman, D. 2017. Design, Business Models, and Human-Technology Teamwork. *Research-Technology Management*, 60 (1): 26-30. doi: 10.1080/08956308.2017.1255051.

Nunamaker, J. F., Chen, M., & Purdin, Titus D. M. 1990. Systems Development in Information Systems Research. *Journal of Management Information Systems*, 7 (3): 89-106. doi: 10.1080/07421222.1990.11517898.

Österle, H., Becker, J., Frank, U., Hess, T., Karagiannis, D., Krcmar, H. et al. 2011. Memorandum on Design-Oriented Information Systems Research. *European Journal of Information Systems*, 20 (1): 7-10. doi: 10.1057/ejis.2010.55.

Panetta, K. 2019. Gartner Top 10 Strategic Technology Trends for 2020. *Gartner*. Retrieved April 19, 2020 (https://www.gartner.com/smarterwithgartner/gartner-top-10-strategic-technology-trends-for-2020/).

Parasuraman, R., Sheridan, T. B., & Wickens, C. D. 2000. A Model for Types and Levels of Human Interaction with Automation. *IEEE Transactions on Systems, Man, and Cybernetics – Part A: Systems and Humans*, 30 (3): 286-97. doi: 10.1109/3468.844354.

Paresh, P. P. 2018. Intelligent Automation to Work for Federal. Accenture Federal Services. *Compelling Benefits, Common Misconceptions*. (https://www.accenture.com/_acnmedia/PDF-90/Accenture-Putting-Automation-to-Work-for-Federal.pdf)

Peffers, K., Tuunanen, T., Rothenberger, M. A., & Chatterjee, S. 2007. A Design Science Research Methodology for Information Systems Research. *Journal of Management Information Systems*, 24 (3): 45-77. doi: 10.2753/MIS0742-1222240302.

Pipefy. 2018. What Is a Workflow? Building Workflow Processes for Efficiency & Control. *Pipefy*. Retrieved May 3, 2020 (https://www.pipefy.com/workflows/).

Processmaker. n.d. Glossary | Documentation@ProcessMaker. Retrieved May 3, 2020 (https://wiki.processmaker.com/3.0/Glossary#w).

Rieley, J., & Clarkson, I. 2001. The Impact of Change on Performance. *Journal of Change Management*, 2 (2): 160-72. doi: 10.1080/714042499.

RioTinto. n.d. Autonomous Trucks. *Rio Tinto – Innovation*. Retrieved January 2, 2021 (https://www.riotinto.com/en/about/innovation/automation).

Russell, S. J., & Norvig, P. 2020. *Artificial Intelligence – A Modern Approach*. Fourth Ed. Prentice Hall.

Schatsky, D., Muraskin, C., & Gurumurthy, R. 2015. Cognitive Technologies: The Real Opportunities for Business. *Deloitte Review*, (16): 17.

Schatsky, D., Muraskin, C., & Iyengar, K. 2016. A Path to the Cognitive Enterprise. *Deloitte. University Press*. (https://www2.deloitte.com/uk/en/pages/innovation/articles/path-to-cognitive-enterprise.html).

Seasongood, S. 2017. Not Just for the Assembly Line: A Case for Robotics in Accounting and Finance. *Financial Executives*. Retrieved May 2, 2020 (https://www.financialexecutives.org/Topics/Technology/Not-Just-for-the-Assembly-Line-A-Case-for-Robotic.aspx).

Sheridan, T. B., Verplank, W. L., & Brooks, T. L. 1978. Human and Computer Control of Undersea Teleoperators. (https://www.researchgate.net/publication/23882567_Human_and_Computer_Control_of_Undersea_Teleoperators).

Stoilova, K. P., & Stoilov, T. A. 2004. *Evolution of the Workflow Management* Systems. (https://www.academia.edu/17466373/Evolution_of_the_workflow_management_systems).

Suri, V. K., Elia, M., & Hillegersberg, J. van. 2017. Software Bots – The Next Frontier for Shared Services and Functional Excellence. *Global Sourcing of Digital Services: Micro and Macro Perspectives. Global Sourcing 2017*. 81-94. (https://doi.org/10.1007/978-3-319-70305-3_5).

Syed, R., Suriadi, S., Adams, M., Bandara, W., Leemans, S. J. J., Ouyang, C. et al. 2020. Robotic Process Automation: Contemporary Themes and Challenges. *Computers in Industry*, 115. doi: 10.1016/j.compind.2019.103162.

Talia, D. 2013. Workflow Systems for Science: Concepts and Tools. *ISRN Software Engineering*, 2013: 1-15. doi: 10.1155/2013/404525.

Taulli, T. 2019. Robotic Process Automation (RPA). *Artificial Intelligence Basics*, 91-102. Berkeley, CA: Apress. (https://link.springer.com/chapter/10.1007%2F978-1-4842-5028-0_5)

Tornbohm, C., & Dunie, R. 2017, December. Market Guide for Robotic Process Automation Software. Gartner, Inc.: 1-35.

UiPath. n.d. Intelligent Process Automation – Automation Enabled by Context-Aware Robots. UiPath. Retrieved May 31, 2020 (https://www.uipath.com/rpa/intelligent-process-automation).

Uskenbayeva, R., Kalpeyeva, Z., Satybaldiyeva, R., Moldagulova, A., & Kassymova, A. 2019. Applying of RPA in Administrative Processes of Public Administration. *2019 IEEE 21st Conference on Business Informatics (CBI)*, 9-12. IEEE.

