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

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Abstract: The advancement of technology and its integration into our daily lives has created a need for organisations to adapt and digitally transform working methods and how we use the available digital tools to conduct business successfully. Organisations implement digital transformation initiatives in addition to their internal processes, which can start in one department and expand to the entire organisation. The main objective of this article is to propose a new architecture for the automatic processing of accounting documents. The new architecture aims to streamline organisations by helping them transform the accounting area, enabling better decision-making, access to relevant information, and cost reduction. The study includes concepts related to accounting, the accountant's profession, and the impacts/challenges regarding information technologies. It also includes principles on AI, machine learning, optical character recognition, process automation, intelligent interfaces, intelligent accounting tools, and a set of available products. With the necessity of proposing a standard software architecture to process accounting documents, a proposal with four stages (classification, document management, integration, and analytical stages) was developed and later validated by specialists. This proposal is expected to contribute to organisations' clear understanding when implementing these architectures, besides enriching the scientific field by bringing a new perspective to future research on this subject.

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

1. Introduction

In the present day, technology is part of everyday life. Digital transformation is disrupting every type of business and industry (Branco et al., 2016; Schwertner, 2017) by destroying barriers between people and the business, originating in new types of products and services (Fortes et al., 2016) leading to "The ability to transform process and business models…" and the need for companies to build "…Digital Business Platform that is outcome driven and enabled by technology…" (Schwertner, 2017). With this kind of rapid transformation occurring, organisations are trying to respond to industry challenges and their customer's needs by reinventing the way they do business (Fernandes, 2018; Gartner, 2023; Möller et al., 2020), which could lead to struggles by small and medium companies to keep up with the constant changes and consequently

lose customers or profit. Another impactful factor on organisations was the worldwide COVID-19 pandemic crisis that accelerated the need for remote work and the use of digital tools to connect at times when presential meetings were not possible (Torous et al., 2020), physical activities were no longer possible, and the need for quick responses to the pandemic to secure the survival of companies (Gartner, 2023).

Organisations use Enterprise Resource Planning (ERPs) to manage their resources and integrate processes such as purchasing, supply chain, or human resources. Moreover, ERPs underpin the integration of each department into a single environment (Fernandes, 2018). This advancement has become one of the most critical developments in the company IT sphere, showing us how the companies will seek benefits such as faster information and decision-making, lower costs, or global control over operations (Basoglu et al., 2007). This modus operandum is relevant to fulfilling the need for businesses to maintain their systems and not let them become obsolete, which, according to the IDC, represents 35.4% of SMEs. The IDC has begun to raise warning signals regarding this adverse phenomenon, as companies possess unused data that could be used to increase profitability. Not heeding these dire signals leads to a disconnection from user experience and a lack of flexibility to scale up entrepreneurial operations and decisions, which leads to less-than-optimal outcomes (Schoenborn, 2021a). We also know that "… businesses want applications and business processes embedded with data intelligence…" (Schoenborn, 2021b) that could help companies make better decisions and generate innovation (Jenab et al., 2019), improve employee user experience, and reduce the need to carry out redundant tasks such as inserting accounting data in an ERP system.

Intelligent ERP systems bestow businesses a competitive edge and improve internal operations (Schoenborn, 2021b) while also enabling the incorporation of AI that can disrupt an industry by creating new forms of doing business (J. Lee et al., 2019). These tools are enhanced through machine learning to develop a single system that unifies and automates tasks in the accounting field. . As a result, it is desirable to build an architecture that could be applied to accounting business processes and clarify what organisations 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. Undoubtedly, 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 colossal value for companies (Siderska, 2020).

This research aims to create an architecture for the accounting modules of an ERP to automatically process physical or digital accounting documents that answers the question: "What organizations should do to process accounting documents automatically?", focusing how managers or directors should act do automate accounting, besides what software developers need to implement, and which software will be used. To accomplish this goal, artificial intelligence and process flow strategies will be used in the architecture, in addition to enable its adaptation to several types of ERP providers. First, we need to gather data regarding accounting and technologies related to intelligent interfaces (how they can interact and impact accounting). After this information is collected, we will start investigating technologies that can be applied to accounting and intelligent interfaces, as well as the accounting modules they cover, available functionalities, and integrations with third-party software. After knowing the market offers, we will start determining

and evaluating the necessary technologies and tools in the accounting process workflow since the document arrives at the organisation until it is duly registered in an ERP. With the information previously gathered, the modules and technologies incorporating the architecture will be selected to create a robust solution. Finally, the architecture creation will be based on two points: the information gathered from the previous steps and software that enables the automatic processing of accounting documents.

