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A software architecture for automatic processing of physical or digital accounting documents

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presented as partial requirement for obtaining the Master Degree Program in Information Management

NOVA Information Management School

Instituto Superior de Estatística e Gestão de Informação

Universidade Nova de Lisboa

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A SOFTWARE ARCHITECTURE FOR AUTOMATIC PROCESSING OF PHYSICAL OR DIGITAL ACCOUNTING DOCUMENTS

by

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Master Thesis presented as partial requirement for obtaining the Master's degree in Information Management, with a specialization in Information Systems and Technologies Management

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STATEMENT OF INTEGRITY

I hereby declare having conducted this academic work with integrity. I confirm that I have not used plagiarism or any form of undue use of information or falsification of results along the process leading to its elaboration. I further declare that I have fully acknowledge the Rules of Conduct and Code of Honor from the NOVA Information Management School.

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ABSTRACT

With the advances of technologies and their integration into our daily lives, organizations have the necessity to adapt and digitally transform the way they do business, in addition to their internal processes that can start with one department, such as accounting, and further expand to the entire organization. Having this information, the Design Science Research Methodology was selected for this study, and the defined goal is to explain what organizations need to do to automatically process accounting documents, besides helping them to transform the area of accounting by enabling better decision-making, relevant access to sensitive information, and to reduce costs.

The carried-out study includes accounting concepts and the accountant's role, in addition to the impacts and challenges regarding information technologies, AI concepts, and areas such as machine learning, and the application of optical character recognition. Besides this, process automation that can be divided into three types: business process automation, robotic process automation, and intelligent process automation. Lastly, it includes intelligent interface concepts, intelligent accounting tools as intelligent ERP, and some of the available products in the market.

With the necessity of proposing a standard software architecture to process accounting documents, a proposal with four stages (Classification stage, document management stage, integration stage, analytical stage) has been developed, containing technological and process architecture. That later was validated by specialists in the areas of accounting and information technologies.

This proposal is expected to contribute to a clear understanding of the organizations in the implementation of these architectures, besides enriching the scientific field by bringing a new perspective and becoming a study that can be referenced in future research on this subject.

KEYWORDS

Accounting; Artificial Intelligence; Process Automation; Enterprise Resource Planning; Information Systems

Sustainable Development Goals (SGD):

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LIST OF ABBREVIATIONS AND ACRONYMS

AI	Artificial Intelligence
API	Application Programming Interface
BPA	Business Process Automation
DSR	Design Scientific Research
DSRM	Design Scientific Research Methodology
ERP	Enterprise Resource Planning
IAT	Intelligent Accounting Tools
i-ERP	Intelligent Enterprise Resource Planning
IPA	Intelligent Process Automation
IS	Information Systems
IT	Information Technology
ML	Machine Learning
MRP	Material Requirement Planning
OCR	Optical Character Recognition
PA	Process Automation
RPA	Robot Process Automation
RBL	Rule Based Systems
SME	Small and Medium-size business
UI	User Interface
UX	User Experience

1. INTRODUCTION

The context of this research, as well as the inherited motivation, will be found in the introductory chapter. Aside from the previous points, it will present the proposed objectives along with the document's importance and relevance at the organizational level and academic field.

1.1. CONTEXT

In the present day, technology is part of everyday lives, and digital transformation is disrupting every type of business and industry (Möller et al., 2020) by destroying barriers between people and the business, originating to new types of products and services leading to "*The ability to transform process and business models…*" and the need for companies to build *"…Digital Business Platform that is a outcome driven and enabled by technology…*" (Schwertner, 2017).With this kind of transformation occurring, organizations are trying to respond to industry challenges and their customer's needs by reinventing the way they do business (Gartner, n.d.; Möller et al., 2020), which could lead to struggles by small and medium companies to keep up with constant changes and consequently lose customers or profit.

Another impactful factor on organizations was worldwide covid-19 pandemic crises that accelerated the need for remote work and the use of digital tools to connect in time, when presential meetings were not possible (Torous et al., 2020). Also, it demonstrated its value when physical activities were no longer possible and the need for quick responses to the pandemic to secure the company's survival (Gartner, n.d.).

ERPs are solutions that are used in organizations to manage their resources and integrate processes such as purchasing, supply chain, or human resources, but also by integrating each department in a single environment that became one of the most important developments in the IT of the companies , that show us how the companies will seek benefits as faster information and decision making, lower costs or global control over operations(Basoglu et al., 2007). Being that relevant for the businesses companies need to keep their systems and not let them go outdated which according to IDC represents 35.4% for SMEs and start to give warning signs as unused data that could increase profitability, disconnection from UX, lack of flexibility to scale up their operations and decisions that lead to less-optimal outcomes (Schoenborn, 2021a).

After seeing what it's missing in legacy ERPs and what companies want to archive, Intelligent ERPs could be the next step since it pushes business forward using the correct technologies, using the data left from legacy ERPs and transforming it into relevant information that could be analysed or bring more efficiency and effectiveness to a business process that will benefit the organization growth (Schoenborn, 2021a).

Also, we know that "*… businesses want applications and business process embedded with data intelligence…*" (Schoenborn, 2021b) that could help companies making better decisions and generate innovation (Jenab et al., 2019), improve the user experience for the employees and reduce the need of doing redundant tasks such as inserting accounting data in ERP system.

However, scientific research carried out appears insufficient to enlighten us all about a standard software architecture for business processes such as accounting, which may occur due to its disruptiveness and youth. However, some research shows how these technologies can be valuable and how they may be utilized independently.

1.2. MOTIVATION

Intelligent ERP systems give businesses a competitive edge and improve internal operations (Schoenborn, 2021b), while also enabling the incorporation of AI that can disrupt the industry by creating new forms of doing business (J. Lee et al., 2019) and machine learning to develop a single system that unifies and automate tasks in accounting. In addition, we understand that Intelligent ERPs will be connected to other IT systems, gather data, and benefit companies that opt to invest in this solution; however, scientific investigation on these areas as well as the proposed architecture or frameworks are insufficient to provide a complete overview. Furthermore, it's unclear how the data will be transferred to the Intelligent ERPs after being gathered or who will manage the data since it requires a high level of customization and costs that aren't always accessible to every company (Symeonidis et al., n.d.).

By utilising Neural AI, which recurs to machine learning and enables computers to learn without background experience (J. Lee et al., 2019), we will be apt to use tools like OCR systems capable of recognizing characters from digitised images with recognizing rates that exceed 70% (Berchmans & Kumar, 2014), as well as improve accounting process flow and employee performance by allowing searching information into computers rather than looking in the paper documents (Berchmans & Kumar, 2014). Also, we could utilize RPA to enhance process efficiency and solve business problems in companies (Siderska, 2020) by utilizing AI to simulate human tasks such as entering information from accounting documents obtained via OCR software into the ERP system (van der Aalst et al., 2018).

As a result, it's desired to build an architecture that could be applied to accounting business processes and clarify what organizations need to acquire to fully automate the above process, starting with the entrance of the document (physical or digital) and concluding with its introduction to the ERP system. Without a doubt, the possibility of using software like RPA or OCR that can recur to AI to mitigate or eliminate the gap between an OCR, a digital platform, and an ERP will generate huge value for companies (Siderska, 2020).

1.3 OBJECTIVES

The primary objective of this work is to create an architecture for the accounting modules of an ERP to automatically process physical or digital accounting documents that answers the question: *"What should I do to automatically process accounting documents?"*. To accomplish this goal, artificial intelligence, and process flow strategies will be used in the architecture to enable its adaptation to several types of ERP providers.

To obtain the desired result the following intermediate objectives were defined:

1. Explanation of accounting and accountant's role.

2. Explanation of technologies associated with accounting and intelligent interfaces.
3. Determine and evaluate the required technologies for accounting processes.
4. Propose an architecture for automatic process physical or digital accounting documents.

The first intermediate objective is gathering data regarding the accounting and how technologies related with intelligent interfaces can interact and impact their functionalities. After this information is gathered, we will start researching about technologies that can be applied to accounting and intelligent interfaces, as well as the accounting modules they cover, the functionalities available, their connections and integrations with third-party software.

After knowing the market offer, we will start determining and evaluating the necessary technologies and tools in the accounting process workflow since the document arrives at the organization until it's registered in an ERP. With the information gathered from the previous objectives, the modules and technologies that will incorporate the architecture will be selected to create a robust solution.

After the achievement of the previous objectives the architecture creation will be based on two points, the information from the previous objectives and the software's that enable the automatic processing of accounting documents.

1.3. STUDY IMPORTANCE AND RELEVANCE

We live in a world where a computer is increasingly present in every, especially since the arrival of mobile phones (International Monetary Fund, 2016), affecting the way human beings work, and have social or private life starting with social networks (M. Lee et al., 2018), access their bank account, or pay bills at any place or time. Companies as well must follow the same path to respond to their customers and ensure their survival. So, in this context, a study about an architecture that benefits them will bring value and its development will be relevant to companies that have accounting processes that need to be updated to gain a competitive edge in the market (Schoenborn, 2021b). Since it will provide a straightforward and understandable view of what they are going to need to implement the automation process and which software is requested to purchase. Also, this architecture will give the possibility of uniformization in the internal network of the organization's suppliers due to the possibility of acquiring everything from the same company.

It will be relevant to develop a study about the automation of an accounting process since it recurs to emerging technologies like AI that can disrupt markets and influence business (J. Lee et al., 2019) as previously mentioned in this proposal, since a combination of technologies will enable an architecture that will facilitate the approach of companies to the market and their providers when they decide to go digital and start automating their processes. Nevertheless, this proposal could be a starting point for an organization digital evolution, because it will present a list of software that can be included and which functionalities they have, as well as their benefits, costs, and user experience (including the learning curve) that will simplify the software selection process due to the variety of offers.

Finally, in the scientific field, this architecture will contribute by bringing a new perspective of its advantages, benefits, and required software's to implement these solutions. Furthermore, it will increase the knowledge in the scientific area about the entire process of automating accounting

documents in organizations and, also prove that organizations will have a trustable option that will improve their competitive advantage and performance. Besides that, it will give a clear understanding of the steps required to automate an accounting process, which can be used as a study reference in future studies on this subject.

2. LITERATURE REVIEW

Literature review is one of the most important parts of research, since lays the foundation of this investigation and will be essential to a better understanding of the background knowledge used to produce the artifact, as well as the research gap identified. To ensure the literature review will give accurate knowledge, several books and scientific databases like Google Scholar, Springer or Scopus were used to gather information.

The structure of this chapter will be divided into two sub-chapters starting with 2.1 which will present a review of accounting concepts, challenges, and IT impacts in this area and in the accountant's profession; sub-chapter 2.2 will present an overview of the technologies that will be used in accounting like ERP systems, artificial intelligence, process automation and the available products or tools in the market.

2.1. GENERAL REVIEW OF ACCOUNTING

Accounting is present in every organization and became a lectured course in several academic institutions that makes it valuable and indispensable in the current days. It also became an enormous source information due to research taken in this field and the books, articles or documents produced that requires it to be analysed and prioritized to have the most relevant information about presented topic in the following sub-chapters.

2.1.1. CONCEPT

A business can be seen as an organization that has resources to be processed and has a goal in mind to sell products or services to customers (Warren et al., 2012) . Accounting is the information system that will process the data, measures the activity and communicate the results (Horngren et al., 2012) or economic events of an organization (International Monetary Fund, 2016). Also, according to (Horngren et al., 2012, p. 2) *"…Accounting is "the language of business."* and has a key product that is financial statements, which represents a business in capital terms.

By being so relevant to business and covering a vast area of knowledge, accounting can be divided into two fields that are financial accounting and managerial accounting which will generate useful information for decision-makers. Financial accounting will report information at fixed intervals in time regarding financial statements (Kimmel et al., 2018) for external decision makers like investors, that is someone that has ownership interests and sometimes can provide a budget (Horngren et al., 2012). On the other side managerial accounting meets the specific needs of the managers that run the business and is focused on internal decision-making individuals (Horngren et al., 2012; Kimmel et al., 2018).

2.1.2. ACCOUNTING SYSTEMS

The systems can be seen as crucial to an organization success (Jasim & Raewf, 2020), and according to (Warren et al., 2012) accounting systems are sets of methods and procedures to gather, classify, and resume data like ticket reservations or credit card collections, into business information. This system is represented in figure 1 and divided into a three-step process that starts with analysing the information that a user is going to need, then designing a system that meets its necessities, and finally implementing the system.

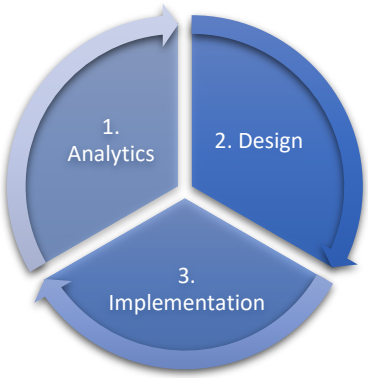

Figure 1 - Basic accounting system adapted from (Warren et al., 2012)

We have manual accounting systems that are useful for identifying relationships and patterns between the gathered data and the produced reports, which are easy to use and understand when we have few transactions or records, but quite complex and become inefficient when these numbers increase. On the other side computerized accounting systems, have more advantages in the simplification of record processing or recording multiple transactions at the same time, providing more accurate and faster information as soon as a transaction occurs (Kimmel et al., 2018; Warren et al., 2012).

By allowing a huge dynamism and according to (Tóth, 2012) computerized system can be typified in tree types:

- The unautomated system could be called a hybrid solution between the two systems previously mentioned, since accountants use papers or write notes on them for most of the tasks, and computers for the electronic archive. Even though we already use a computer to record data, we are susceptible to errors in repetitive tasks processed by humans.

- The computed-base transaction system allows independent data preservation from other processing actions in the systems that will maintain its integrity. Even though data is preserved, the process continues to be manual as accountants register the information in computers instead of paper.

- The database system removes data duplication and reduces inefficiency in processes and excess of information by using ERP systems (that will be presented in the following chapters).

2.1.3. ACCOUNTS PAYABLE, BANK RECONCILIATION AND PAYROLL

As was previously mentioned, accounting is vast and has been split into two fields (Kimmel et al., 2018). In addition, there are several accounting-related fields, such as accounts payable, which is one of its main concerns (Trigo et al., 2014), payroll, which can benefit from automation and emerging technologies (Jędrzejka, 2019), and bank reconciliation.