Vedder, R., & Guynes, C. S. 2016. The Challenge Of Botsourcing. *Review of Business Information Systems (RBIS)*, 20 (1): 1-4. doi: 10.19030/rbis.v20i1.9677.

Venkatesh, T. 2018. International Trends in RPA Adoption. *RPA Conferences*. (https://rpaconferences.com/assets/pdfs/Tejus-Venkatesh.pdf).

Walls, J. G., Widmeyer, G. R., & el Sawy, O. A. 1992. Building an Information System Design Theory for Vigilant EIS. *Information Systems Research*, 3 (1): 36-59. doi: 10.1287/isre.3.1.36.

Wellmann, C., Stierle, M., Dunzer, S., & Matzner, M.. 2020. A Framework to Evaluate the Viability of Robotic Process Automation for Business Process Activities. *Business Process Management: Blockchain and Robotic Process Automation Forum. BPM 2020.* 200-214. (https://link.springer.com/chapter/10.1007%2F978-3-030-58779-6_14)

Westland, J. C., & Clark, T. H. K. 1999. *Global Electronic Commerce: Theory and Case Studies*. MIT Press.

Willcocks, L., & Craig, A. 2015. Robotic Process Automation at Xchanging. *The Outsourcing Unit Working Research Paper Series*. (https://www.blueprism.com/uploads/resources/white-papers/LSE-Case-Study-XchangingOUWP032015.pdf)

Willcocks, L., Lacity, M., & Craig, A. 2015. The IT Function and Robotic Process Automation. *The Outsourcing Unit Working Research Paper Series*. (https://eprints.lse.ac.uk/64519/1/OUWRPS_15_05_published.pdf)

Winter, R. 2008. Design Science Research in Europe. *European Journal of Information Systems*, 17 (5): 470-75. doi: 10.1057/ejis.2008.44.

Workflow Management Coalition. 1999. Workflow Management Coalition Terminology & Glossary 3.0. *The Workflow Management Coalition Specification*.

Wright, D., Witherick, D., & Gordeeva, M. 2017. The Robots Are Ready. Are You? Untapped Advantage in Your Digital Workforce. Deloitte, 28.

# ANNEXES

## Annex I – APQC's Process Framework – Cross Industry (Adapted)

| PCF ID | Hierarchy ID | Name | Suitable for Intelligent Automation? |
|---|---|---|---|
| 10002 | 1.0 | Develop vision and strategy | |
| 17040 | 1.1 | Define the business concept and long-term vision | |
| 10017 | 1.1.1 | Assess the external environment | No |
| 10018 | 1.1.2 | Survey market and determine customer needs and wants | Yes |
| 10019 | 1.1.3 | Assess the internal environment | No |
| 10020 | 1.1.4 | Establish strategic vision | No |
| 16792 | 1.1.5 | Conduct organization restructuring opportunities | No |
| 10015 | 1.2 | Develop business strategy | |
| 10037 | 1.2.1 | Develop overall mission statement | No |
| 10038 | 1.2.2 | Define and evaluate strategic options to achieve the objectives | No |
| 10039 | 1.2.3 | Select long-term business strategy | No |
| 10040 | 1.2.4 | Coordinate and align functional and process strategies | No |
| 10041 | 1.2.5 | Create organizational design | No |
| 10042 | 1.2.6 | Develop and set organizational goals | No |
| 10043 | 1.2.7 | Formulate business unit strategies | No |
| 19959 | 1.2.8 | Develop customer experience strategy | No |
| 18916 | 1.2.9 | Communicate strategies internally and externally | No |
| 10016 | 1.3 | Execute and measure strategic initiatives | |
| 10057 | 1.3.1 | Develop strategic initiatives | No |
| 10058 | 1.3.2 | Evaluate strategic initiatives | No |
| 10059 | 1.3.3 | Select strategic initiatives | No |

| | | | |
|---|---|---|---|
| 10060 | 1.3.4 | Establish high-level measures | No |
| 19507 | 1.3.5 | Execute strategic initiatives | No |
| 20944 | 1.4 | Develop and maintain business models | |
| 20945 | 1.4.1 | Develop business models | No |
| 20950 | 1.4.2 | Maintain business models | No |
| 20955 | 1.4.3 | Establish business model governance | No |
| 10003 | 2.0 | Develop and manage products and services | |
| 19696 | 2.1 | Govern and manage product/ service development program | |
| 10061 | 2.1.1 | Manage product and service portfolio | No |
| 10067 | 2.1.2 | Manage product and service lifecycle | No |
| 19985 | 2.1.3 | Manage patents, copyrights, and regulatory requirements | No |
| 11740 | 2.1.4 | Manage product and service master data | No |
| 19698 | 2.2 | Generate and define new product/ service ideas | |
| 10065 | 2.2.1 | Perform discovery research | No |
| 19669 | 2.2.2 | Generate new product/ service concepts | No |
| 19990 | 2.2.3 | Define product/ service development requirements | No |
| 10062 | 2.3 | Develop products and services | |
| 19993 | 2.3.1 | Design and prototype products and services | No |
| 19996 | 2.3.2 | Test market for new or revised products and services | No |
| 19997 | 2.3.3 | Prepare for production/ service delivery | No |
| 10004 | 3.0 | Market and sell products and services | |
| 10101 | 3.1 | Understand markets, customers, and capabilities | |
| 10106 | 3.1.1 | Perform customer and market intelligence analysis | Yes |
| 10107 | 3.1.2 | Evaluate and prioritize market opportunities | No |
| 10102 | 3.2 | Develop marketing strategy | |