We live in a world where computers are increasingly present in our daily activities, especially since the arrival of mobile phones (International Monetary Fund, 2016), affecting the way human beings work and have social or private lives starting with social networks (M. Lee et al., 2018), access to bank accounts, or paying bills at any place or time. Companies are also obliged to follow the same path to respond to their customers (Araújo & Cota, 2016; Fortes et al., 2016) and ensure their survival. Thus, a study about an architecture that benefits businesses will add value in this context. Its development will be relevant to companies with accounting processes that need updating to gain a competitive edge in the market (Schoenborn, 2021b) since it will provide a straightforward and understandable view of what they will need to implement the automation process and which software is recommended to purchase. This architecture will also facilitate the possibility of uniformity in the internal network of the organisation'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 a novel 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 embrace a digital stratagem and start automating their processes. Nevertheless, this proposal could be a starting point for an organisation's 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.

2. Background

2.1. Accounting

A business can be seen as an organisation with resources to be processed and the primary goal in mind to sell products or services to customers (Warren et al., 2012). The well-oiled functional accounting department system requires an information system that will process the data, measure the activity, and communicate the results (Horngren et al., 2012) or economic events of an organisation (International Monetary Fund, 2016). This system can be divided into two fields, viz., financial accounting, which will report information at fixed intervals regarding financial statements (Kimmel et al., 2018) for external decision-makers like investors (Horngren et al., 2012). The other field is managerial accounting, which meets the specific needs of the managers who run the business and is focused on internal decision-making individuals (Horngren et al., 2012; Kimmel et al., 2018).

Accounting Systems can be considered crucial to an organisation's success (Jasim & Raewf, 2020). According to (Warren et al., 2012), there are sets of methods and procedures to gather, classify, and summarise data, like ticket reservations or credit card collections, into business information. This system is 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. We also have manual accounting systems, which are useful for identifying relationships and patterns between the gathered data and the produced reports. These are easy to use and understand when we have few transactions or records, but they are quite complex and become inefficient when these numbers increase. Conversely, computerised accounting systems have more advantages in simplifying record processing or recording multiple transactions simultaneously, providing more accurate and faster information as soon as a transaction occurs (Kimmel et al., 2018; Warren et al., 2012). By allowing a vast dynamism and according to (Tóth, 2012), a computerised system can be typified into three types: **The unautomated system** could be called a hybrid solution between the previously mentioned systems since accountants use papers or write notes for most tasks and computers for the electronic archive. Even though we already use computers 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 on computers instead of paper. **The database system** removes data duplication and reduces inefficiency in processes and excess of information by using ERP systems (these will be presented in the following chapters).

As previously noted, the accounting topic is vast, and it includes 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, it 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, with the purpose of obtaining an adjusted balance from the bank and company that must be equal, is split into two sections: **the bank section** includes a cash balance according to bank statements, recipes, and payments through the bank. It also contains the deposits in transit, which are deposits made by the company, and outstanding cheques, which are cheques that the company wrote and have not been paid into the bank; **the company section** corresponds to the cash account balances in the

company books. It contains bank collections, which are cash receipts the company has not recorded, electronic funds transfers, service charges, interest revenue on checking accounts, and insufficient funds (cash receipts that become worthless).

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, they become liabilities once payroll expenses are paid (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 contain 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 created after each payroll period. It contains specific data for each payroll, as well as information on Social Security withholding and employer payroll taxes; Lastly the **Payroll checks**, which are issued when the business pays its employees, particularly those who work part-time, have a specific bank account.