ACCOUNTS PAYABLE

Given the fact that debt is recorded as a liability (Warren et al., 2012), there are currently two kinds of liabilities in accounting: those that must be estimated and those with known amounts, which include accounts payable (Horngren et al., 2012). Also, accounts payable can be defined as *"an obligation to pay cash in the near future"* (Horngren et al., 2012, p. 64), that comes from a credit purchase transaction as merchandise or suppliers (Warren et al., 2012) or the amounts owned for products or services purchases (Horngren et al., 2012).

BANK RECONCILIATION

As it reconciles differences between the cash on the company's books and the cash on the bank records over specific periods (Horngren et al., 2012), bank reconciliation is the analysis of the items and amounts that result in cash balance (Warren et al., 2012). According to (Horngren et al., 2012; Warren et al., 2012), bank reconciliation is split into two sections (bank and company), with purpose of obtaining an adjusted balance from the bank and company that must be equal:

- The bank section includes a cash balance according to bank statements, recipes, and payments through the bank and contains the *deposits in transit*, which are deposits made by the company, and *outstanding checks* that are checks that the company wrote and aren't paid in the bank.
- The company section corresponds to the cash account, balances in the company books, and contains the bank collections which are cash receipts that have not been recorded by the company, electronic funds transfers, service charges, interest revenue on checking account, and nonsufficient funds (cash receipts that become worthless).

PAYROLL

Payroll, also known as employee compensation (Horngren et al., 2012), is a system created to pay employees, meet legal obligations, and give useful information for management decision-making. However, once payroll expenses are paid, they turn into liabilities (Warren et al., 2012).

According to (Warren et al., 2012), most payroll systems have three elements:

- The payroll register is a report with multiple columns that contains the employee's name, the number of hours they worked, the amount of social security tax withheld, and the total gross earnings for the payroll period.

- An employee earning record is a document that is created after each payroll period and contains specific data for each payroll as well as information on social security withholding taxes and employer payroll taxes.
- Payroll checks, which are issued when the business pays its employees, particularly those who work part-time, have a specific bank account.

2.1.4. IMPACT OF INFORMATION SYSTEMS INTO THE FINANCIAL AREA

With the emergence of information technologies and the software's that were developed, companies suffered a significant impact in areas like accounting were everything has been done using papers and books to register information. With IT systems, these records started to become digitalized and customized for each type of business or organization depending on its size and number of operations (Ghasemi et al., 2011), impacting the efficiency, productivity, availability of information and the shape of its activities (Jasim & Raewf, 2020) by managing the information, influencing processes and operations that support the decisions of managers inside these organizations (Tóth, 2012).

Furthermore, according to (Ghasemi et al., 2011) one of the biggest IT impacts was the capacity to develop and utilize systems to track and record financial information, instead of using manual spreadsheets or written papers to store data that will be used to produce reports.

These kinds of impact are not always positive in organizations, especially when these changes impact the accounting itself as well as the accountants, leading of a set of drawbacks such as:

- Necessity to change and adapt to new technologies.
- Degree of knowledge required to implement information systems.
- Cost and time required implementing these systems, transform and restructure processes.
- Resistance to change or demotivation by the accountants when forced to adapt and work with new processes and technologies.
- Accountants fear of losing power or their own jobs.

On the other side according to (Ghasemi et al., 2011; Jasim & Raewf, 2020) brings a huge set of advantages such as:

- Efficiency will increase by combining several activities in a single platform and will reduce the costs due to remote work provided by cloud services.
- Accuracy will be achieved by having less error probability with a management program instead of manual checking of records, leading to more accurate and liable information for decision-makers as well as for external investors.
- Adequacy allows limited resources to deliver the best outcomes, which will increase efficiency and raise employees level of work.
- Security by having information stored digitally, encrypted, with limited access, and managed by the governance department. This department will assign access to specific information based on the role and level of authority in an organization.

- Flexibility will increase with solutions like cloud computing, that allow information to be accessed and shared at any time, adapting, and responding faster to internal or external changes.
- Velocity will accelerate information sharing, reports production, and performance.

Besides the impacts previously mentioned, we cannot forget automation, which arises from internal and external factors such as client demands, the necessity to deliver new products or increase the performance of those that already are in the market, and cost reduction (Wilson & Sangster, 1992). This lead us in recent past to use RPAs that allow configured computers to read, extract and process information without human intervention, which can increase productivity, reduce costs, decrease the probability of errors and negatively impact employee's motivation as their tasks start to be replaced by machines (Fernandez & Aman, 2018; Jędrzejka, 2019).

Furthermore, according to (Jędrzejka, 2019) the RPA can be beneficial to account for the following processes and tasks:

- Period-end closing: regarding the general ledger's tasks or low-risks accounting reconciliation.
- Accounting reports: that are produced monthly with financial and operational data.
- Accounts receivable and payable: by maintaining, processing, or delivering invoices to customers, executing automatic approvals or payments, and comparing the data present in invoices against purchase orders.
- Cash management, transactions, inventory, and expenses: using expense reports, refunding requests, payroll, and tax accounting.

2.1.5. CURRENT CHALLENGES

With the evolution of technologies being faster than ever, accounting needs to follow this tendency to keep providing credible information and improve decisions. Accounting needs to tackle several challenges to fully take advantage of these technologies (Jasim & Raewf, 2020; Möller et al., 2020). According to (Möller et al., 2020) we can identify as challenges:

- Need to find the right balance between the human being and machine by selecting the appropriate tools, techniques and applying them to a process.
- Digitalization is not at the required level in companies, especially the largest ones.
- Lack of knowledge and expertise in digital tools like analytics, which could facilitate the way they process data and communicate the results.
- Lack of communication and involvement between accounting and data science, as many controllers yet do not see them as partners that could bring them benefits in near future.

According to (Mohamed & Lashine, 2003) the rapid advancement of technology in IT where information is produced faster, with fewer costs, and easily accessed and shared due to the meaningless of distances and boundaries could represent an accounting challenge.

Since accounting is focused on providing information to improve decision-making, the way reports are done also will face multiple challenges in the way software products can present the information to answer faster to business problems and opportunities. According to (Trigo et al., 2014) one of the greatest challenges is having real-time reports that can provide information to managers about company performance, whether they are inside or outside the organization to allow them do decide which direction or actions should be taken.

Nevertheless, the ethical side can present a huge challenge since the responsibility of gathering data and delivering information to accounting decision-makers must be rigorous and reliable to avoid business loss or damage. Also, ethical practices can affect the decision of financial creditors based on viable information about organizations and their financial state, or awake interest from potential investors (Horngren et al., 2012).

2.1.6. ACCOUNTANT

Being a relevant key member in the organizations, the accountant role is going to be described in the section below, as well as the current challenges it will be facing because of impact of information systems and emerging technologies, the role that automation has and the way it will shape their job as it requests a new set of skills.

ROLE

From the "*Traditional financial accounting operations such as "data input" are still the main operations of accountants*" (Chen et al., 2012) or being a provider of information to decision-making business partners (Holmgren Caicedo et al., 2018) to interpret, analyse, and monitor financial records or transactions (Moll & Yigitbasioglu, 2019) the accountant roles have been changing and evolving. The main tasks such as analysing and processing accounting documents, generating reports, or payroll are automated (Gulin et al., 2019) due to the way information technologies leverage them and for accountants, it's no longer enough just execute those tasks as they require a new set of skills and responsibilities in order to work with these platforms (Mohamed & Lashine, 2003).

This role more than ever is connected with IT systems and will require accountants to be able to work with a diverse set of technologies as big data to manage data more efficiently, to transform it into something useful recurring to analytical tools (Crookes & Conway, 2018) and *"providing persuasive evidence that can complement accounting to convince others of a particular course of action"*(Moll & Yigitbasioglu, 2019, p. 9), cloud computing to obtain a competitive edge and manage IT resources, blockchain and artificial intelligence such as process automation to leverage the continuous process of adding value to an organization (Crookes & Conway, 2018) or machine learning to provide support to other employees in the understanding of complex models (Stancheva-Todorova, 2018).

IMPACT OF EMERGING TECHNOLOGIES

As accounting is impacted by technologies, the accountant's professionals (Kroon et al., 2021) also suffers from the challenges that arise from its evolution, the necessity to adapt their roles by changing their methods or principles and the willingness to learn (Gulin et al., 2019). Besides that, they could be at risk of computerization in near future (Stancheva-Todorova, 2018) as emerging technologies that impacted the accountant's role (Kroon et al., 2021) are:

- Big Data: since it's able to store an enormous set of data that can generate financial information to enhance decision-making (Zhang et al., 2020), will require accountants to be able to analyse this data and the reports generated.
- Artificial Intelligence: by changing their working patterns and creating new types of roles that negatively impacts employment, since automation can replace structured tasks or decisions, and affect human lives and working patterns (Stancheva-Todorova, 2018). But from another perspective, AI allows business managers without accounting knowledge to make business decisions from the information that is generated (Zhang et al., 2020).
- Blockchain: by proving reliable information with distributed ledgers that improve the authenticity and reliability of data while reducing the risk of attacks, increasing the difficulty of forging data and removing ownership from the accounting database (Kroon et al., 2021; Zhang et al., 2020).

As can be seen in the blockchain implementation, the use of artificial intelligence and big data can affect the accountant's role in its advisory functions, auditing procedures, judgement, and information governance.

Furthermore, in research made by (Stancheva-Todorova, 2018) we can verify how artificial intelligence affects employment positively by raising productivity and lowering costs, increasing the specialized labour to work with technologies, and negatively by allowing technologies to automate roles, and activities by adapting technological innovation and putting humans as a completements of a machine.

CURRENT CHALLENGES

With the accounting industry evolving and changing faster than ever with the help of emerging technologies, the role of accountants is to constantly change and bring a new set of challenges, opportunities, and drawbacks from their need to adapt or transform business practices and processes, as well as leaving behind rules and principles (Gulin et al., 2019).

According to (Crookes & Conway, 2018; Gulin et al., 2019; Kroon et al., 2021; Mohamed & Lashine, 2003) we can identify challenges to accounting the profession:

- Automation of accounting: by allowing the accountant to have more time with their clients and discuss future solutions or what are their needs, as well as introducing advisory services, that will require a specific set of skills to gain their trust and confidence.
- Accounting engineering: where it's required to have critical thinking and creativity to use digital systems, to acquire knowledge and actively adapt to technological developments as well as new products.

- Accountant personality and skills: they are required to have a varied set of skills such as communication, to effectively communicate inside and outside an organization, analytical and intellectual to gather the proper information, analyse business problems, and apply the solution, critical thinking to justify the conclusions reached or computer skills by having basic of knowledge to work with digital products.
- Emerging technologies: will be required to have programming skills and improve their data analysis skills, to be able to understand the tools and reports (Zhang et al., 2020) generated recurring to the technologies like big data, cloud computing, blockchain, and artificial intelligence.

2.2. TECHNOLOGIES FOR ACCOUNTING

This section will have an overview of technologies that are present in accounting and have been mentioned in the previous sections and are challenging/impacting accounting with their evolution and integration in the organizations. Beneath will be found research regarding the MRP and ERP systems that help in resource management (Chen et al., 2012), artificial intelligence and its application in the OCR systems, process automation, and Intelligent interfaces in accounting as well as intelligent accounting tools and products.

2.2.1. MRP AND ERP SYSTEMS

As accounting started to be informatized the necessity of systems that could help to manage and process the information has appeared and with them the MRP (Material Requirements Planning) systems from the necessity to manage resources more efficiently. However, as companies started to adopt these systems more necessities and challenges started to surge until the MRP could not correspond and other systems started to be created until the ERP systems emerged as a solution that manage the information across organization (Chen et al., 2012; Robert Jacobs & 'Ted' Weston, 2007).

MRP CONCEPT

MRP systems were "*developed to calculate more efficiently the materials needed*" (Klaus et al., 2000, p. 144) and according to (Robert Jacobs & 'Ted' Weston, 2007) it has the concept of *dependent demand* that can be seen as the predecessor of ERP Systems and the "*state-of-the-art method for planning and scheduling materials for complex manufactured products*" (Robert Jacobs & 'Ted' Weston, 2007, p. 558) that are capable of fitting requirements as production integration and planning due it's integration between forecasting, scheduling and procurement.

According to (Md. Saiful Islam et al., 2013) these systems (in figure 2), are advantageous because they *"…facilitate the calculation of requirements of materials and timing*" and attempt to maintain the necessary inventory levels to ensure the required materials are available.

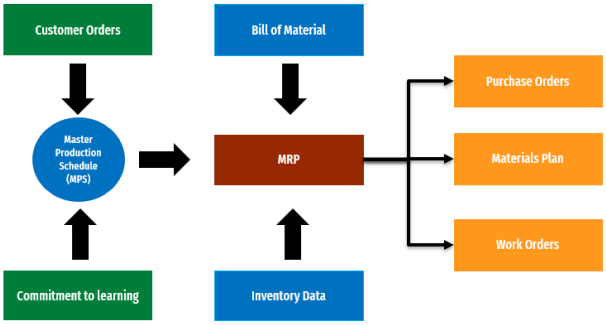

Figure 2 - MRP System diagram adapted from (Md. Saiful Islam et al., 2013)

ERP Concept

An ERP system is a software solution that has an interdependence of business functions (Klaus et al., 2000) and is used to manage the organization's resources by integrating the departments and functions into a single system to serve their needs (Basoglu et al., 2007). The function is the integration of information from all departments and combining all operational information needed in one database independently of its origin that can serve and send it to accounting (Chen et al., 2012).

ERPs can be seen as "*criteria for evaluating the extent that software was actually integrated both across and within the various functional silos*" (Robert Jacobs & 'Ted' Weston, 2007, p. 361) and a standardized business process to efficiently plan and control an organizational knowledge to obtain external advantages. These advantages can also come from the concept of standardization and flexibility (Al-Mashari, 2002) that enables the existence of software packages that are now more focused on specific market segments.

Furthermore, these systems can coordinate activities and decisions, and allows the combination of business processes into a single system that ensures the information flows through the entire company, offering managers that run the business a holistic view of the processes (Basoglu et al., 2007; Klaus et al., 2000; Moon, 2007).

ERP Implementation

Implementing an ERP is a large, costly, and complex process (Hoseini, 2013) that can be seen as one of the most difficult to develop (Basoglu et al., 2007) since it involves a great part of the organization and its major process (Moon, 2007). Due to the high expectations for costs reduction, the adaptation to the functionalities and business culture of the organization (Basoglu et al., 2007) as well as lack of planning and self-awareness of employee's resistance to change and difficulties to use a new system lead this implementation to fail and become a negative investment in most of the cases.