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|---|---|---|---|
| 11168 | 3.2.1 | Define offering and customer value proposition | No |
| 10123 | 3.2.2 | Define pricing strategy | No |
| 20000 | 3.2.3 | Define and manage channel strategy | No |
| 20006 | 3.2.4 | Analyze and manage channel performance | No |
| 16848 | 3.2.5 | Develop marketing communication strategy | Yes |
| 18924 | 3.2.6 | Design and manage customer loyalty program | Yes |
| 20008 | 3.3 | Develop and manage marketing plans | |
| 10148 | 3.3.1 | Establish goals, objectives, and metrics for products/ services by channel/ segment | No |
| 10149 | 3.3.2 | Establish marketing budgets | No |
| 20593 | 3.3.3 | Develop and manage pricing | No |
| 20010 | 3.3.4 | Develop and manage promotional activities | No |
| 10153 | 3.3.5 | Track customer management measures | Yes |
| 16613 | 3.3.6 | Analyze and respond to customer insight | Yes |
| 10154 | 3.3.7 | Develop and manage packaging strategy | No |
| 16629 | 3.3.8 | Manage product marketing content | No |
| 10103 | 3.4 | Develop sales strategy | |
| 10129 | 3.4.1 | Develop sales forecast | No |
| 10130 | 3.4.2 | Develop sales partner/ alliance relationships | No |
| 10131 | 3.4.3 | Establish overall sales budgets | No |
| 10132 | 3.4.4 | Establish sales goals and measures | No |
| 10133 | 3.4.5 | Establish customer management measures | No |
| 10105 | 3.5 | Develop and manage sales plans | |
| 10182 | 3.5.1 | Manage leads/ opportunities | No |
| 10183 | 3.5.2 | Manage customers and accounts | No |
| 11779 | 3.5.3 | Develop and manage sales proposals, bids, and quotes | No |

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|---|---|---|---|
| 10185 | 3.5.4 | Manage sales orders | Yes |
| 10187 | 3.5.5 | Manage sales partners and alliances | No |
| 20022 | 4.0 | Deliver physical products | |
| 10215 | 4.1 | Plan for and align supply chain resources | |
| 10221 | 4.1.1 | Develop production and materials strategies | No |
| 10222 | 4.1.2 | Manage demand for products | Yes |
| 10223 | 4.1.3 | Create materials plan | No |
| 10224 | 4.1.4 | Create and manage master production schedule | No |
| 17042 | 4.1.5 | Plan distribution requirements | No |
| 10226 | 4.1.6 | Establish distribution planning constraints | No |
| 10227 | 4.1.7 | Review distribution planning policies | No |
| 10368 | 4.1.8 | Develop quality standards and procedures | No |
| 10216 | 4.2 | Procure materials and services | |
| 10277 | 4.2.1 | Provide sourcing governance and perform category management | No |
| 20973 | 4.2.2 | Develop sourcing and category management strategies | No |
| 10278 | 4.2.3 | Select suppliers and develop/ maintain contracts | Yes |
| 10279 | 4.2.4 | Order materials and services | Yes |
| 10280 | 4.2.5 | Manage suppliers | Yes |
| 10217 | 4.3 | Produce/ assemble/ test product | |
| 10303 | 4.3.1 | Schedule production | Yes |
| 10304 | 4.3.2 | Produce/ assemble product | Yes |
| 10369 | 4.3.3 | Perform quality testing | Yes |
| 10370 | 4.3.4 | Maintain production records and manage lot traceability | Yes |
| 10219 | 4.4 | Manage logistics and warehousing | |
| 10338 | 4.4.1 | Provide logistics governance | No |

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|---|---|---|---|
| 20936 | 4.4.2 | Plan and manage inbound material flow | No |
| 10340 | 4.4.3 | Operate warehousing | No |
| 10341 | 4.4.4 | Operate outbound transportation | No |
| 20025 | 5.0 | Deliver services | |
| 20026 | 5.1 | Establish service delivery governance and strategies | |
| 20027 | 5.1.1 | Establish service delivery governance | No |
| 20032 | 5.1.2 | Develop service delivery strategies | No |
| 20040 | 5.2 | Manage service delivery resources | |
| 20041 | 5.2.1 | Manage service delivery resource demand | No |
| 20050 | 5.2.2 | Create and manage resource plan | No |
| 12127 | 5.2.3 | Enable service delivery resources | No |
| 20058 | 5.3 | Deliver service to customer | |
| 20059 | 5.3.1 | Initiate service delivery | No |
| 20069 | 5.3.2 | Execute service delivery | No |
| 20077 | 5.3.3 | Complete service delivery | No |
| 20085 | 6.0 | Manage customer service | |
| 10378 | 6.1 | Develop customer care/ customer service strategy | |
| 20086 | 6.1.1 | Define customer service requirements across the enterprise | No |
| 20087 | 6.1.2 | Define customer service experience | No |
| 20088 | 6.1.3 | Define and manage customer service channel strategy | No |
| 10382 | 6.1.4 | Define customer service policies and procedures | No |
| 10383 | 6.1.5 | Establish target service level for each customer segment | No |
| 20089 | 6.1.6 | Define warranty offering | No |
| 20092 | 6.1.7 | Develop recall strategy | No |
| 10379 | 6.2 | Plan and manage customer service contacts | |