Impact of Information Systems on the Financial Area: With the emergence of information technologies and the software programs that have been developed, companies have undergone a significant impact in areas like accounting, where processes have always been done using papers and books to register information. With IT systems, these records started to become digitalised and customised for each type of business or organisation 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 data, influencing processes and operations that support the decisions of managers inside these organisations (Tóth, 2012). Furthermore, according to (Ghasemi et al., 2011), one of the predominant IT impacts was the capacity to develop and utilise 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 impacts are not always positive in organisations, especially when these changes impact accounting procedures as well as accountants who carry them out, leading to 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 to implement these systems to transform and restructure processes; **resistance to change** or demotivation by accountants when forced to adapt and work with new processes and technologies; **accountants' fear** of losing power and influence or their actual professions.

On the other side, according to (Ghasemi et al., 2011; Jasim & Raewf, 2020) brings a vast set of advantages such as increased **efficiency**, **accuracy** with less error probability, **adequacy** by allowing limited resources to deliver the best outcomes, **security** by having information encrypted and managed digitally, increased **flexibility** with cloud solutions that enable information to be accessed and shared at any time and **velocity** that will accelerate the information sharing.

Besides the impacts previously mentioned, we cannot forget automation, which led us to use Robotic process automation (RPA) in the recent past, which can increase productivity, reduce costs, and decrease the probability of errors but negatively impact employee motivation as their tasks start to be replaced by machines (Fernandez & Aman, 2018; Jędrzejka, 2019). Furthermore, according to (Jędrzejka, 2019), RPA can be

beneficial to account for period-end closing, accounting reports, accounts receivable and payable, cash management, transactions, inventory, and expenses processes and tasks.

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 to tackle several challenges to take full 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 and techniques and applying them to a process; **digitalisation** 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 how accountants process data and communicate the results; **lack of communication and involvement** between accounting and data science, as many controllers do not yet see them as partners that could bring them benefits in the 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 inconsequential distances and boundaries, could represent an accounting challenge. According to (Trigo et al., 2014), one of the greatest predicaments is having real-time reports that can provide information to managers about company performance, whether they are inside or outside the organisation, to allow them to decide which direction or actions should be taken.

From "Traditional financial accounting operations such as 'data input' which are still the main operations of accountants" (Chen et al., 2012) to 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) accountants' roles have been changing and evolving. The central tasks, such as analysing and processing accounting documents, generating reports, or payroll, are automated (Gulin et al., 2019) due to how information technologies leverage them. For accountants, it is no longer enough to simply 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 tightly connected with IT systems and will require accountants to be able to work with a diverse set of technologies, such as big data, to manage data more efficiently, to transform it into something useful recurring to analytical tools (Crookes & Conway, 2018), 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 organisation (Crookes & Conway, 2018) or machine learning to provide support to other employees in the understanding of complex models (Stancheva-Todorova, 2018).

As accounting is impacted by technologies, accountant professionals (Kroon et al., 2021) also suffer 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 computerisation in the near future (Stancheva-Todorova, 2018) as the most remarkable emerging technologies that impacted the accountant's role (Kroon et al., 2021) are: **big data**: Since it can store an enormous set of data that can generate financial information to enhance decision-making

(Y. Zhang et al., 2020), accountants will be required to have the capacity to analyse this data and the reports generated; **artificial intelligence**: Changing accountants' working patterns and creating new types of roles that negatively impact employment since automation can replace structured tasks or decisions and affect human lives and working practices (Stancheva-Todorova, 2018). But from another perspective, AI allows business managers without accounting knowledge to make business decisions based on generated information (Y. Zhang et al., 2020); **blockchain**: Providing 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; Y. Zhang et al., 2020).

As seen in the implementation of blockchain, using artificial intelligence and big data can affect the accountant's role in its advisory functions, auditing procedures, judgement, and information governance. Furthermore, in research conducted by (Stancheva-Todorova, 2018), we can verify how artificial intelligence affects employment positively by raising productivity and lowering costs, increasing the specialised labour to work with technologies, and negatively by allowing technologies to automate roles and activities by adapting technological innovation and placing humans as a complement of a machine.