To prevent this lack of success it's crucial that the commitment of top management of an organization, the ERP processes to be aligned with the organization's business process for each business unit affected, introduce ERP and its functionalities step-by-step to optimize the training and support of key

users as well as prevent resistance to change (Al-Mashari, 2002; Basoglu et al., 2007) and improve the satisfaction (Moon, 2007). An example of this model is presented below in figure 3.

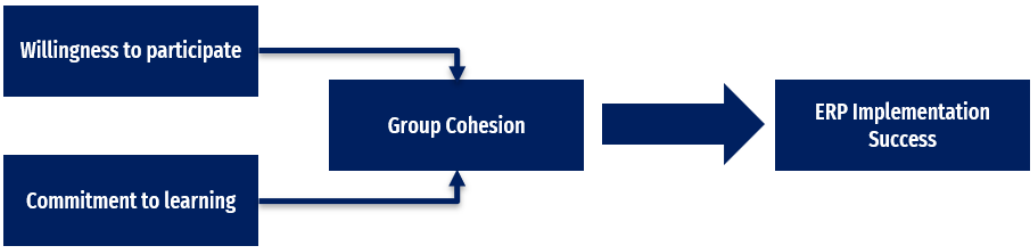

Figure 3 - Conceptual model of a successful ERP implementation adapted from (Basoglu et al., 2007)

ERP RELEVANCE

From the moment these systems are present in an organization they become extremely important due to their capability to store information across diverse departments, support business process as procurement or payroll, to present a solution that supports different industries from hospitals with patient management to retail transactions (Klaus et al., 2000).

Being better and faster (Klaus et al., 2000) made these systems so relevant when implemented in organizations, as well as the following benefits:

- Efficiently manage resources and save costs (Moon, 2007).
- Improve productivity, financial cycle (Chen et al., 2012), the capabilities to decide (Klaus et al., 2000), and scalability (Adrian-Cosmin, 2015).
- Standardization of business processes by redesigning and adopting the ERP best practices (Adrian-Cosmin, 2015).
- Securing access to the information and quality of the store data (Adrian-Cosmin, 2015).

2.2.2. ARTIFICIAL INTELLIGENCE

By becoming part of our life (Haenlein & Kaplan, 2019) and being used in business (Burgess, 2018), Artificial Intelligence is impacting our lives and business like accounting which makes it a valuable subject to research and in the following chapter will be presented its concept, areas, applications, benefits, and drawbacks. Besides this, other relevant topics that recur to AI as rule-based systems, machine learning, and optical character recognition will be introduced.

AN OVERVIEW

Having the capability to be present in several areas, as well as being a branch of computer science that is focused on dealing with the intelligence that computers and machines demonstrate (Jeyamani et al., 2016), AI "*was based around 'expert systems'*" (Burgess, 2018, p. 11) and it's focused on the acquisition

of knowledge to solve complex problems (Moret-Bonillo, 2018). Besides wanting machines to have human intelligence, AI does not have a consensual concept defined by the authors present in the research carried out, as presented below:

- A system that replicates human aspects by allowing a computer to have human intelligence to make decisions, learn and solve problems with the goal of being able to engage with humans using "*natural human language*" (Crookes & Conway, 2018).
- "*A system's ability to interpret external data correctly, to learn from such data, and to use those learnings to achieve specific goals and tasks through flexible adaptation*" (Haenlein & Kaplan, 2019, p. 5).
- The capacity that a machine has to learn from experience and process, and adapt the received inputs to perform human tasks (Duan et al., 2019).
- "*a science that tries to establish the basis for the later development of a set of techniques destined to endow machines a certain autonomy*" (Moret-Bonillo, 2018, p. 2).
- *"the theory and development of computer systems able to perform tasks normally requiring human intelligence"* (Burgess, 2018, p. 5).

AREAS

AI expanded and became complex and vast, which has led to its segmentation into several areas "*that cannot be seen in isolation and have a certain relationship and dependencies"* (Bertram, 2022). According to (Moret-Bonillo, 2018) we can have nine areas (figure 4) in artificial intelligence:

- Knowledge Representation: intends to describe aspects of the real world.
- Machine Learning: to enable identification of trends based on data.
- Planning Field: develops algorithms to execute scripts automatically.
- Uncertainty Reasoning: "*develop encodings of uncertain information."* (Moret-Bonillo, 2018, p. 2).
- Study of Agent Architectures: look for the integration of AI with other areas.
- Multi-agent Coordination and Collaboration: enables "*the development of techniques to represent the capabilities of other agents and the specification of the knowledge necessary for collaboration between them*" (Moret-Bonillo, 2018, p. 2).
- Ontologies Development: seeks the creation of catalogues that can be used by intelligent systems.
- Voice and Language Processing: wants to create systems capable of communication with persons using their human language.
- Synthesis and Images Understanding: seeks the production of algorithms capable of analysing images or videos.

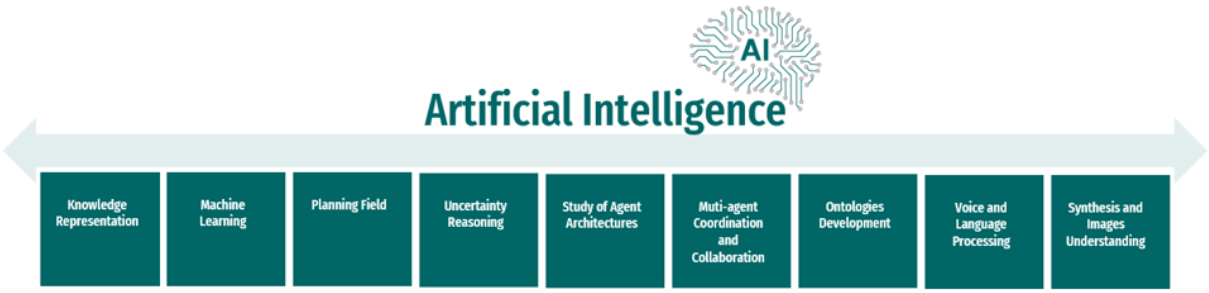

Figure 4 - Adaptation of AI Areas adapted from (Moret-Bonillo, 2018)

Furthermore, this work will explore in more detail the areas of machine learning and expert system that were identified as relevant for this study, as well as OCR systems that recur to AI techniques to collect data from images.

BENEFITS AND DRAWBACKS

An organization seeks AI to obtain a competitive edge and obtain benefits such as productivity and efficiency improvement and/or cost reduction in their business areas, but sometimes they are accompanied by task automatization that affects human jobs or lack of regulation. Table 1 will present the benefits of using AI and table 2 its drawbacks.

Benefit	Description	Authors
Predictions cost	Enable cost reduction when data is needed to make predictions	(Duan et al., 2019)
Search Engine	Enable information search across several datasets	(Zhang et al., 2020)
Decision Making	Improving the decision-making from information that is generated from data at a lower cost	(Stancheva-Todorova, 2018; Zhang et al., 2020)

Table 1 - Benefits of AI

Drawback	Description	Authors
Biased Information	AI systems can be biased due to the data collected and affect functionalities as self-driving cars	(Haenlein & Kaplan, 2019)
Employment	Using automation to replace structured tasks or manufacturing processes will result in jobs loss	(Haenlein & Kaplan, 2019; Stancheva-Todorova, 2018)

Lack of Regulation	Since AI has no regulation regarding data that is processed and shared	(Haenlein & Kaplan, 2019)

Table 2 - Drawbacks of AI

2.2.2.1. RULE BASED SYSTEMS

This system can be known as an expert system that according to (Jeyamani et al., 2016) is a sub-field of AI "*that can create resolutions which generally necessitate human level of proficiency"* (Jeyamani et al., 2016, p. 546) and are the simplest form of AI (Grosan & Abraham, 2011). They are sequential programs that are dependent on the initial data, the defined parameters, conditions, and rules, and the results obtained from the previous computations that were created and specified in the program code(Grosan & Abraham, 2011; Moret-Bonillo, 2018).

According to (Grosan & Abraham, 2011), RBS are simple models that consist of a set of *rules* (group of data and conditions that contains all the actions taken by the system), *facts* (statements that were made and should be relevant for the initial state of the system), and *interpreter* to control the application of the rule for the facts. It also says that rules interact with the conditions previously made and not with data since they can change their value (directly or based on a condition).

DATA	CONDITIONS	RULES
SEASON WINTER		**PREMISES**
Temperature	< 0, > 0	**IF** *temperature < 0* **AND**
Wind blushing	Strongly, gently	**IF** *wind blushing is strongly* **OR**
Road	Slippery, not slippery	**IF** *the road is slippery*
Weather	Cold, Warm, Hot	
		CONCLUSION
		THEN *the weather is cold*

Table 3 - An example of Rule based system adapted from (Grosan & Abraham, 2011)

Although this system is very simple, it can be classified into two types, the forward chaining or data-driven system that use the available data as start and do not require all the facts to be represented, but only the ones used in the rules (Moret-Bonillo, 2018); the backward chaining or goal-driven system, the rules must be considered as statements or assertions (Moret-Bonillo, 2018).

The forward chaining system starts with initial facts such as temperature or road present in table 3 and uses the rules as wind blushing is strongly or temperature below zero to generate new facts until a

conclusion is reached (weather is cold) (Grosan & Abraham, 2011). For the backward chaining system, it starts with the goal that we want to reach and looks for rules that enable the conclusion or evidence to prove of our hypothesis, and in case the evidence has not been reached we have to define a new hypothesis and start a new process (Grosan & Abraham, 2011).

2.2.2.2. MACHINE LEARNING

As a subfield of computer science (Ongsulee, 2017), machine learning gives computers the capability of learning from data without the need to be programmed (Jenab et al., 2019; Ongsulee, 2017; Singh et al., 2021) and can be represented as a machine that does all computational work to learn how to solve problems (Burgess, 2018), identify patterns as customers behaviours (Jenab et al., 2019; Jeyamani et al., 2016). Furthermore, its relation with statistics and mathematics (Ongsulee, 2017) allows ML to be focused on predictions recuring to algorithms as predictive models or neural networks to make decisions (Singh et al., 2021). To make predictions, identify patterns, or solve problems machine learning has been divided into supervised, unsupervised, and reinforcement learning as represented in figure 5.

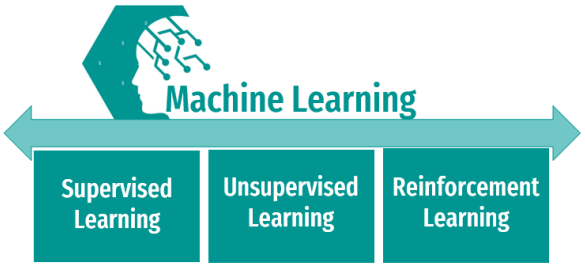

Figure 5 - Machine Learning types adapted from (Ongsulee, 2017; Singh et al., 2021)

Supervised Learning is an algorithm in which the machine learns from classified data and already knows the results or outputs based on the initial inputs (Singh et al., 2021), which means it will learn from the comparison between them and will adjust the model accordingly (Ongsulee, 2017).

Unsupervised Learning is an algorithm that has to identify what is presented (Ongsulee, 2017) and is used to describe the data that has not been classified, meaning the machine has to return an output without observation (Singh et al., 2021).

Reinforcement Learning is an algorithm that learns from trial and error and is commonly used in gaming and robotics (Ongsulee, 2017; Singh et al., 2021). In this type o ML, the machine is not trained to act (Singh et al., 2021) , but instead composed by the *agent* (decision-maker) that takes the required *actions* (what the agent can do) to perform a task in the *environment* (everything that interacts with agent*)* to provide an outcome that is assigned as a reward or penalty (Ongsulee, 2017; Singh et al., 2021).

Nerveless, the area of application of ML is vast and is used for speech recognition recurring to deep learning (Jeyamani et al., 2016; Ongsulee, 2017), on streaming platforms by providing a section of

"*movies you would like*" based on your watch history (Singh et al., 2021) and in image recognition and classification with the use algorithms to identify individuals or characters in the images and then recurring to deep learning for its classification and categorization that are an integrated part OCR systems (Jeyamani et al., 2016; Ongsulee, 2017).

2.2.2.3. OPTICAL CHARACTER RECOGNITION

Often referred to as text recognition (IBM, 2022) or a subset of pattern recognition area (Chaudhuri et al., 2017), optical character recognition is a program that extracts data from scanned images as bills or invoices, documents as purchase orders or books or handwritten manuscripts (Berchmans & Kumar, 2014; IBM, 2022). The capacity it has to convert different types of documents into searchable data made this system one of the most successful applications in the AI fields (Chaudhuri et al., 2017).

With the capability of processing information without control processes, the OCR system can work offline after the documents or images have been scanned (Chaudhuri et al., 2017) and have an approximate rate of recognition of 73% (Berchmans & Kumar, 2014), as well as working online with the possibility of recognizing characters as soon as they are drawn, and obtain an approximate rate of recognition of 84 % (Berchmans & Kumar, 2014).

According to (Chaudhuri et al., 2017) OCR systems are composed of eight components (figure 6):

- Optical scanning: where the physical form of a document (IBM, 2022) is scanned to obtain a digital image, which is converted to two colour levels of black and white.
- Location Segmentation: locates regions in the document that have printed as letters or numbers.
- Pre-processing: Each character that is targeted (IBM, 2022), is subject to preliminary processing to verify its usefulness in the next steps. In this phase broken characters (obtained due to the lack of quality of the image) are eliminated.
- Segmentation: the characters of the image are segmented into subcomponents.
- Representation: is one most important roles, and in the *"simplest case, gray level or binary images are fed to a recognizer"* (Chaudhuri et al., 2017, p. 23).
- Feature Extraction: this is responsible for capturing the characteristics of the symbols and is one of the most difficult problems for pattern recognition.
- Training and Recognition: methodologies such as pattern recognition are used to assign a predefined class to unknown samples.
- Post-processing: is a set of activities that include group and error detection and correction.

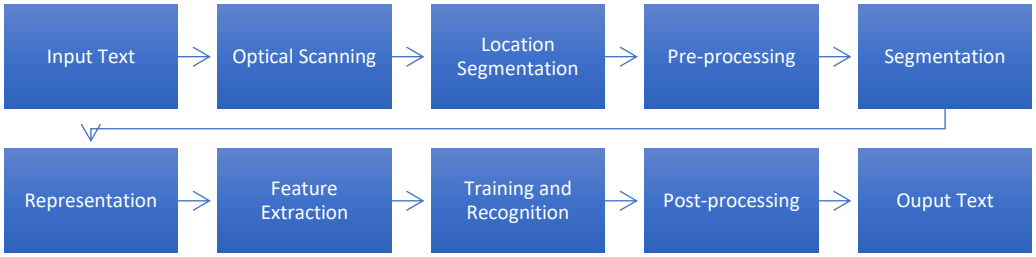

Figure 6 - OCR system components adapted from (Chaudhuri et al., 2017)

The benefit of using OCR system are the improving efficiency by in the search of electronic copies of documents that were physically archived (Berchmans & Kumar, 2014), and the security and information centralization by storing the information of the scanned documents in databases with restricted access (IBM, 2022). As major drawback it has the image quality that can influence the rate of recognition of the information present in the scanned documents or images (Berchmans & Kumar, 2014).