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|---|---|---|---|
| 10387 | 6.2.1 | Plan and manage customer service work force | No |
| 10388 | 6.2.2 | Manage customer service problems, requests, and inquiries | Yes |
| 10389 | 6.2.3 | Manage customer complaints | Yes |
| 20094 | 6.2.4 | Process returns | No |
| 12840 | 6.2.5 | Report incidents and risks to regulatory bodies | Yes |
| 12658 | 6.3 | Service products after sales | |
| 20605 | 6.3.1 | Register products | Yes |
| 12669 | 6.3.2 | Process warranty claims | Yes |
| 20106 | 6.3.3 | Manage supplier recovery | No |
| 10218 | 6.3.4 | Service products | No |
| 20110 | 6.4 | Manage product recalls and regulatory audits | |
| 20111 | 6.4.1 | Initiate recall | No |
| 20112 | 6.4.2 | Assess the likelihood and consequences of occurrence of any hazards | Yes |
| 20113 | 6.4.3 | Manage recall related communications | Yes |
| 20114 | 6.4.4 | Submit regulatory reports | No |
| 20115 | 6.4.5 | Monitor and audit recall effectiveness | Yes |
| 20116 | 6.4.6 | Manage recall termination | Yes |
| 20595 | 6.5 | Evaluate customer service operations and customer satisfaction | |
| 10401 | 6.5.1 | Measure customer satisfaction with customer problems, requests, and inquiries handling | Yes |
| 10402 | 6.5.2 | Measure customer satisfaction with customer complaint handling and resolution | Yes |
| 10403 | 6.5.3 | Measure customer satisfaction with products and services | Yes |
| 12672 | 6.5.4 | Evaluate and manage warranty performance | Yes |
| 20121 | 6.5.5 | Evaluate recall performance | Yes |
| 10007 | 7.0 | Develop and manage human capital | |

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|---|---|---|---|
| 17043 | 7.1 | Procurement | |
| 20958 | 7.1.1 | Develop human resources strategy | No |
| 17045 | 7.1.2 | Develop and implement workforce strategy and policies | No |
| 10417 | 7.1.3 | Monitor and update strategy, plans, and policies | No |
| 17046 | 7.1.4 | Develop competency management models | No |
| 10410 | 7.2 | Recruit, source, and select employees | |
| 10439 | 7.2.1 | Manage employee requisitions | No |
| 10440 | 7.2.2 | Recruit/ source candidates | No |
| 20123 | 7.2.3 | Screen and select candidates | Yes |
| 10443 | 7.2.4 | Manage new hire/ re-hire | No |
| 10444 | 7.2.5 | Manage applicant information | No |
| 20599 | 7.3 | Manage employee on boarding, development, and training | |
| 10469 | 7.3.1 | Manage employee orientation and deployment | No |
| 10470 | 7.3.2 | Manage employee performance | No |
| 10472 | 7.3.3 | Manage employee development | No |
| 10473 | 7.3.4 | Develop and train employees | Yes |
| 17052 | 7.4 | Manage employee relations | |
| 10483 | 7.4.1 | Manage labor relations | No |
| 10484 | 7.4.2 | Manage collective bargaining process | No |
| 10485 | 7.4.3 | Manage labor management partnerships | No |
| 10531 | 7.4.4 | Manage employee grievances | No |
| 10412 | 7.5 | Reward and retain employees | |
| 10494 | 7.5.1 | Develop and manage reward, recognition, and motivation programs | No |
| 10495 | 7.5.2 | Manage and administer benefits | No |
| 10496 | 7.5.3 | Manage employee assistance and retention | No |

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|---|---|---|---|
| 10497 | 7.5.4 | Administer payroll | No |
| 10413 | 7.6 | Redeploy and retire employees | |
| 10512 | 7.6.1 | Manage promotion and demotion process | No |
| 10513 | 7.6.2 | Manage separation | No |
| 10514 | 7.6.3 | Manage retirement | No |
| 10515 | 7.6.4 | Manage leave of absence | No |
| 10516 | 7.6.5 | Develop and implement employee outplacement | No |
| 20132 | 7.6.6 | Manage workforce scheduling | No |
| 17055 | 7.6.7 | Relocate employees and manage assignments | No |
| 17056 | 7.7 | Manage employee information and analytics | |
| 10522 | 7.7.1 | Manage reporting processes | No |
| 10523 | 7.7.2 | Manage employee inquiry process | No |
| 10524 | 7.7.3 | Manage and maintain employee data | Yes |
| 10525 | 7.7.4 | Manage human resource information systems HRIS | No |
| 10526 | 7.7.5 | Develop and manage employee metrics | No |
| 10527 | 7.7.6 | Develop and manage time and attendance systems | No |
| 10530 | 7.7.7 | Manage/ collect employee suggestions and perform employee research | No |
| 17057 | 7.8 | Manage employee communication | |
| 10529 | 7.8.1 | Develop employee communication plan | No |
| 16944 | 7.8.2 | Conduct employee engagement surveys | Yes |
| 10532 | 7.9 | Deliver employee communications | |
| 20607 | 8.0 | Manage Information Technology (IT) | |
| 20608 | 8.1 | Develop and manage IT customer relationships | |
| 20609 | 8.1.1 | Understand IT customer needs | No |
| 20612 | 8.1.2 | Identify IT customer transformation needs | No |