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**: Allowing the accountant to have more time with their clients and discuss future solutions or explore their unmet needs, as well as introducing advisory services, will require a specific set of skills to gain their trust and confidence; **accounting engineering**: where critical thinking and creativity to use digital systems are imperative to acquire knowledge and actively adapt to technological developments as well as new products; **accountant personality and skills**: Accountants are required to have a varied set of skills such as communication to effectively communicate inside and outside an organisation, analytical and intellectual traits 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 knowledge to work with digital products; **emerging technologies**: Accountants will be required to have programming skills and improve their data analysis skills to be able to understand the tools and reports (Y. Zhang et al., 2020) generated recurring to technologies like big data, cloud computing, blockchain, and artificial intelligence.

2.2. Technologies for Accounting

As accounting began to be computerised, the need for systems that could help manage and process information has appeared. With them, Material Requirements Planning systems (MRPs) caused the necessity to manage resources more efficiently. However, as companies started to adopt these systems, more necessities and challenges began to surge until MRPs could not correspond. Other systems started to be created until ERPs emerged as a solution to manage information across organisations (Chen et al., 2012; Robert Jacobs & 'Ted' Weston, 2007).

MRPs were "developed to calculate the materials needed more efficiently" (Klaus et al., 2000, p. 144). According to (Robert Jacobs & 'Ted' Weston, 2007), they have the concept of dependent demand that can be seen as the predecessor of ERP Systems. They are capable of fitting requirements such as production integration and planning due to their integration between forecasting, scheduling, and procurement. According to (Md. Saiful Islam et al., 2013), these systems are advantageous because they attempt to maintain the necessary inventory levels to ensure the required materials are available.

An ERP system is a software solution interdependent on business functions (Klaus et al., 2000). It is used to manage the organisation's resources by integrating the departments and functions into a single system to serve their needs (Basoglu et al., 2007; Fernandes, 2018). ERPs can be seen as a standardised business process to plan and control organisational knowledge to obtain external advantages efficiently. These advantages can also come from the concept of standardisation 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 allow the combination of business processes into a single system that ensures the information flows through the entire company, offering managers who run the business a holistic view of the processes (Basoglu et al., 2007; Klaus et al., 2000; Moon, 2007).

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 significant part of the organisation and its major process (Moon, 2007). Due to the high expectations for cost reduction, the adaptation to the functionalities and business culture of the organisation (Basoglu et al., 2007), as well as lack of planning and self-awareness of employees' resistance to change and difficulties in using a new system led this implementation to fail and become a negative investment in most cases. To prevent this lack of success, the commitment of an organisation's top management is crucial to ERP processes being aligned with the organisation's business process for each affected business unit, carefully introducing ERP and its functionalities step-by-step to optimise the training and support of key users as well as preventing resistance to change (Al-Mashari, 2002; Basoglu et al., 2007) and improving satisfaction (Moon, 2007).

From the moment these systems are present in an organisation, they become extremely important due to their capability to store information across diverse departments, support business processes such as procurement or payroll, and present a solution that supports different industries ranging 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 organisations, as well as bringing benefits such as efficiently manage resources and save costs (Moon, 2007); improve productivity, financial cycle (Chen et al., 2012), capabilities to decide (Klaus et al., 2000), and scalability (Adrian-Cosmin, 2015):standardisation of business processes by redesigning and adopting ERP best practices (Adrian-Cosmin, 2015); securing access to the information and quality of the stored data (Adrian-Cosmin, 2015).

Artificial Intelligence

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 is 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 extant research carried out, as presented: A system that replicates human aspects by allowing a computer to mimic 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).

AI expanded and became complex and vast, leading 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 identify nine main areas in artificial intelligence, viz., knowledge representation, machine learning, the planning field, uncertainty reasoning, the study of agent architectures, multi-agent coordination and collaboration, ontologies development, voice and language processing and synthesis and images understating.

An organisation seeks AI to obtain a competitive edge and obtain benefits such as cost predictions by enabling cost reduction when data is needed to make predictions (Duan et al., 2019), improving the decision-making from information that is generated from data at a lower cost (Stancheva-Todorova, 2018; Y. Zhang et al., 2020) and, enable information search across several datasets (Y. Zhang et al., 2020). Sometimes, they are accompanied by drawbacks such as biased information in AI Systems due to the data collected and affect functionalities such as self-driving cars (Haenlein & Kaplan, 2019), using automation to replace structured tasks or manufacturing processes will result in jobs loss (Haenlein & Kaplan, 2019; Stancheva-Todorova, 2018) and, lack of regulation since AI has no regulations regarding data that is processed and shared (Haenlein & Kaplan, 2019).