2.2.3. PROCESS AUTOMATION

With AI starting to be used in business (Burgess, 2018) and the changes driven by disruptive technologies associated with automation (Sousa, 2022), process automation appeared by using software and a set of technologies to the automate business process or function to achieve a goal, such as providing customer service or hiring employees (SAP, n.d.) and can be represented as the act of replacing with for machine to execute sequential tasks (Outsystems, n.d.).

With speed and efficiency increase, more resilient business structures improved compliance and archived better customer sever quality and experience (Outsystems, n.d.; SAP, n.d.). Areas such as accounting and finance, as well as its derivations like invoices, purchase orders and requisitions and order processing, directly benefit from process automation (Outsystems, n.d.).

Process automation can be divided into three types (figure 7):

- Business process automation (BPA): automates business operations (Sousa, 2022).
- Robotic process automation (RPA): it runs business operations without human intervention time (Fernandez & Aman, 2018).
- Intelligent process automation (IPA): enables more complex automation by reducing human-dependent training (Sousa, 2022).

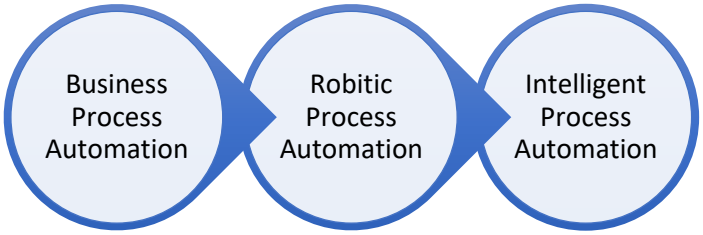

Figure 7 - Process Automation types adapted from (Sousa, 2022)

BUSINESS PROCESS AUTOMATION

Business process automation uses automation to eliminate mistakes from human operations and increase the effectiveness of business processes to encourage growth and keep low costs (Chakraborti et al., 2020). It also is focused on improving back-end productivity, which may be applied to the payroll process (SAP, n.d.) and the fulfilment of purchase orders (Sousa, 2022).

Some of the advantages of BPA, according to (Cummins, 2017) are:

- Reliability: is achieved by making clear who, what, when, and how participants perform all the assigned tasks.
- Control: Ensuring effectiveness to meet compliance requirements and reduce risk.
- Optimization: by identifying the impacts in particular tasks and measuring all aspects of the business procedure to identify the necessary improvements.
- Customer service: for a faster response to international marketplaces, business processes are driven by online customer inquiries.

ROBOTIC PROCESS AUTOMATION

An RPA is an alternative to traditional automation and non-invasive technology that offers cross-functional operations (Jędrzejka, 2019), that enables the integration of several systems and the reduction of workload in business process workers by reproducing human tasks recuring to automation using robots and AI workers (Ribeiro et al., 2021). This technology uses AI and ML (van der Aalst et al., 2018) that allows robots to be configured by end users and work in parallel with other robots or humans (Jędrzejka, 2019) and can be described as a system that can be configured to run business operations without human intervention and trained to be autonomous after a certain amount of time (Fernandez & Aman, 2018).

This type of automation can be defined as a "*technique that results in the automatic execution of administrative, scientific or industrial tasks which uses robotics*" (Ribeiro et al., 2021, p. 52) or "*an umbrella term for tools that operate on the user interface of other computer systems in the way a*

human would do" (van der Aalst et al., 2018) that can be approached from three ways according to (Chakraborti et al., 2020):

1. Learns to automate tasks recurring to examples or demonstrations as processing behaviours inside system logs.
2. Learns from tasks step by step using natural language text description of a process that can be written by humans.
3. Learns from the task defined by an environment with a *"reward function"* that relies on reinforcement learning algorithms or an input/output example.

According to (Jędrzejka, 2019) the utilization of these robots can be applied to areas such as accounting to simple tasks such as mail management where emails can be opened, read, and sent automatically, data management with search and extraction of data that can be validated and inserted/updated in a system or database and to do more complex tasks as decision-making recurring to predefined rules that guide the paths which are going to be taken based on data and inputs.

BENEFITS AND CHALLENGES

An organization implements RPA to obtain benefits such as productivity and efficiency, improvement, or cost reduction in their business areas, but sometimes there are accompanied with some challenges regarding the implementation. Table 4 will present the benefits of using RPA and table 5 the challenges.

Benefit	Description	Authors
Scalability	Robots can be easily cloned and scheduled, work across multiple systems and connect to several applications	(Jędrzejka, 2019; Siderska, 2020)
Productivity	Increase productivity by automating standardized, and routine tasks	(Fernandez & Aman, 2018)
Data Analysis	Employees will commit fewer errors in data analysis with the help of robots	(Siderska, 2020)

Table 4 - Benefits of RPA

Challenge	Description	Authors
Cybersecurity	Data available in digital channels can be exposed to hackers	(Jędrzejka, 2019)

Regulatory risks	Lack of testing by robots and use of invalid algorithms can lead to financial losses	(Jędrzejka, 2019)
Satisfaction	Reducing the employee's burden of doing repetitive tasks can positively impact employees as well as decrease their morale due the possibility of being replaced by machines	(Jędrzejka, 2019; Siderska, 2020; van der Aalst et al., 2018)

Table 5 - Challenges of RPA

INTELLIGENT PROCESS AUTOMATION

As part of process automation IPA, brings ML and AI to improve business processes (Chakraborti et al., 2020), and can be seen as a sub-field of AI or as a fusion with RPA that aims to create end-to-end process, where automation requires the coordination of tasks in the systems (Ferreira et al., 2020; Kholiya et al., 2021). IPA accents in three pillars represented in figure 8, which are AI with the use of Machine Learning and its algorithms, BPM to streamline and automatize processes, and an RPA (Kholiya et al., 2021).

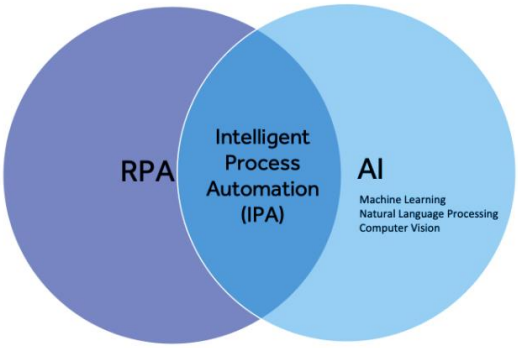

Figure 8 - Intelligent Process Automation Representation adapted from (Kholiya et al., 2021)

The objective of IPA is allowing a robot or a bot to be configured to perform human tasks as RPAs can, and is also capable of working with several types of data (unstructured, semi-structured and structured) (Kholiya et al., 2021). According to (Chakraborti et al., 2020; Ferreira et al., 2020; Kholiya et al., 2021) IPA has several goals:

- Increase the efficiency of the process with self-learning.
- Decrease or eliminate repetitive tasks.
- Drive employees to increase its productivity and satisfaction.
- Provide tools to create complex workflow with reduced human interaction.

Predictive analytics ML algorithms can be applied to predict customers behaviours (Kholiya et al., 2021) regarding a product or service and enable the organization to respond to this change. Predictive maintenance and anomaly detection also recuring to machine learning and AI (Kholiya et al., 2021) can also be used to prevent breakdowns by sending proactive warnings regarding and detect anomalies.

BENEFITS AND DRAWBACKS

As previously referred, implementing technology is always accompanied with benefits (present in table 6) and drawbacks (present in table 7).

Benefit	Description	Authors
Customer Experience	Provides a richer experience by being faster and more accurate processing queries	(Kholiya et al., 2021)
Compliance	Improve compliance and regulations with human error decrease due to automation	(Kholiya et al., 2021)
Satisfaction	Improve employee satisfaction by freeing him to realize challenging tasks instead of repetitive ones.	(Kholiya et al., 2021)

Table 6 - Benefits of IPA

Drawback	Description	Authors
Cost	Implementing IPA has a higher cost than an RPA	(Chakraborti et al., 2020)
Low Adoption	The financial risks associated with and lack of trust in AI by uses compromises IPA adoption	(Chakraborti et al., 2020)
AI Expertise	The necessity of re-train employees in the organization, as well as the lack of skilled workforce	(Kholiya et al., 2021)

Table 7 - Drawback of IPA

2.2.4. INTELLIGENT USER INTERFACES

Intelligent Interfaces can be seen as a combination of several disciplines present in figure 9 (Sousa, 2022) or a combination of the most recent human-centred design and best technologies such as computer vision, analytics, or augmented/virtual reality that results in a set of techniques that can transform the way we interact with machines, data and each other (Cook et al., 2019). Since it requires a component of design it's important to have a user interface ("*consists of modifying a software system's UI in order to satisfy requirements"*(Abrahão et al., 2021, p. 1)) that is easy to understand and meets the expectation of the users, otherwise, it will become a poor interface that leads to frustration, unsatisfaction, and less productivity by the users (Stone et al., 2005).

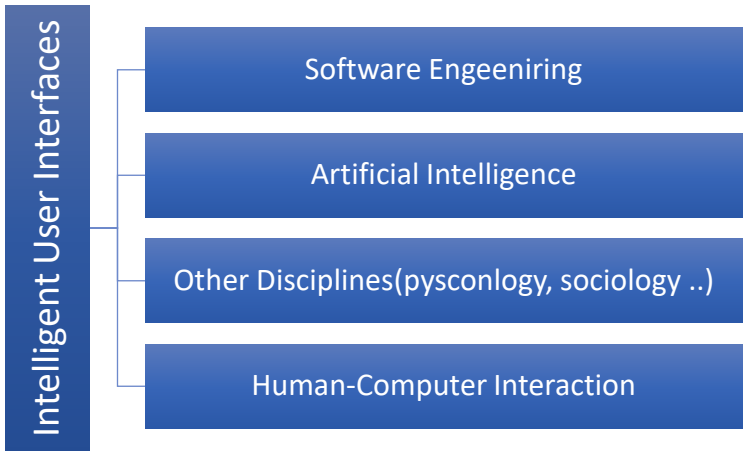

Figure 9 - Disciplines of Intelligent User Interfaces adapted from (Sousa, 2022)

USER INTERFACES

Before we talk about intelligent interfaces, we need to understand that the user interfaces is the way a user interacts with a computer system to do tasks and archive goals (Stone et al., 2005). Even though it's a bridge between users and systems, each interaction will be different, and can dictate its usability and adoption to the users (Stone et al., 2005) and should benefit the end-user experience and facilitate its understanding (Abrahão et al., 2021).

As UI takes an important role in the adoption of an intelligent interface, (Abrahão et al., 2021) states that technologies like ML and AI provide useful ways to support the adaption of UI more efficiently and its adoption is a sequence of seven stages:

1. We obtain the *entity* from the UI adoption goals, that can be expressed in the system or maintained in the head of the users.
2. UI adaptation starts from an initiative by the entity previously identified.
3. Based on the Inputs gathered, some UI adaption is subjected to a specification that allows the way this adoption will be carried out to be expressed.
4. UI adaption is selected and applied.
5. A transition from the initial state to the final state is made to preserve its continuity.

6. Output results are subjected to the entity identified in stage 1 for interpretation based on the system feedback.
7. An evaluation it's made from the interpretation made in the last stage to verify if the initial goals are partially or totally met.

BENEFITS AND CHALLENGES

Based on the studies made by (Abrahão et al., 2021; Stone et al., 2005) we can verify that when UI is adopted into a system, end-users will have several benefits and challenges. Table 8 will present the benefits and table 9 the challenges.

Benefit	Description	Authors
Efficiency	A good UI can increase the usability of the system that leads to increased efficiency for the end-users	(Abrahão et al., 2021; Stone et al., 2005)
Satisfaction	A good UI can increase user satisfaction and morale	(Abrahão et al., 2021; Stone et al., 2005)
Productivity	A good interface can lead to a higher productivity	(Stone et al., 2005)

Table 8 - Benefits of Intelligent User Interfaces

Challenge	Description	Authors
Time and Place	Selecting the right timing and place to implement UI that is valuable for the end-user	(Abrahão et al., 2021)
Productivity	A bad implementation of UI can cause a loss of productivity and increase financial costs	(Stone et al., 2005)
Safety	A poor UI can compromise the safety of the users and lead to disasters	(Stone et al., 2005)

Table 9 - Challenges of Intelligent User Interfaces

2.2.5. INTELLIGENT ACCOUNTING TOOLS

As we overviewed accounting and its challenges, as well as its impacts that can be caused by several technologies such as artificial intelligence or process automation and the use of ERP systems, a set of tools are required to enable humans to work with systems. So, when we mention an intelligent

accounting tool, we assume that intelligent solutions will be applied to business process (Sousa, 2022) recurring to AI and processes automation.

INTELLIGENT ERP

One of the most recent applications of this kind of application is intelligent ERPs which can be described as cloud-based systems that are capable of learning and adapting to business rules via machine learning, as well as enabling innovative products, and services, and increasing employees productivity (Morris et al., 2016). These systems are an upgrade version of the existing ERP systems since it potentiates more informed business decisions (Sousa, 2022), process efficiency, and automation recurring to several intelligent technologies (Bertram, 2022).

According to (Morris et al., 2016), an i-ERP is a combination of the three dimensions present in figure 10 that are: the user experience which is assertive and enables personalized access to information via a controversial style; the process that contains innovation processes redefinition and uses automation and augmentation using machine learning; and data that is personalized in-context access and includes its quality.