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|---|---|---|---|
| 20617 | 8.1.3 | Plan and communicate IT services | No |
| 20623 | 8.1.4 | Provide IT transformation guidance | No |
| 20632 | 8.1.5 | Develop and manage IT service levels | No |
| 20641 | 8.1.6 | Manage IT customer relationships | No |
| 20648 | 8.1.7 | Analyze service performance | Yes |
| 20652 | 8.2 | Develop and manage IT business strategy | |
| 20653 | 8.2.1 | Define business technology and governance strategy | No |
| 20660 | 8.2.2 | Manage IT portfolio strategy | No |
| 20668 | 8.2.3 | Define and maintain enterprise architecture | No |
| 20674 | 8.2.4 | Define IT service management strategy | No |
| 20682 | 8.2.5 | Control IT management system | Yes |
| 20693 | 8.2.6 | Manage IT value portfolio | No |
| 20699 | 8.2.7 | Define and manage technology innovation | No |
| 20706 | 8.3 | Develop and manage IT resilience and risk | |
| 20707 | 8.3.1 | Develop IT compliance, risk, and security strategy | No |
| 20716 | 8.3.2 | Develop IT resilience strategy | No |
| 20721 | 8.3.3 | Control IT risk, compliance, and security | Yes |
| 20731 | 8.3.4 | Plan and manage IT continuity | No |
| 20735 | 8.3.5 | Develop and manage IT security, privacy, and data protection | No |
| 20743 | 8.3.6 | Conduct and analyze IT compliance assessments | No |
| 20749 | 8.3.7 | Develop and execute IT resilience and continuity operations | No |
| 20756 | 8.3.8 | Manage IT user identity and authorization | No |
| 20765 | 8.4 | Manage information | |
| 20766 | 8.4.1 | Define business information and analytics strategy | No |
| 20770 | 8.4.2 | Define and maintain business information architecture | No |

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| 20776 | 8.4.3 | Define and execute business information lifecycle planning and control | No |
| 20779 | 8.4.4 | Manage business information content | No |
| 20784 | 8.5 | Develop and manage services/ solutions | |
| 20785 | 8.5.1 | Develop service/ solution and integration strategy | No |
| 20793 | 8.5.2 | Manage service/ solution lifecycle planning | No |
| 20799 | 8.5.3 | Develop and manage service/ solution architecture | No |
| 20808 | 8.5.4 | Execute IT service/ solution creation and testing | No |
| 20817 | 8.5.5 | Perform service/ solution maintenance and testing | No |
| 20824 | 8.6 | Deploy services/ solutions | |
| 20825 | 8.6.1 | Develop and manage service/ solution deployment strategy | No |
| 20832 | 8.6.2 | Plan service and solution implementation | No |
| 20840 | 8.6.3 | Manage change deployment control | No |
| 20848 | 8.6.4 | Implement technology solutions | No |
| 20858 | 8.6.5 | Perform service and solution rollout | No |
| 20866 | 8.7 | Create and manage support services/ solutions | |
| 20867 | 8.7.1 | Define and establish service delivery strategy | No |
| 20873 | 8.7.2 | Define and develop service support strategy | No |
| 20880 | 8.7.3 | Plan and manage service delivery control | No |
| 20888 | 8.7.4 | Develop and manage infrastructure resource planning | No |
| 20895 | 8.7.5 | Define service support planning | No |
| 20905 | 8.7.6 | Develop and manage service delivery operations | No |
| 20914 | 8.7.7 | Manage infrastructure resource administration | Yes |
| 20921 | 8.7.8 | Operate IT user support | Yes |
| 17058 | 9.0 | Manage financial resources | |
| 10728 | 9.1 | Perform planning and management accounting | |

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|---|---|---|---|
| 10738 | 9.1.1 | Perform planning/ budgeting/ forecasting | No |
| 10739 | 9.1.2 | Perform cost accounting and control | No |
| 10740 | 9.1.3 | Perform cost management | No |
| 10741 | 9.1.4 | Evaluate and manage financial performance | Yes |
| 10729 | 9.2 | Perform revenue accounting | |
| 10742 | 9.2.1 | Process customer credit | No |
| 10743 | 9.2.2 | Invoice customer | Yes |
| 10744 | 9.2.3 | Process accounts receivable (AR) | Yes |
| 10745 | 9.2.4 | Manage and process collections | No |
| 10746 | 9.2.5 | Manage and process adjustments/ deductions | No |
| 10730 | 9.3 | Perform general accounting and reporting | |
| 10747 | 9.3.1 | Manage policies and procedures | No |
| 10748 | 9.3.2 | Perform general accounting | Yes |
| 10749 | 9.3.3 | Perform fixed-asset accounting | Yes |
| 10750 | 9.3.4 | Perform financial reporting | Yes |
| 10731 | 9.4 | Manage fixed-asset project accounting | |
| 10751 | 9.4.1 | Perform capital planning and project approval | Yes |
| 10752 | 9.4.2 | Perform capital project accounting | Yes |
| 10732 | 9.5 | Process payroll | |
| 10753 | 9.5.1 | Report time | Yes |
| 10754 | 9.5.2 | Manage pay | Yes |
| 10755 | 9.5.3 | Manage and process payroll taxes | Yes |
| 10733 | 9.6 | Process accounts payable and expense reimbursements | |
| 10756 | 9.6.1 | Process accounts payable (AP) | Yes |
| 10757 | 9.6.2 | Process expense reimbursements | Yes |