Rule Based Systems are mostly known as expert systems that, according to (Jeyamani et al., 2016), are a sub-field of AI "that can create resolutions which generally necessitate a human level of proficiency" (Jeyamani et al., 2016, p. 546) and are the simplest form of AI (Grosan & Abraham, 2011). They are sequential programs dependent on the initial data, the defined parameters, conditions, and rules, and the results obtained from the previous computations 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 previously made conditions, not with data, since they can change their value (directly or based on a condition).

Although this system is basic, it can be classified into two types: **the forward chaining or data-driven system** that uses the available data as a start and does 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 1 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). The **backward chaining system** starts with the goal we want to achieve and looks for rules that enable the conclusion or evidence to prove our hypothesis. If the evidence has not been reached, we have to define a new hypothesis and start a new process (Grosan & Abraham, 2011).

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

Table 1 – An example of a Rule-based system adapted from (Grosan & Abraham, 2011)

Machine Learning

As a subfield of computer science (Ongsulee, 2017), machine learning gives computers the capability to learn from data without the need to be programmed (Jenab et al., 2019; Ongsulee, 2017; Singh et al., 2021). It can be represented as a machine that does all computational work to learn how to solve problems (Burgess, 2018) and identify patterns such as customer 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, recurring 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 three types: **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 of ML, the machine is not trained to act (Singh et al., 2021) but is 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 the 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 categorisation that are an integrated part OCR systems (Jeyamani et al., 2016; Ongsulee, 2017).

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, as well as work online with the possibility of recognising characters as soon as they are drawn (Chaudhuri et al., 2017). According to (Chaudhuri et al., 2017), OCR systems are composed of eight components, that are optical scanning, location segmentation, pre-processing, segmentation, representation, feature extraction, training and recognition and post-processing.

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

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 automate business processes or functions to achieve a goal, such as providing customer service or hiring employees (SAP, 2023). They can be represented as the act of replacing a human being with a machine to execute sequential tasks (Outsystems, 2023). With the increased speed and efficiency, more resilient business structures, improved compliance and archives, better customer service quality and experience (Outsystems, 2023; SAP, 2023), 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, 2023). It can be divided into **business process automation (BPA)**, which automates business operations (Sousa, 2022); **robotic process automation (RPA),** which runs business operations without human intervention time (Fernandez & Aman, 2018); **intelligent process automation (IPA**) that enables more complex automation by reducing

human-dependent training (Sousa, 2022). Furthermore, the most recent developments in the area were proposed by (Perdana et al., 2023; Plattfaut & Borghoff, 2022; C. (Abigail) Zhang et al., 2023), particularly in the most significant areas of using RPA to enhance accounting functions.

Business process automation uses automation to eliminate mistakes from human operations and increase the effectiveness of business processes to encourage growth and keep costs low (Chakraborti et al., 2020). It is also focused on improving back-end productivity, which may be applied to the payroll process (SAP, 2023) and the fulfilment of purchase orders (Sousa, 2022). Some of the advantages of BPA, according to (Cummins, 2017), are reliability, control, optimisation and customer service.

Robotic Process Automation

An RPA is an alternative to traditional automation and non-invasive technology that offers cross-functional operations (Jędrzejka, 2019), enabling the integration of several systems and the reduction of workload in business processes. It allows robots to be configured by end users and work in parallel with other robots or humans (Jędrzejka, 2019). It can be described as a system 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) that can be approached in three ways according to (Chakraborti et al., 2020): **learns to automate tasks** recurring to examples or demonstrations as processing behaviours inside system logs; **learns from tasks step by step** using natural language text description of a process that humans can write: **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 utilisation of these robots can be applied to areas such as accounting to simplify tasks such as mail management data management and execute more complex tasks such as decision-making recurring to predefined rules. An organisation implements RPA to obtain benefits such as scalability since robots can be easily cloned and scheduled, work across multiple systems and connect to several applications (Jędrzejka, 2019; Siderska, 2020), leading to increased productivity by automating standardised and routine tasks (Fernandez & Aman, 2018) and, data analysis with the help of robots since employees will commit fewer errors (Siderska, 2020). Sometimes, they cause some challenges regarding the implementation, such as cybersecurity since the data available in digital channels can be exposed to hackers (Jędrzejka, 2019), regulatory risks due to the lack of testing by robots, and the use of invalid algorithms can lead to financial losses (Jędrzejka, 2019) and, satisfaction by 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).