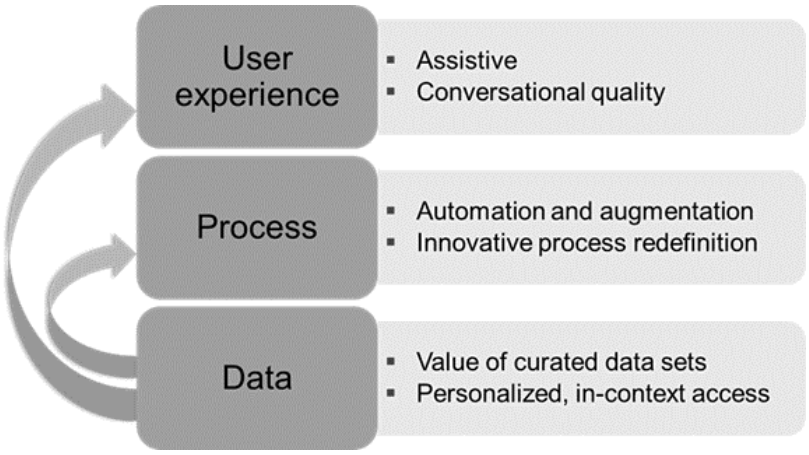

Figure 10 - i-ERP dimension adapted from (Morris et al., 2016)

Also (Morris et al., 2016) evidenced what differentiates an ERP from an i-ERP is the fact that ERP applications are "*systems designed to automate and optimize business processes"*(Morris et al., 2016, p. 3) that collect data regarding several aspects of the business process, transaction, and details while i-ERP is set of ERP applications, that can be deployed to manage the entire organization and uses machine learning and advanced analytics to forecast, analyse and manage resources and business processes. One of the most visible differences is the capability that an i-ERP has to analyse a large volume of data in real-time and the ability to learn that will enable the adaptation of the user experience.

AVAILABLE PRODUCTS

As emerging technologies expanded and started to be connected with business (Burgess, 2018), several companies started to develop intelligent products for accounting such as Primavera, Kofax, or Oracle. Bellow will be present suppliers that have intelligent accounting tools and an overview of their functionalities.

PAA (PRIMAVERA Accounting Automation) is a software solution that automates accounting posts into the PRIMAVERA system through an automatic integration of data with origins such as SAFT-T, e-Fatura (electronic Portuguese invoices), or Jasmin. This solution also has is capable of automatic reconciliation and provides an intelligent mechanism capable of suggesting templates and helping in the definition accounting rules. (PRIMAVERA, 2023)

Xero is an online accounting software for small business that automates invoices, allows bank connection for automatic transactions, and enables data access in real-time (Xero, 2023b). Some of the features included are bank connection and reconciliation, bill payments, expense claims, reporting, and inventory (Xero, 2023a).

Oracle NetSuite is a cloud-based management platform that has a suite of applications that help companies run their business, understand how their business performs, and enable cost savings, and more efficiency (NetSuite, 2021). This platform allows a unified view of the business by bringing together HR, finance, supply chain, and manufacturing in one single system that enables an extensive reporting capability and a role-based dashboard that allows faster informed decisions (NetSuite, 2021).

KOFAX has an intelligent automation platform (figure 11) that leverages RPA and AI in a set of advanced technologies to unlock document's intelligence (use cognitive capture and AI to automate and extract information from unstructured data), connect complex business systems and automate workflows (KOFAX, 2023a). One of its products is KOFAX Total Agility which is an integrated platform of automating workflows, AI-drive intelligent document processing and can be integrated with RPA, Analytics, and have business rules (KOFAX, 2023b).

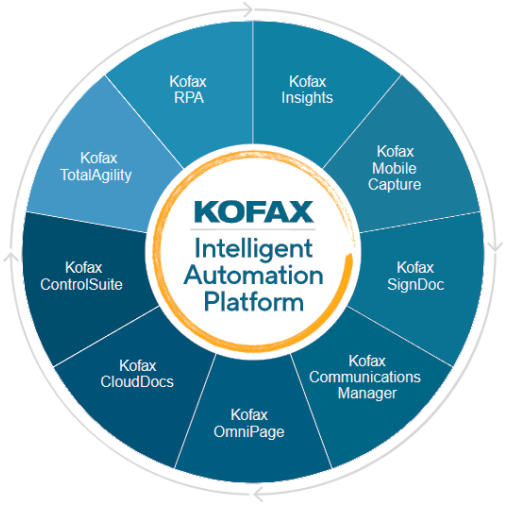

Figure 11 - KOFAX intelligent Automation Platform adapted from KOFAX, 2023a)

After knowing some of the capabilities of each product we understand that PPA and Xero have solutions specifically for accounting and bring some feature that facilitate the work of accountants as automatic Bank Reconciliation and Invoice Posts (PRIMAVERA, 2023; Xero, 2023a), but in case of NetSuite it already possesses an ERP, offers a Cloud-based solution and the possibility of integrating accounting and other departments in the organization (NetSuite, 2021). Finally, KOFAX is much broad by presenting a set of intelligent automation platforms that has on-premises and cloud-based solutions, as well as specific solutions for accounting and another business processes of an organization, besides the capability to communicate with several ERP using KOFAX Accounts Payable Agility (KOFAX, 2023c).

3. METHODOLOGY

The goal of this study is to create an artefact which is a solution to real-world problems (Peffers et al., 2007) or *"something created by humans usually for a practical purpose"* (Geerts, 2011, p. 1). To do so, an architecture of an intelligent interface for the accounting modules of an ERP is going to be developed recurring to DSR methodology.

The DSR was selected with the perception that it will enable the achievement of the intended goals, because it supports the production of an artefact by enhancing its effectiveness in IT (Hevner & Chatterjee, 2010). Also, because it could be applied to accounting modules in Information Systems, as well as potentially solve the identified issues.

3.1. DESIGN SCIENCE RESEARCH

According to (Peffers et al., 2007) the DSR methodology helps in the production of rigorous and high-quality research which includes three elements *"conceptual principles to define what is meant by DS research, practice rules, and a process for carrying out and presenting the research"*, besides bringing the "*value of design science (DS) as an IS research paradigm"*.

In addition, to produce the artefact it going to be followed six activities: Identification of the Problem and Motivation; Define Objectives of the solution; Design and Development; Demonstration; Evaluation; Communication (Peffers et al., 2007). Also, to obtain robust data about the real-world environment to fortify the artefact it's going to be used the Hevner & Chatterjee (2010) relevance cycle that connects the experience gathered from environmental context with design science, recurring to the interaction between people and systems .

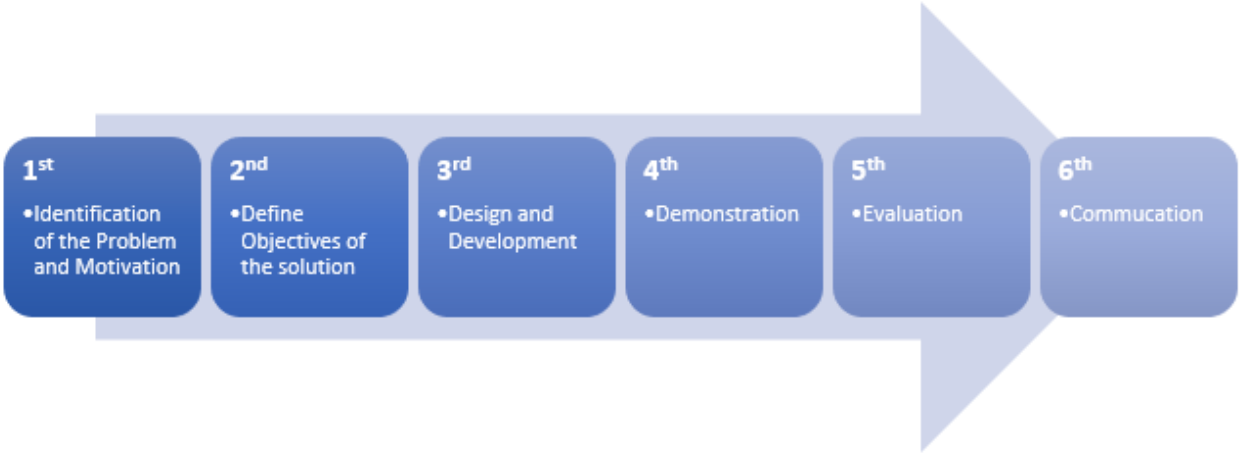

Figure 12 - DSRM adapted from *(Peffers et al., 2007)*

According with (Peffers et al., 2007) , DSR main activities represented in table 10 can be defined as six sequential activities (figure 12):

1. **Identification of Problem and Motivation**

The first activity is the definition of the research problem and justification of the relevance in the desired solution. This identification will be used to develop the artefact recuring to a solid base of knowledge that is going to be gathered during the investigation.

2. **Define Objectives of the Solution**

The second activity is focused on defining the objectives for the proposed solution recuring to the knowledge gathered during the problem identification and evaluation of what is feasible to develop. These objectives could be quantitative if we compare the proposed solution with the previous or qualitative if the artefact produced provides solutions to the stated problem.

3. **Design and Development**

For third activity, the artefact is going to be created based on the knowledge gathered from the two previous steps and the desired functionalities that meet the defined objectives.

4. **Demonstration**

In the fourth activity, it will be presented how the artefact could solve the problem recuring to simulations, experimentations, or case studies.

5. **Evaluation**

For the fifth step it's going to be done the observation and measurement of the artefact using the defined objectives in activity two and the results obtained from the previous activity. Also, this activity will require evidence to decide if it's necessary to return to activity three to improve the artefact or proceed to the last activity.

6. **Communication**

In the last activity it will be communicated the importance of the artefact, it's utility, effectiveness to researchers and other relevant audience. Also, this activity needs the knowledge gathered from the previous steps to produce a structure paper that contain a detailed information about the artefact produced.

DSRM activities	Activity description	Knowledge base
Problem identification and motivation	*What is the problem?* Define the research problem and justify the value of a solution.	Understand the problem's relevance and its current solutions and their weaknesses.
Define the objectives of a solution	*How should the problem be solved?* In addition to general objectives such as feasibility and performance. what are the specific criteria that a solution for the problem defined in step one should meet?	Knowledge of what is possible and what is feasible. Knowledge of methods, technologies and theories that can help with defining the objectives.
Design and development	*Create an artifact that solves the problem.* Create constructs. models, methods, or instantiations in which a research contribution is embedded	Application of methods, technologies, and theories to create an artifact that solves the problem.
Demonstration	*Demonstrate the use of the artifact.* Prove that the artifact works by solving one or more instances of the problem.	Knowledge of how to use the artifact to solve the problem.
Evaluation	*How well does the artifact work?* Observe and measure how well the artifact supports a solution to the problem by comparing the objectives with observed results.	Knowledge of relevant metrics and evaluation techniques.
Communication	Communicate the problem, its solution, and the utility, novelty, and effectiveness of the solution to researchers and other relevant audiences.	Knowledge of the disciplinary culture.

Table 10 - Design science research methodology adapted from (Geerts, 2011, p. 144)

3.2. RESEARCH STRATEGY

To follow (Peffers et al., 2007) DSR activities and (Hevner & Chatterjee, 2010) relevance cycle, a research strategy is going to be defined with the initial idea of existing problem for accounting documents. Bellow it will be found the strategic steps that required follow this methodology.

1. **Problem Identification and Data Gathering**

The aim of this step is defining the problem in the digitalization of accounting documents and obtain data regarding the accounting processes, what are the struggles and opportunities in the automation process. Besides this, it will be done research about Intelligent interfaces, existing architectures for accounting processes and the software's that are integrated. For the last step, the accounting workflows will be examined, and the data previously gathered will be connected, as well as partnerships they already have.

2. **Objectives Definition and Solution**

After gathering all the information from the literature review and problem identification the main objective and sub-objectives are going to be defined. It will include the definition of the required platforms for the architecture, tasks that are going to be automated and which require human intervention, as well as documents classification strategies based on success criteria.

3. **Artefact Development**

With the information gathered from the previous two steps the artefact, software architecture for automatic processing of physical or digital accounting documents, is going to be developed according to the functionalities and necessities to solve the identified problem.

4. **Demonstration**

Having the artifact developed, the use case is going to be created to demonstrate how the proposed artifact can be applied and which functionalities will be included.

5. **Evaluation**

To evaluate the artifact a presentation, followed by an interview will be performed with a group of specialists in the accounting and software area, to allow us to understand if the produced artifact is feasible and will help accountants or need adjustments and improvements.

6. **Communication**

In the last step, a document will be produced with detailed information about the artefact development and research, the reached conclusions, limitations, and future improvements.

4. AN ARCHITECTURE FOR AUTOMATIC PROCESSING OF ACCOUNTING DOCUMENTS

After carrying out the study for the literature review, the required knowledge is gathered to produce the artefact that is going to be present in the following sections, which will be composed of a set of assumptions, the artefact proposal, and respective evaluation, results, and discussion. Based on that, it will be briefly described some of the gathered concepts regarding accounting and accountants, as well as the technologies that are currently used and their interrelation to let us know that it's possible to have a symbiosis between humans and machines that will benefit the organizations. Accounting has changed with the arrival of the computer and according to section 2.1.2, we can verify that we have manual systems where paper is still used to record information, computerized systems where the information its stored digitally, and papers are partially used besides their connection.

On the other side, technologies also had a crucial role in the life of accountants by removing the necessity of humans doing repetitive tasks such as introducing data in the computer or comparing data between files, but also pushed them to improve their skills to be able to work with these software's (Zhang et al., 2020).

Regarding technologies, the literature review showed that ERP Systems are a basis in accounting and are completely integrated into this area, and also they started to use AI to build intelligent systems such as i-ERP that enable them to learn (Morris et al., 2016). Besides this, process automation is becoming present in several areas by allowing businesses to process routine tasks, to be automated recurring to pre-programmed robots that eventually will have self-learning capabilities.

Lastly, the literature review was fundamental for gathering this knowledge that will enable us to propose an artifact that will be divided into two parts:

1. **Architecture proposal:** a concept of an architecture for document automation will be presented.
2. **Guidelines, technologies, and software selection:** recurring to the information gathered will be presented a set of guidelines and a selection of the software that will integrate the proposed architecture based on the existing offers.

4.1. ASSUMPTIONS

The research carried out to produce the literature review, has given the necessary knowledge to enumerate several assumptions regarding the artefact that is going to be produced. Regarding the area of accounting the assumptions made for the new architecture are:

- Accounting has been through a gradual evolution since the arrival of computers, and that increases the potential to improve business and processes. Also, areas such as bank reconciliation, payroll, and accounts payable have been greatly affected by this digital transformation.
- The introduction of emerging technologies like AI, machine learning, and process automation will affect the accountant's role and will push them to change to adapt to these tools and products so they can continuously provide meaningful inputs.

- Selection of the right tools and products for accounting has to have into consideration the balance between the human and machines to allow users to have time to learn how to interact with systems, improve their communication channels with data science and avoid negative impacts.
- Accounting will benefit from the use of new technologies and products by improving the efficiency and accuracy of processes, flexibility, velocity, and security to share information, and cost reduction.