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|---|---|---|---|
| 20929 | 9.6.3 | Manage corporate credit cards | No |
| 10734 | 9.7 | Manage treasury operations | |
| 10758 | 9.7.1 | Manage treasury policies and procedures | No |
| 10759 | 9.7.2 | Manage cash | No |
| 10760 | 9.7.3 | Manage in-house bank accounts | No |
| 10761 | 9.7.4 | Manage debt and investment | No |
| 11208 | 9.7.5 | Monitor and execute risk and hedging transactions | No |
| 16958 | 9.7.6 | Manage financial fraud/ dispute cases | No |
| 10735 | 9.8 | Manage internal controls | |
| 10762 | 9.8.1 | Establish internal controls, policies, and procedures | No |
| 10763 | 9.8.2 | Operate controls and monitor compliance with internal controls policies and procedures | No |
| 10764 | 9.8.3 | Report on internal controls compliance | No |
| 10736 | 9.9 | Manage taxes | |
| 10765 | 9.9.1 | Develop tax strategy and plan | No |
| 10766 | 9.9.2 | Process taxes | No |
| 10737 | 9.10 | Manage international funds/ consolidation | |
| 10767 | 9.10.1 | Monitor international rates | Yes |
| 10768 | 9.10.2 | Manage transactions | No |
| 10769 | 9.10.3 | Monitor currency exposure/ hedge currency | Yes |
| 10770 | 9.10.4 | Report results | Yes |
| 17059 | 9.11 | Perform global trade services | |
| 14090 | 9.11.1 | Screen sanctioned party list | No |
| 14091 | 9.11.2 | Control exports and imports | No |
| 14092 | 9.11.3 | Classify products | Yes |
| 19593 | 9.11.4 | Perform currency conversion | Yes |

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|---|---|---|---|
| 14093 | 9.11.5 | Calculate duty | Yes |
| 14094 | 9.11.6 | Communicate with customs | No |
| 14095 | 9.11.7 | Document trade | Yes |
| 14096 | 9.11.8 | Process trade preferences | No |
| 14097 | 9.11.9 | Handle restitution | No |
| 14098 | 9.11.10 | Prepare letter of credit | No |
| 19207 | 10.0 | Acquire, construct, and manage assets | |
| 10937 | 10.1 | Plan and acquire assets | |
| 10941 | 10.1.1 | Develop property strategy and long term vision | No |
| 10943 | 10.1.2 | Plan facility | No |
| 10944 | 10.1.3 | Provide workspace and facilities | No |
| 10949 | 10.1.4 | Manage facilities operations | No |
| 19208 | 10.2 | Design and construct productive assets | |
| 19209 | 10.2.1 | Manage capital program for productive assets | No |
| 20139 | 10.2.2 | Design and plan asset construction | No |
| 19229 | 10.2.3 | Schedule and perform construction work | No |
| 19224 | 10.2.4 | Manage asset construction | No |
| 19238 | 10.3 | Maintain productive assets | |
| 19239 | 10.3.1 | Plan asset maintenance | No |
| 19245 | 10.3.2 | Manage asset maintenance | No |
| 19253 | 10.3.3 | Perform asset maintenance | No |
| 10940 | 10.4 | Dispose of assets | |
| 10952 | 10.4.1 | Develop exit strategy | No |
| 19258 | 10.4.2 | Decommission productive assets | No |
| 10953 | 10.4.3 | Perform sale or trade | No |

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| 10954 | 10.4.4 | Perform abandonment | No |
| 16970 | 10.4.5 | Perform waste and hazardous goods management | No |
| 16437 | 11.0 | Manage enterprise risk, compliance, remediation, and resiliency | |
| 17060 | 11.1 | Manage enterprise risk | |
| 16439 | 11.1.1 | Establish the enterprise risk framework and policies | No |
| 16445 | 11.1.2 | Oversee and coordinate enterprise risk management activities | No |
| 17462 | 11.1.3 | Manage business unit and function risk | No |
| 17467 | 11.2 | Manage compliance | |
| 17468 | 11.2.1 | Establish compliance framework and policies | No |
| 16463 | 11.2.2 | Manage regulatory compliance | No |
| 11185 | 11.3 | Manage remediation efforts | |
| 11201 | 11.3.1 | Create remediation plans | No |
| 11202 | 11.3.2 | Contact and confer with experts | No |
| 11203 | 11.3.3 | Identify/ dedicate resources | No |
| 11204 | 11.3.4 | Investigate legal aspects | No |
| 11205 | 11.3.5 | Investigate damage cause | No |
| 11206 | 11.3.6 | Amend or create policy | No |
| 11216 | 11.4 | Manage business resiliency | |
| 11221 | 11.4.1 | Develop the business resilience strategy | No |
| 11222 | 11.4.2 | Perform continuous business operations planning | No |
| 11223 | 11.4.3 | Test continuous business operations | No |
| 11224 | 11.4.4 | Maintain continuous business operations | No |
| 16471 | 11.4.5 | Share knowledge of specific risks across other parts of the organization | No |
| 10012 | 12.0 | Manage external relationships | |

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|---|---|---|---|
| 11010 | 12.1 | Build investor relationships | |
| 11035 | 12.1.1 | Plan, build, and manage lender relations | No |
| 11036 | 12.1.2 | Plan, build, and manage analyst relations | No |
| 11037 | 12.1.3 | Communicate with shareholders | No |
| 11011 | 12.2 | Manage government and industry relationships | |
| 11038 | 12.2.1 | Manage government relations | No |
| 11039 | 12.2.2 | Manage relations with quasi-government bodies | No |
| 11040 | 12.2.3 | Manage relations with trade or industry groups | No |
| 11041 | 12.2.4 | Manage lobby activities | No |
| 11012 | 12.3 | Manage relations with board of directors | |
| 11042 | 12.3.1 | Report financial results | No |
| 11043 | 12.3.2 | Report audit findings | No |
| 11013 | 12.4 | Manage legal and ethical issues | |
| 11044 | 12.4.1 | Create ethics policies | No |
| 11045 | 12.4.2 | Manage corporate governance policies | No |
| 11046 | 12.4.3 | Develop and perform preventive law programs | No |
| 11047 | 12.4.4 | Ensure compliance | No |
| 11048 | 12.4.5 | Manage outside counsel | No |
| 11049 | 12.4.6 | Protect intellectual property | No |
| 11050 | 12.4.7 | Resolve disputes and litigations | No |
| 11051 | 12.4.8 | Provide legal advice/ counselling | No |
| 11052 | 12.4.9 | Negotiate and document agreements/ contracts | No |
| 11014 | 12.5 | Manage public relations program | |
| 11066 | 12.5.1 | Manage community relations | No |
| 11067 | 12.5.2 | Manage media relations | No |