Regarding the technologies involved in the accounting processes it's assumed that:

- The market already has available a set of intelligent accounting tools, that will provide intelligent solutions to be applied to business processes (Sousa, 2022) and will help accounting and accountants to prosper.
- Connection and interrelation between accounting systems is possible as Primavera allows a connection to e-Fatura, but to connect invoices or purchase orders to an ERP it's needed to recur to other technologies such as RPA or IPA or implement these connections with customized development. Also, the integration between the products previously mentioned and ERP systems can be limited to their portfolio.
- The i-ERP enables data gathering from several business processes and provides real-time analysis from huge volumes of data, and adapts to the user's experience (Morris et al., 2016), even though it's not enough to cover the whole of the process of accounting documents automatization.
- Even though a huge set of accounting processes are covered and automated, they still do not cover all the existing types and a tool to scan and classify them is required, as well as a digital repository to store these documents and make them searchable and connected to BI to produce reports.
- To connect several systems, regarding the software providers it will be necessary to have an API or pre-programmed robot, to work as a bridge that will be responsible for retrieving data from one system and sending it to another, to allow data to be synced and up to date to enable reporting sheets to be produced.

4.2. ARTEFACT PROPOSAL

A set of assumptions have been defined to build the artifact and allow it to match the previous objectives. This proposal will consist of two parts: the architecture, which will include several stages and technologies that enable autonomous processing, and a use case to demonstrate its functionalities. The second section contains the implementation guidelines, suggested software vendors, and products.

4.2.1. ARCHITECTURE

This architecture is composed of four stages and transversal modules that will include several systems and technologies such as OCR, rule base systems, and machine learning to capture the information

from the accounting documents and proceed to its classification. It also will include a document management system where all the data is stored and available to be consulted by the accountants. Finally, process automation will enable the transition of the information between the proposed stages.

The first stage starts with the arrival of a document, despite not being part of the architecture it will be explored in the implementation guidelines, to an OCR system that can be cloud-based or on-premises, as it extracts data from scanned images, documents, manuscripts (Berchmans & Kumar, 2014; IBM, 2022) or other compatible formats using ML and deep learning for image recognition (Jeyamani et al., 2016; Ongsulee, 2017), uses rule-based systems for the document classification and, converts the file in a searchable document. The document's automatic classification depends on the image's quality, the configured algorithm, and the recognition rate which will determine if it's classified and can be processed for the next stage, or partially classified and requires human intervention to fulfil the information that was not recognized and validated by the system. Also, in this stage is where the classification rules for documents are going to be determined based on the document templates such as invoices, purchase orders, credit memos, or delivery notes, and the system is going to be trained to archive the desired recognition rate.

The second stage begins with the entry of the documents from the OCR system into a document management system where the files and data are going to be stored, organized, and segmented according to the previous classification. With this data, the existing workflows will automatically process the documents according to specific criteria, and for those that do not meet the requirements, a flow with the human intervention will be started with validation and approval stages. Besides that, accountants and other key users will be able to consult the documents based on their roles and permissions, allowing safe and controlled access to sensitive information. For other processes such as bank reconciliation or payroll that do not start with a physical or digital document, the automatic or semi-automatic processing will be available through a scheduled workflow or triggered when the key users insert the information in the system.

Also, in the second stage there will be present three crucial models which are: the automatic relation module, which will automatically connect documents as invoices to credit notes recuring to ML and rule-based systems to relate them by using their metadata; the workflow module as previously mentioned will manage all the flows and will automatically process documents; and finally, the connection module, which will be responsible to retrieve classified documents from stage one and incorporate them into stage two, as well as retrieve data from stage one and three, that will be required for specific dashboards into the analytics system present into stage four.

The third stage is the integration with the ERP systems where process automation will be required and, where a robot will be used to retrieve the information from stage 2 and log-in on ERP system and insert this information based on specific criteria. The using of IPA will be a key factor by allowing the robot to be configured to perform human tasks as RPAs and be capable of working with several types of systems (Kholiya et al., 2021). Also, in this stage will be possible to use another solution besides process automation, by recurring to customized API that will rule-based systems and ML to perform the tasks as the robot.

The final and fourth stage is the analytic system that is connected to the other systems present in the initial stages due to the connection module, which will be responsible for retrieving all the required data to populate the database. Besides this, it will incorporate other modules, such as dashboard

module that will provide a set of reports with crucial information for decision makers, as well as to accounts to have a holistic view of each process and the predictive module that will be incorporated in the reports and present a forecast for sales, incoming documents volume or market fluctuations. Also, this stage will have information that has not been in the other stages since it will receive data that only exist in ERP System, as e-Fatura or other government systems that directly send or integrate it through other processes.

Nevertheless, the automatism provided by AI in this architecture will be not able to cover one hundred percent of the cases and for that reason, will always be required human intervention into the proposed stages, as well as for cases where an approval decision is required. But on another side will also allow:

- Access to information and the possibility to do act in the required workflows at any time, place, and device.
- Safe, secure, and controlled access to the information and the digital version of each document.
- Language profile according to customer necessities.
- A 360 overview of every process, and stage since the document arrives at OCR until it reaches the ERP.
- Documents and respective processes to be processed in parallel, regardless of the stage they are in.

To represent the proposed architecture will be presented the technological architecture in figure 13, which displays a holistic view of the several platforms that are going to be used and the way in which users integrate with the different platforms.

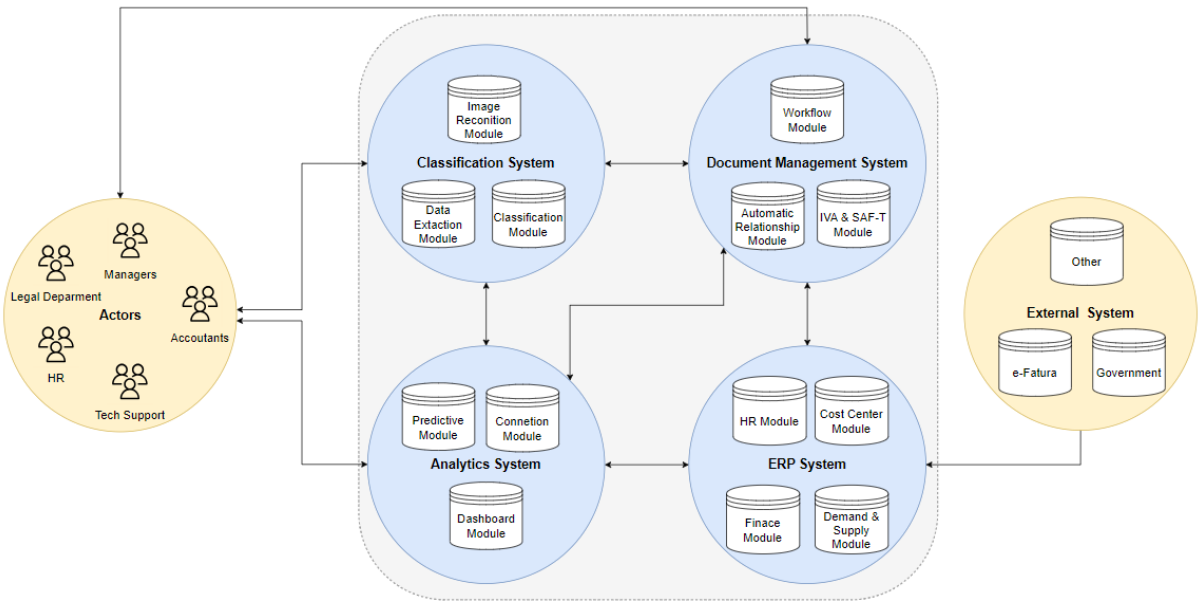

Figure 13 - Technological Architecture

Also, the process architecture in figure 14 and figure 15, represents several processes of an organization through a set of diagrams using BPMN to provide a simple and clear reading of each process incorporated through the proposed architecture.

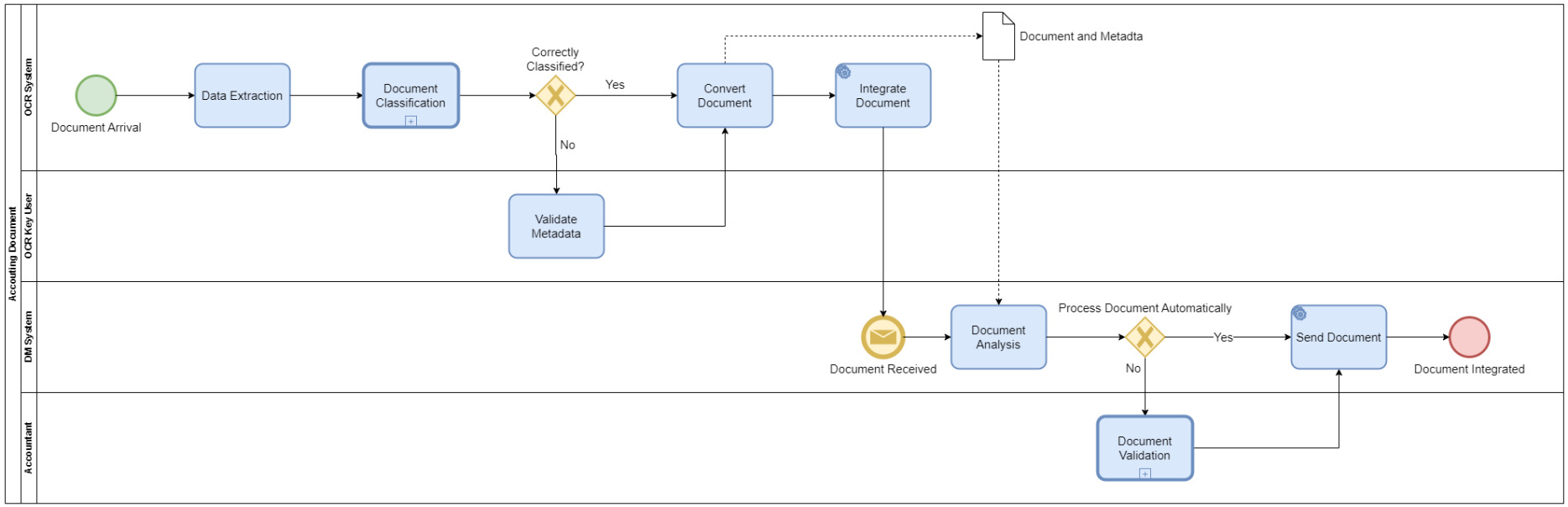

Figure 14 - Process Architecture

This process represents the accounting, accounts payable business process from stage one, which is represented by the first lane where the document arrives at the classification system and the OCR performs the data extraction and does the document classification, proceeding to its conversion into a searchable pdf if it's correctly classified otherwise, the OCR Key user, present into the second lane, needs to intervene and perform a validation task. After this, the document is integrated and enters stage two which is represented in the lane tree by the DM (Document Management) System where documents are going to be analysed and automatically processed if the requirements are met, case not in the fourth lane a document validation workflow is going be performed by the accountant, and then the document its sent to ERP by an RPA that will represent the stage three.

For other business processes without the presence of a document, such as payroll or a bank reconciliation, figure 15 represents the process architecture, which does not contain stage one due to the inexistence of a document and the process starts in stage two with the metadata submission through a form into DM System, that will be analysed and automatically processed if the requirements are meet, case not in the second lane a metadata validation workflow is going be performed by the accountant, and then the metadata it is going to be sent to ERP using an RPA.

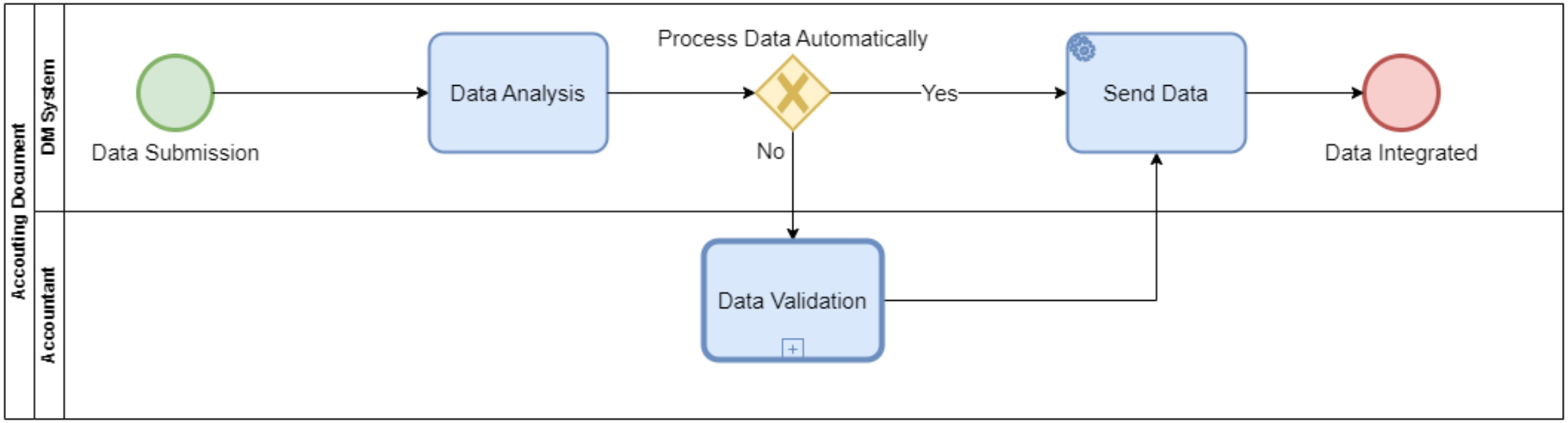

Figure 15 - Process Architecture without a document

4.2.2. USE CASE

To demonstrate how each actor and system will interact with each other in the four stages of this architecture, as well as which actions, they can perform in each stage, it's going to be presented a use case diagram in figure 16.

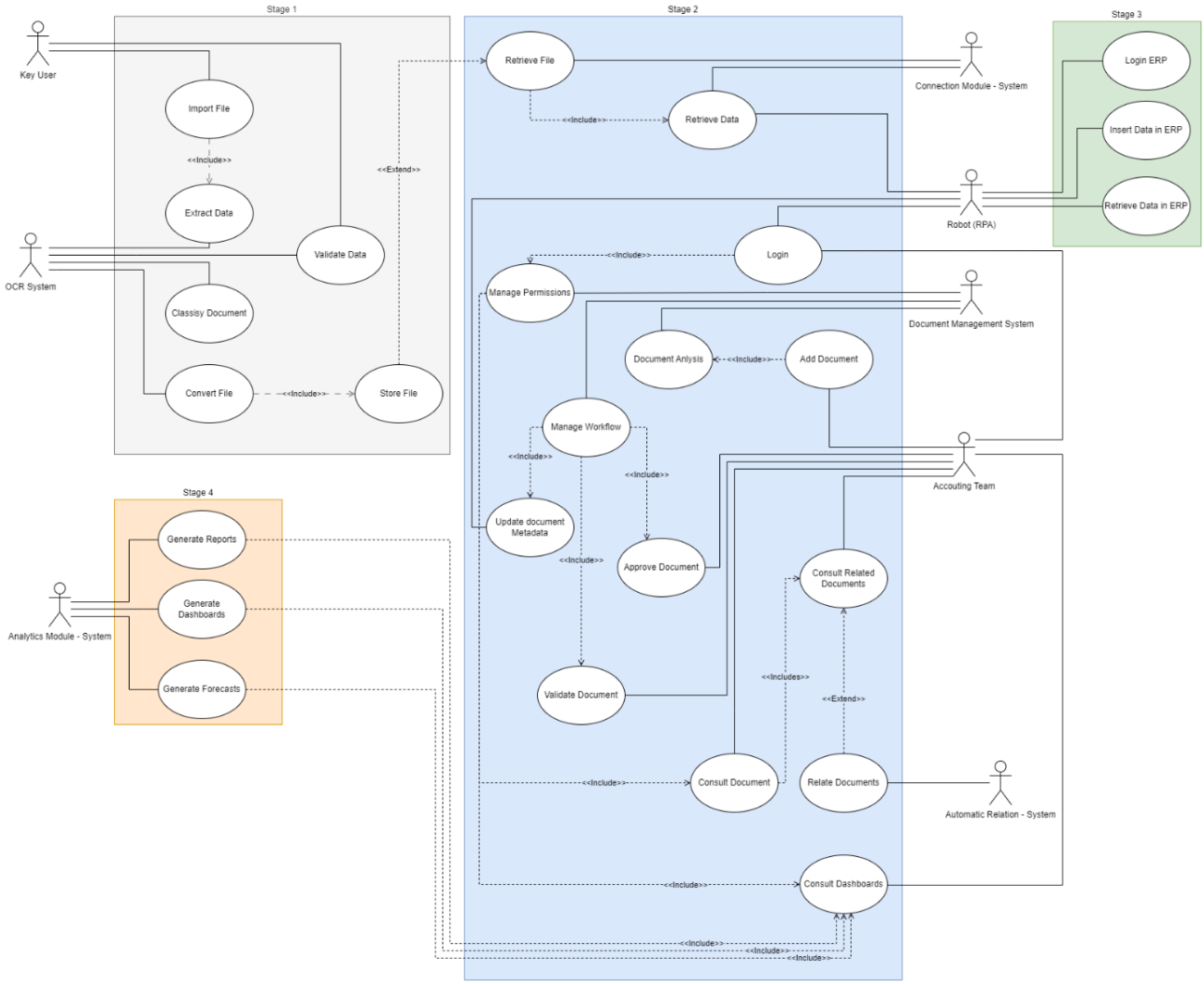

Figure 16 - Use case Diagram

By using an invoice in figure 17 as an example, we can verify from this document, which can be in physical or digital format, a vast amount of data that is going to be extracted by the OCR system after the key user imports the file.

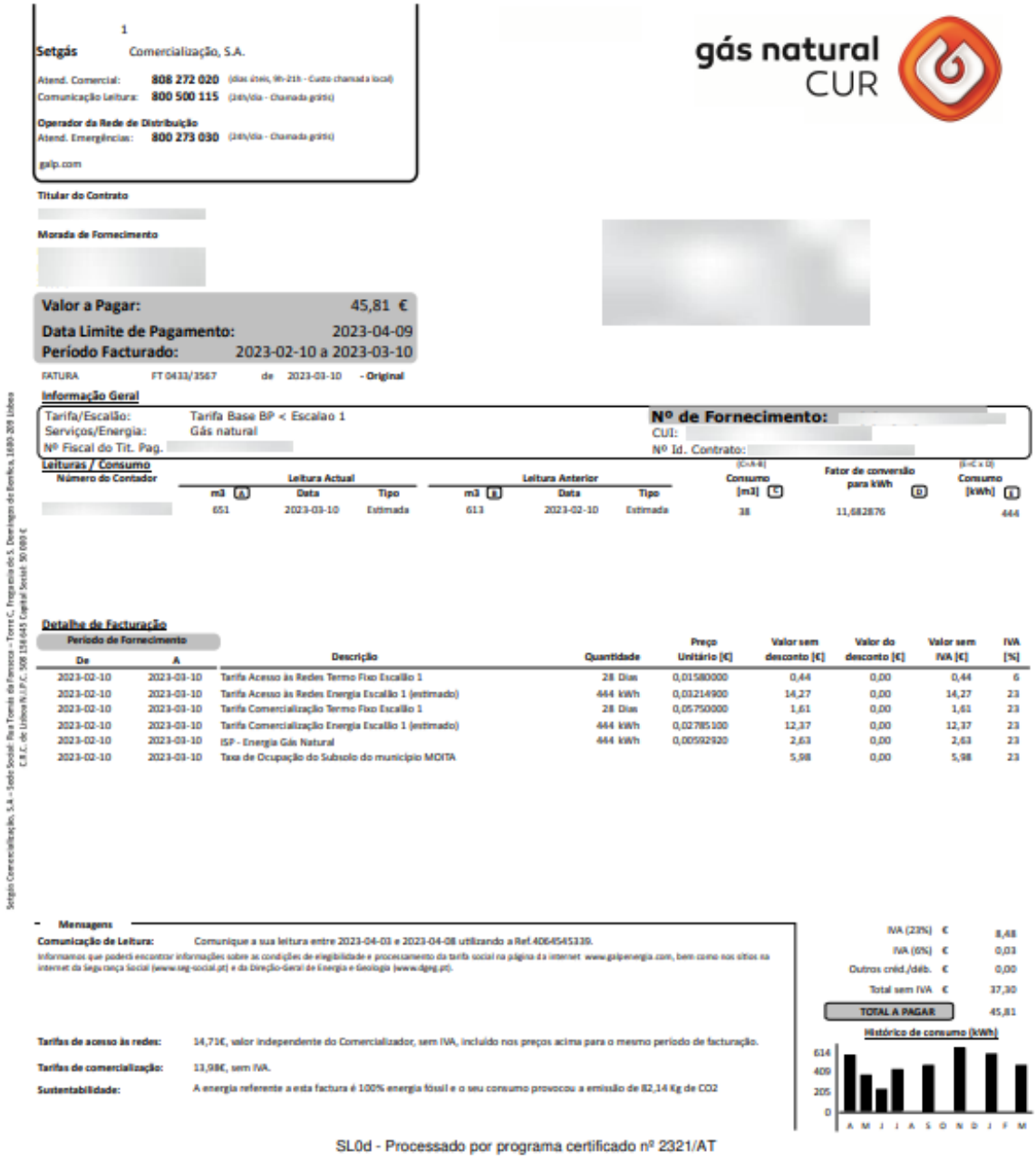

Figure 17 - Use Case Invoice

With this document the following steps, are performed in stage one:

1. The system classifies the invoice into financial accounting.
2. Validates the data.
3. Converts the document into a searchable file and generates a document with metadata.

After this, in stage two the system will use the connection module to retrieve the document from stage one and will proceed with the following actions:

1. The system classifies and analyses the retrieved document.

2. Starts a workflow that automatically validates if the document can be automatically processed or requires an accountant intervention.
3. Process the document to finalize the status and finish the workflow.

In the third and last stage the robot will log in the document management system stage and proceed with following actions:

1. Retrieve the documents ready to be integrated, which includes its metadata and file.
2. Logins into ERP System and access to a specific area for financial accounting.
3. Insert the retrieved data into the ERP and saves the file as an attachment.
4. Updates document metadata with ERP information in the document management system.

The fourth stage which includes the dashboards and reports creation, as well as other activities present in the use case diagram as consult documents, consult dashboards, and add documents are not present since they are not required for this example, and can be performed at any time for other types of documents or business processes.

4.2.3. IMPLEMENTATIONS GUIDELINES

When implementing an architecture, especially with technology, organizations always have doubts about which software they should acquire or if they can keep what already have. To help them to ensure that they can take advantage of this change, below are presented five guidelines that should be followed:

1. Select which business process is going to be migrated: to understand what the requirements and functionalities will be required, otherwise will lead to faulty implementation that does not meet the predefined goals.
2. Perform an analysis of the solutions and software that already has been acquired: to verify which can be integrated into the new architecture, as well as to reduce the financial investment that is required.
3. Analysis and selection of the technology: before acquiring any software verify if it has AI or Process Automation and which level is included, as well as its scalability when it's required to include new business processes or to expand to other areas of the organization.
4. Select few software suppliers: to mitigate risks between integrations, improve customer support, and lower costs. However, it's not recommended to select only to due to its exclusive dependency.
5. Ensure that existing staff has the required set of skills: to implement the architecture and provide support and maintenance to the solutions, as well as to reduce the time and effort to learn how to work with new products.

After following the presented guidelines, an example of which software and providers can be selected for each stage of the architecture are KOFAX for stage one and three, as well as some integration into stage two since it provides a set of tools such as Process Automation, RPA, OCR and has an option for cloud-based solutions. Regarding stage two, many companies use Microsoft Office 365, which it's a

viable option since it's a cloud-based solution where documents and data can be stored and accessed safely, as well as Power BI tools that are connected and can produce dashboards.

4.3. ARTEFACT VALIDATION

According to the research strategy that was defined and the DSR methodology, after the design and development phase, and demonstration phase then we proceed to the evaluation phase where we are going to verify if we reach our goals and meet the proposed objectives. As (Geerts, 2011) mentioned we need to have evaluation techniques and metrics to evaluate the artifact, and to do so this solution was introduced to a group of specialists in the areas of information technologies and accounting in form of a presentation followed by an interview.

The inquired person's professional background and expertise, are the following:

1. **Daniel Carvalho:** Has a graduation in economy and post-graduation in accounting and tax, and as worked in several companies in the accounting area, such as Webasto, Delloite.
2. **Nasser Abdula:** Has a graduation in accounting and finances, a post-graduation in Taxation, and has been working in the last eight years at P.S.C.F. Lda, where currently performs the role of an Accountant.
3. **Mylene Pedrosa:** Has a graduation in biomedical engineering and currently is a Team Lead at Konica Minolta Portugal, and has working been with implementation accounting and tax solutions.
4. **João Casas Fernandes:** Has a graduation in Informatic engineering and has worked for Portugal Telecom, Vodafone Ireland and currently is a Tech Lead at NOS SGPS Portugal with a vast experience with several technologies, as well as leading projects.

Also, the inquires above mentioned that they agree with their information being present in this master thesis, as well as positively answered to the following questions, asked during the interview that followed the artifact presentation:

- **Question 1:** The proposed architecture is useful for the work of an accountant? Case not, please explain.
- **Question 2:** Have you already worked with automatic document processing solutions? Case yes, why and which are differences and similarities.
- **Question 3:** Do you have any objection to the proposed architecture? Please explain.
- **Question 4:** Do you have any recommendations or suggestions to improve the proposed architecture? Please explain.

The presentation can be found in the annexes section and is a short resume of this paper, which includes the objective of this thesis and stated problems, as well as the motivation to develop architecture in this area and artifact/architecture itself. The interview was composed of a set of questions that will allow the retrieval of relevant information concerning the artifact, its utility, and improvements, as well as limitations.

4.4. DISCUSSION

To evaluate and validate the proposed artefact, a presentation and interviews were conducted with specialists in accounting and IT technologies area. It helped us to understand its usefulness, similarities, and differences regarding the existing accounting solutions in the market, perceive opportunities of future work as well as the limitations. Below will be presented a synthesis of the information gathered in each question from the interviewed specialists.

Question 1: The proposed architecture is useful for the work of an accountant? Case not, please explain.

Three of the interviewees thought that the proposed architecture is useful and has the correct approach to automatize accounting documents, and two of them mentioned that is going to help to improve and facilitate the processes of an accountant, releasing them to perform another type of task while these autonomous processes are running. Also, a third element mentioned the necessity to adapt this architecture to the organization reality and define the requirements to obtain success.

Nevertheless, one of the interviewees thinks this architecture will not be useful for the accountants since it will reduce the necessity of having many accountants in the organization, as we have today since AI will reduce the necessity of having human interactions. On the other hand, the interviewee said that will be useful and good practice in the business structure since it will enable technological advancement.

Question 2: Have you already worked with automatic document processing solutions? Case yes, why and which are differences and similarities.

All the interviewees worked with automated solutions, which were fully customized and some included OCR systems or used OutSystems. One of the interviewees mentioned solutions, which included add-ons inside an ERP that contained chat functionalities and an OCR performed by a third-party enterprise, which does not generate a satisfactory level of confidence in some cases.

Two of the interviewees mentioned the similarities between the proposed artefact, one regarding the automatization performed SAFT-T Online, where an Excel is sent and information about its integration is returned. The other interviewee mentioned that already has worked with several automatic document processing solutions such as KOFAX, which is mentioned in the literature review.

Question 3: Do you have any objection to the proposed architecture? Please explain.

The interviewees did not express any objections when responding to this question, but one of them stated that the proposed architecture might not be the best option for procedures in micro/small businesses, but that it's suitable for medium-sized businesses. Meanwhile, another one pointed the necessity of direct integration between stage one and two, but also controlling the permissions to access the sensitive information should be of high importance to prevent data leakage.

Question 4: Do you have any recommendations or suggestions to improve the proposed architecture? Please explain.

For an implementation of this scale to be successful, one of the interviewees stated that the solution and the systems that comprise it should adapt to the company itself. Another one, suggested using the analytics system on an outside platform to enhance the security of the information that is stored, and highlighted the need for ongoing support in these processes, specifically those that are new, as well as having standard channels to make it easier for the maintenance and development teams to collaborate during the entire implementation, and finally suggested that these teams should use the agile methodology.

Based on the feedback received from the interviewees, as well as from their answers to question one, it can be concluded that the architecture meets the proposed objectives and it will be useful for the accountants, even though concerns regarding the employment of the accountants were mentioned.

As for the second question, half of the interviewees mentioned that they found similarities with the solutions they are using, meanwhile in the third question no objections were found.