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| 11068 | 12.5.3 | Promote political stability | No |
| 11069 | 12.5.4 | Create press releases | No |
| 11070 | 12.5.5 | Issue press releases | No |
| 10013 | 13.0 | Develop and manage business capabilities | |
| 16378 | 13.1 | Manage business processes | |
| 16379 | 13.1.1 | Establish and maintain process management governance | No |
| 16384 | 13.1.2 | Define and manage process frameworks | No |
| 16387 | 13.1.3 | Define processes | No |
| 16392 | 13.1.4 | Manage process performance | No |
| 16396 | 13.1.5 | Improve processes | No |
| 16400 | 13.2 | Manage portfolio, program, and project | |
| 16401 | 13.2.1 | Manage portfolio | No |
| 16405 | 13.2.2 | Manage programs | No |
| 16410 | 13.2.3 | Manage projects | No |
| 17471 | 13.3 | Manage enterprise quality | |
| 17472 | 13.3.1 | Establish quality requirements | No |
| 17482 | 13.3.2 | Evaluate performance to requirements | No |
| 17492 | 13.3.3 | Manage non-conformance | No |
| 17498 | 13.3.4 | Implement and maintain the enterprise quality management system (EQMS) | No |
| 11074 | 13.4 | Manage change | |
| 11134 | 13.4.1 | Plan for change | No |
| 11135 | 13.4.2 | Design the change | No |
| 11136 | 13.4.3 | Implement change | No |
| 11137 | 13.4.4 | Sustain improvement | No |
| 11073 | 13.5 | Develop and manage enterprise-wide knowledge | |

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|---|---|---|---|
| | | management (KM) capability | |
| 11095 | 13.5.1 | Develop KM strategy | No |
| 11096 | 13.5.2 | Assess KM capabilities | No |
| 20965 | 13.5.3 | Design and implement KM capabilities | No |
| 20969 | 13.5.4 | Evolve and sustain KM capabilities | No |
| 16436 | 13.6 | Measure and benchmark | |
| 11071 | 13.6.1 | Create and manage organizational performance strategy | No |
| 11072 | 13.6.2 | Benchmark performance | No |
| 20147 | 13.6.3 | Evaluate process performance | No |
| 11179 | 13.7 | Manage environmental health and safety (EHS) | |
| 11180 | 13.7.1 | Determine environmental health and safety impacts | No |
| 11181 | 13.7.2 | Develop and execute functional EHS program | No |
| 11182 | 13.7.3 | Train and educate functional employees | Yes |
| 11183 | 13.7.4 | Monitor and manage functional EHS management program | No |
| 20959 | 13.8 | Develop, manage, and deliver analytics | |
| 20960 | 13.8.1 | Develop and manage hypotheses | No |
| 20961 | 13.8.2 | Collect data | Yes |
| 20962 | 13.8.3 | Analyze data | Yes |
| 20963 | 13.8.4 | Report on data | Yes |
| 20964 | 13.8.5 | Identify remedial actions | Yes |

## Annex II – Process identification form

| | |
|---|---|
| **Process Title** | It is recommended the use of verb noun phrasing. |
| **Purpose** | The outline of the process, with its purpose and scope. Should be a short section with 2-4 sentences. |
| **Entry Criteria** | Identify what triggers the process. |
| **Inputs** | Bullet-point of deliverables that provide data to the process, like receipts, emails, documents either physical or electronic form. |
| **Workflow Diagram** | Visual diagram indicating the relationship between activities in the process. |
| **Activity Descriptions** | Describe each activity within the process in bullets, together with the roles and responsibilities of the people involved. |
| **Exceptions** | List exceptions and describe them. |
| **Business Rules** | List the rules within the process, as per instance, an email must be sent after five business days if there is no reply. |
| **Outputs** | Bullet-point of the deliverables resulting from the completion of the workflow diagram. |
| **Exit Criteria** | Identify what ends the process. |
| **Metrics** | List metrics if there are known metrics for process evaluation. |

## Annex III – Task identification form

| | |
|---|---|
| **Task Title** | It is recommended the use of verb noun phrasing. |
| **Purpose/ Goal** | The outline of the task, with its purpose and scope. Should be a short section with 2-4 sentences. |
| **Assign to** | Identify who executes the task. |
| **Periodicity** | Identify how often this task is executed. |
| **Type** | Identify the task automation type: user/ system/ mixed. |
| **Data** | Identify what kind of data is managed. |
| **Software** | The software name and how and why is it useful for the task execution. |