However, from the some of the answers in question three and all in question four, several points of improvement have been mentioned, and will be interpreted as limitations and opportunities for future work.

5. CONCLUSIONS

The closing chapter of this paper includes three sections that bring the work to an end. The first section 5.1 contains a summary of the developed work, which includes the research carried out and the proposed artifact; the second section 5.2 includes the study's limitations; and the last section 5.3 will include opportunities for future research as well as improvements to the proposed architecture.

5.1. SYNTHESIS OF THE DEVELOPED WORK

The purpose of this work is to create an architecture that enables organizations to use accounting solutions to automatically process physical or digital documents, thereby making accountants more effective and productive while also lowering costs, optimizing procedures, and enhancing decision-making. To answer the proposed work's main question, "*What should I do to automatically process accounting documents?*" a research study was carried out in the field of accounting, related technologies, and products that are already on the market.

Before the research study has been carried out, the DSR methodology has been selected due to its capacity to help in the production of rigorous and high-quality research (Peffers et al., 2007), and used the Hevner & Chatterjee (2010) *relevance cycle* to connect environmental context with design science. After this, a strategy was defined with six steps on the DSR activities that started with problem identification and data gathering, followed the solution identification and artifact development, and finished with a use case demonstration, a set of interviews to evaluate the proposed artifact that will include the present document to communicate the obtained results.

In the carried-out study for accounting, it can be seen as an information system that processes data, measures the activities and communicates the results (Horngren et al., 2012) or economic events of an organization (International Monetary Fund, 2016). Areas and sub-areas as payroll, accounts payable or bank reconciliation, were researched since technologies are already present and relevant to its processes. Besides this, it was studied the impacts of information systems in accounting as the capacity to develop and utilize systems to track and record financial information (Ghasemi et al., 2011), the current challenges as the lack of knowledge and expertise in digital tools (Möller et al., 2020). Also, it has been studied the accountant role, the impact of emerging technologies such as AI, by changing their working patterns and creating new types of roles (Stancheva-Todorova, 2018), and their current challenges as automation.

The study on technologies for accounting has been made on topics as the ERP system, that is a software solution that has an interdependence of business functions (Klaus et al., 2000), and is a predecessor to the MRP System (Robert Jacobs & 'Ted' Weston, 2007), as well as how it's implemented. Another research topic was artificial intelligence where an overview has been made, followed by the identification of several areas as machine learning and multi-agent coordination and collaboration (Moret-Bonillo, 2018) that are relevant to produce the proposed artifact, its drawbacks as lack of regulation and benefits as costs prediction.

Also, regarding AI further research was made on machine learning, rule-based systems, and OCR due to its relevance and impact on automatic processing systems. Besides these two technologies, Process

Automation and Intelligent user Interfaces were also researched for a better understanding of how this can be applied to the solution that was going to be presented, as well as its benefits and drawbacks. Finally, this study was closed with research on intelligent accounting tools such as intelligent ERP and the available products on the market as XERO or KOFAX.

With the knowledge gathering concluded, the necessary conditions to produce the artefact to solve the research question have been meet and an architecture has been started to be developed, firstly by doing a set of assumptions on how introduction of emerging technologies will affect the accountant's role and to connect several systems in which, it will be necessary to have an API or pre-programmed robot to work. Afterwards the artefact proposal was developed with an architecture composed of four stages and transversal modules as the automatic relation, which is represented by a technological architecture for an overview of the interrelation between stages and a process architecture recurring to BPMN to represent the flows of the documents. To understand how this can be applied, a use case diagram has been developed and each step of the process of atomization of an invoice was described, as well as where each system intervenes. Finally, it was presented a set of guidelines to help organization to implement this solution.

With the artifact concluded, a presentation followed by an interview with four specialists in the areas of technology and accounting allowed us to understand that the research question has been answered as well as the objective defined was accomplished since the feedback received was positive and demonstrated to be useful for accountants and the right approach to implement this type of solutions.

5.2. LIMITATIONS

During the study and development of the proposed artifact limitations have been found, besides the ones identified by the experts during the performed interviews in section 4.4.

The main limitation of this research is the non-implementation of this architecture into an organization, which would enable us to understand the interaction between the stages and the accountants. Also, if a successful implementation is achieved, recurring to proposed guidelines, the usefulness for the accountants and decision-makers, in addition to providing more data, would fortify the success of the proposed objectives.

Another limitation was the lack of time to obtain a deeper knowledge of artificial intelligence and its areas, which would enable a more robust architecture, that could include several subsystems to perform complex tasks, in addition to a detailed description of each component and technologies involved.

From the interviews, the limitations were the lack of a permissions management module to manage sensitive information and a third-party platform to host the analytics system, to prevent data leakage from cyber-attacks, which could cause damage to the organizations. Another one was regarding the micro/small companies that cannot invest in architectures of this scale and have fully customized systems for their necessities.

5.3. FUTURE WORK

Future work should start by improving this proposal based on the limitations mentioned in the previous chapter, such as following the implementation of this architecture into an organization to mitigate the identified limitations and understand the complexity of these processes. Also, an investigation into the field of Artificial Intelligence should be performed to deeply understand which technologies still could be included in this architecture, as well as the full potential that already exists to improve the proposal and enrich the academic research field regarding emerging technologies.

Another point should be the inclusion of a separate permissions management module to manage the access to all information from stage one to stage four, which would be the first touchpoint when a user interacts with the diverse platforms, in addition to seek for an analytics system from the market offers that could be hosted externally and communicate with the existing platforms.

From the interviews, suggestions that will be interpreted as future work were received, such as the improvement of this architecture to have a simpler and smaller version for better approach and adaption to micro/small companies and its specificities.

To conclude the research, its crucial to proceed with the points previously identified as we can understand that artificial intelligence is becoming part of organizations and has a vast set of areas that need to be explored, and researched to improve the systems that are into this architecture and support humans, especially accountants.

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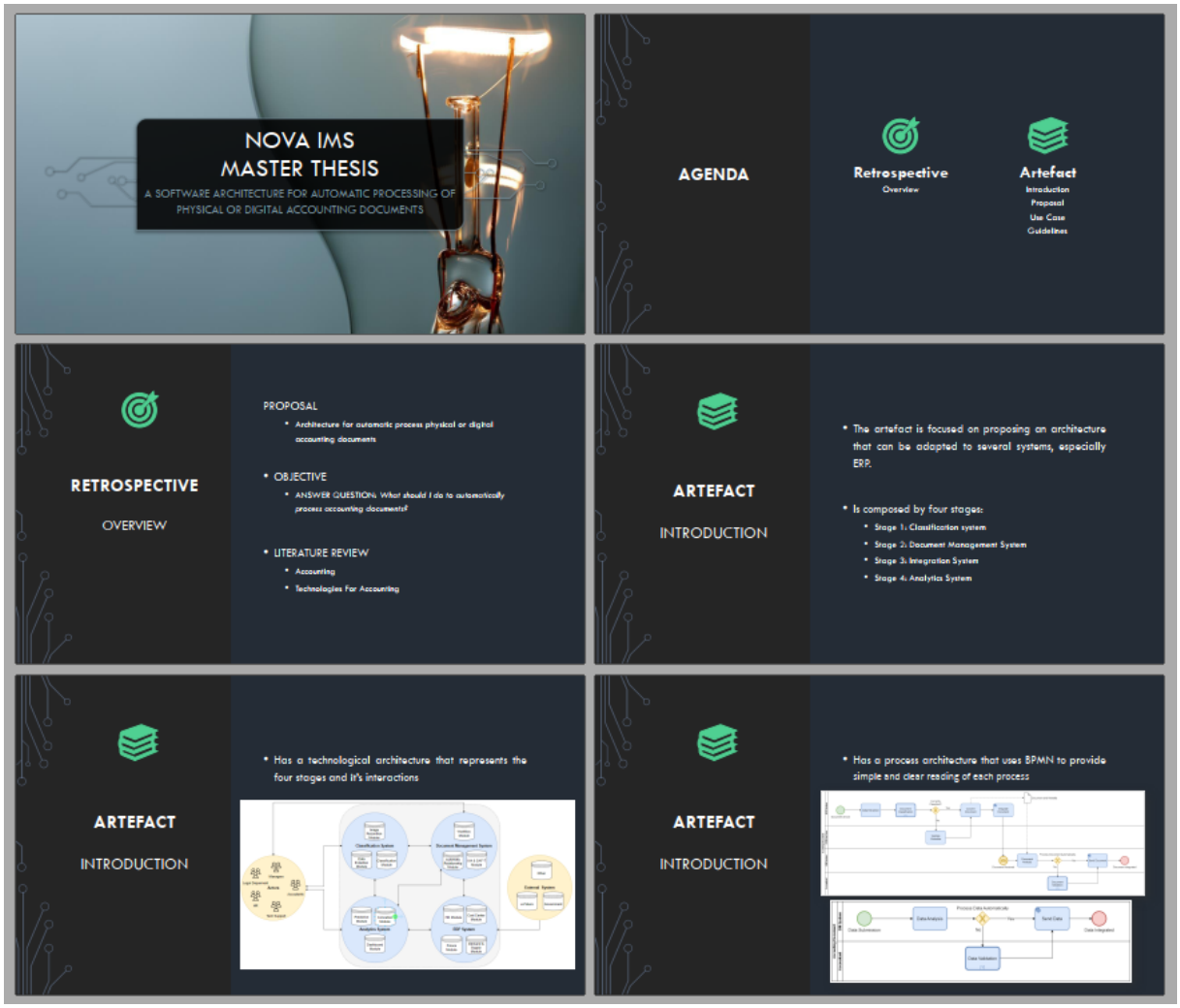
ANNEXES

ANNEX 1 – Interview Presentation

Bellow will be the slides used in the PowerPoint presentation to the specialists mentioned into section 4.3.



ARTEFACT

STAGE 1

- Classification System has an OCR (Optical Character Recognition) that:
  - Has an image recognition and data extraction system to obtain its metadata;
  - Has a classification system based on retrieved and preprogramed rules;
  - Uses AI to improve is learning mechanism.

ARTEFACT

STAGE 2

- Document Management System that:
  - Has an workflow system that is responsible for processed documents and metadata, as well as decide if they need human intervention;
  - Has a connection module that is responsible for retrieving the documents an it's metadata from the stage 1;
  - Has an automatic relationship system that allows the documents to connected based on it's own metadata;
  - Can incorporate specific accounting types and processes as VAT and SAF-T.

ARTEFACT

STAGE 3

- Integration System has an RPA (Robot Process Automation) that:
  - Has a Robot that is responsible to retrieve data and documents from DM System in the stage 2 and insert into the ERP System;
  - Robot also can be used to retrieve the information from stage 1 and insert it into the stage 2.

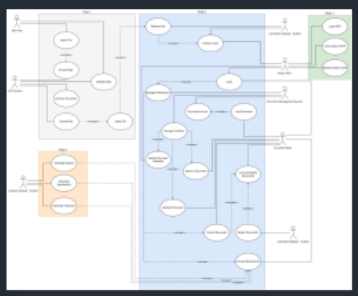
ARTEFACT

STAGE 4

- Analytics System that:
  - Has capacity to produce dashboard and reports based on data that is extruded from the other stages;
  - Has a predictive module that enable accounting forecasts, as sales;
  - Has the connection module , present in stage 2, to retrieve information from the other stage to populate it's own database.

ARTEFACT

USE CASE



ARTEFACT

GUIDELINES

- To ensure a successful implementation of the proposed architecture have been proposed five guidelines:
  1. Select which business process is going to be migrated
  2. Perform an analysis of the solutions and software that already have been acquired
  3. Analysis and selection of the technology
  4. Select a few software suppliers
  5. Ensure that existing staff has the required set of skills

QUESTIONS

- **Question 1:** The proposed architecture is useful for the work of an accountant? Case not, please explain.
- **Question 2:** Have you already worked with automatic document processing solutions? Case yes, why and which are differences and similarities.
- **Question 3:** Do you have any objection to the proposed architecture? Please explain.
- **Question 4:** Do you have any recommendations or suggestions to improve the proposed architecture? Please explain.

ANNEX 2 – Interviewees answers

Bellow will be found detailed information regarding the interviews performed to the specialists mentioned into section 4.3.

Interviewee: João Casas Fernandes

Q1: I think not since these processes will remove the necessity of having many accountants as we have today. You have more AI and less required persons since they will only validate metadata. From the perspective of an enterprise, it will make total sense and its good practice to enable the technological advancement.

Q2: Yes, PEEP that has a customized solutions for the necessities of an accountant based on OutSystems.

Q3: No but exists the necessity of a direct integration from Stage 2 to Stage 1 and have narrow permissions to access the information. Also, the reports could be produced externally to ensure more security.

Q4: Yes, have well defined who is going to perform the manual processes between teams and the teams should work with the agile methodology (for each stage) in order to give a better support. Also, exist the necessity of a continuous maintenance, where someone should accompany the ongoing and future processes to give support to the three areas. Finally, without external intervention becomes easier to manage and solve problems.

Interviewee: Daniel Carvalho

Q1: It's useful and correct, but we need to adapt it to our reality and current processes. We need to define the requirements and what we need to implement in order to have success. We need to achieve a certain level of confidence.

Q2: Yes, the EIM is an SAP addon that manages documents and includes functions as an approval chat and an OCR that was performed by an external company, that only return errors. Also, used TANGO that is another SAP addon that includes an OCR. Some of these OCR's did not generate a satisfactory level of confidence.

Q3: No.

Q4: For any project to be successful, us the accountants need to adapt to the solutions we have, as well as the new systems need to be adapted to company itself.

Interviewee: Mylene Pedrosa

Q1: Yes, I believe that is going to be something that is going to help to improve the processes of an accountant.

Q2: Yes, I work with several automatic document processing solutions like Kofax Total Agility, Kofax Express, and TIS Eflow. The Kofax total agility is a BPM that also has the component of OCR with learning, TIS Eflow is an OCR that also have learning and Kofax Express is something simpler that makes the process of the document based on rules.

Q3: No.

Q4: No.

Interviewee: Nasser Abdula

Q1: Yes, because process of automatization facilitates the work of the accountants and release them to perform other tasks, while these processes are running in background. This solution will accelerate the process and the automation should happen in accounting.

Q2: Yes, SAFT-T Online has a process to automatize delivery notes. We generate a PDF to insert information into the Excel that is going to be send to SAF-T and it returns the integrate document. Also, we use E-Fatura integrate with SAF-T

Q3: No, but this proposal could not be the ideal solution for in micro/small businesses due it's specific necessities and small volume. For medium/large business it will be.

Q4: No.