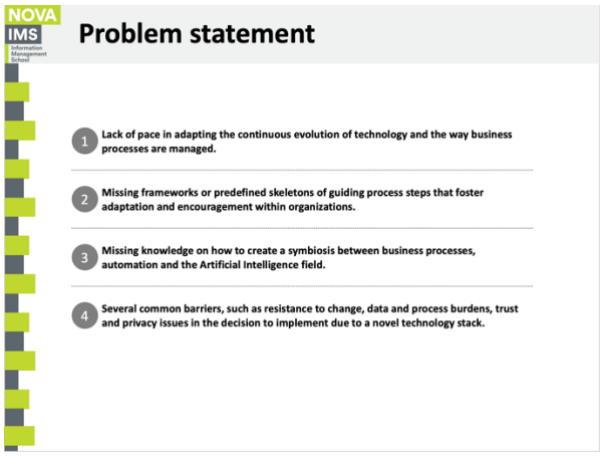
## Annex IV – Identifying intelligent process automation suitability

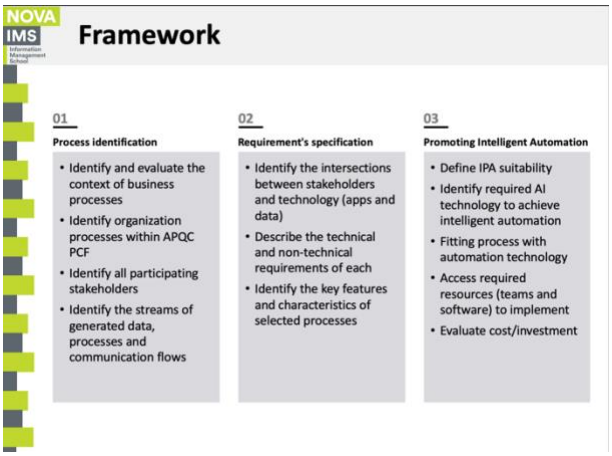
| Questions | Answers | |
|---|---|---|
| **How will this process contribute as a holistic approach?** | ○ Defining how this process automation contributes holistically to the enterprise intelligent process automation strategy. | |
| **How often does the process occur?** | ○ Regularly<br>○ Occasionally | |
| **Is the process time-consuming?** | ○ Yes<br>○ No | |
| **Is the process prone to human mistakes?** | ○ Yes<br>○ No | |
| **Does the process manage data across different systems?** | ○ Yes<br>○ No | |
| **Identify the input and output data involved in the process** | Input | Output |
| | ○ Structured data (spreadsheet, database, JSON, CSV...)<br>○ Unstructured data (scanned documents, handwritten forms, emails, voice messages, images…)<br>○ Both | ○ Structured data (spreadsheet, database, JSON, CSV...)<br>○ Unstructured data (scanned documents, handwritten forms, emails, voice messages, images…)<br>○ Both |
| **How do you describe the process flow?** | ○ Follows a strict set of predefined rules<br>○ It is based on decision-making, open to employee judgment<br>○ Both | |

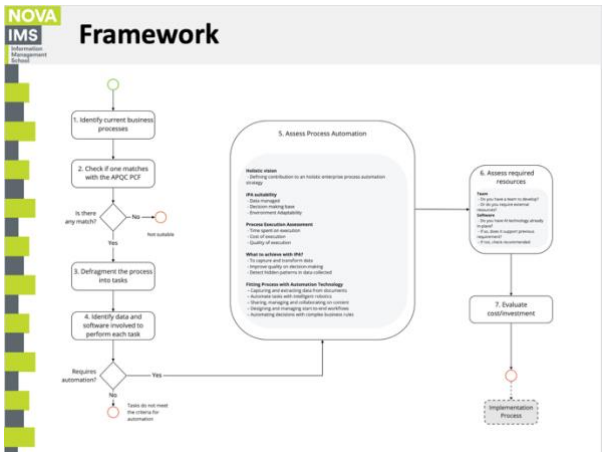
## Annex V – Assess required resources

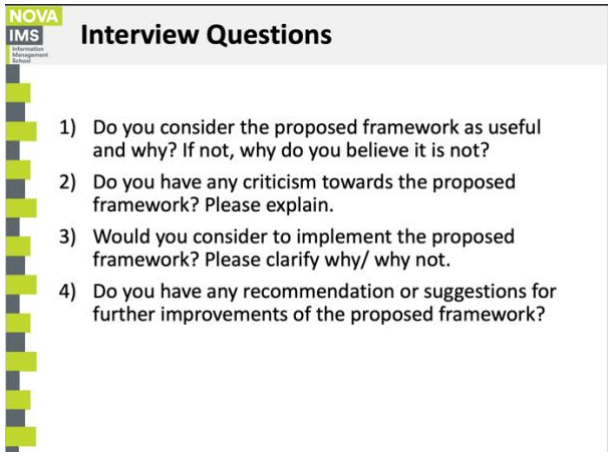
| Questions | Answers |
|---|---|
| **Software** | |
| **Is there already in place any AI technology/ software?** | ○ Yes<br>○ No |
| **Does the current software support previous AI requirements/ integrations?** | ○ Yes<br>○ No |
| **Human Resources** | |
| **Is there a development team available to develop/ implement the AI technology?** | ○ Yes<br>○ No |
| **Do you require external resources?** | ○ Yes<br>○ No |

## Annex VI – Specialist Interviews




- NOVA IMS Professor interview
    - https://liveeduisegiunl-my.sharepoint.com/:v:/r/personal/m20190189_novaims_unl_pt/Documents/Recordings/Re_%20Convite%20para%20entrevista%20-%20Disserta%C3%A7%C3%A3o%20Afonso%20Cardoso%20(NOVA%20IMS)-20210524_173934-Meeting%20Recording.mp4?csf=1&web=1&e=d8TdNZ
- COO & CTO interview
    - https://web.microsoftstream.com/video/738f95d0-545e-4532-b1c3-b7192a26acd6