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 processes, where automation requires the coordination of tasks in the systems (Ferreira et al., 2020; Kholiya et al., 2021). IPA ascends in three represented pillars: AI using Machine Learning and its algorithms, BPM to streamline and automatise processes, and an RPA (Kholiya et al., 2021). The objective of IPA is to allow a robot or a bot to be configured to perform human tasks as RPAs can, and it 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 such as: **increase the efficiency** of the process with self-learning; **decrease or eliminate repetitive tasks**; **drive employees** to increase productivity and satisfaction; **provide tools** to create complex workflow with reduced human interaction.

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

Benefits and Drawbacks: As previously referred, implementing technology is always accompanied by benefits such as customer experience that provides a richer experience by being faster and more accurate in processing queries, improved compliance and regulations with human error decrease due to automation and improved employee satisfaction by freeing him to realise challenging tasks instead of repetitive ones (Kholiya et al., 2021). Conversely, exists drawbacks such as the cost of implementing IPA being a higher cost than an RPA (Chakraborti et al., 2020), the low adoption due to the financial risks associated with and lack of trust in AI by uses compromises IPA adoption (Chakraborti et al., 2020) and, AI expertise due the necessity of re-train employees in the organisation, as well as the lack of skilled workforce (Kholiya et al., 2021).

User Interfaces

User interfaces are how users interact with a computer system to do tasks and achieve goals (Stone et al., 2005). Even though it is 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). It 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 heads of the users: 2 -, UI adaptation starts from an initiative by the previously identified entity; 3 - , Based on the Inputs gathered, some UI adaption is subjected to a specification that allows how this adoption will be carried out to be expressed; 4 - , UI adaption is selected and applied; 5 -, A transition from the initial 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 is made from the interpretation made in the last stage to verify if the initial goals are partially or totally met.

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, such as

efficiency, since 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 since good UI can boost user satisfaction and morale(Abrahão et al., 2021; Stone et al., 2005) and, productivity since a good interface can lead to enhanced productivity(Stone et al., 2005). Regarding the challenges, we can identify the time and place by selecting the right timing and location to implement a valuable UI for the end user (Abrahão et al., 2021). Productivity is salient since a bad implementation of UI can cause a loss of productivity and increase financial costs (Stone et al., 2005), and safety concerns are essential to mitigate since a poor UI can compromise the safety of the users and lead to disasters (Stone et al., 2005).

Intelligent Interfaces can be seen as a combination of several disciplines present (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 design component, it is crucial to have a user interface that is easy to understand and meets users' expectations; otherwise, it will become a poor interface that leads to frustration, unsatisfaction, and less productivity by users (Stone et al., 2005).

Intelligent Accounting Tools

One of the most recent implementations of this kind of application is intelligent ERPs, which can be described as cloud-based systems capable of learning and adapting to business rules via machine learning, as well as enabling innovative products and services and increasing employee productivity (Morris et al., 2016). These systems are an upgraded version of the existing ERP systems since they potentiate 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: the user experience, which is assertive and enables personalised 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 personalised in-context access and includes its quality. Also (Morris et al., 2016) evidenced what differentiates an ERP from an I-ERP is the fact that an I-ERP is a set of ERP applications that can be deployed to manage the entire organisation 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.

As emerging technologies expanded and started to be connected with business (Burgess, 2018), several companies began to develop intelligent products for accounting such as: **KOFAX** which has an intelligent automation platform that leverages RPA and AI in a set of advanced technologies to unlock a 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); **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); **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; **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).

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

3. Methodology

The design research methodology was chosen with the perception that it will enable the achievement of the intended goals that are focused on the creation of an artifact that is a solution to real-world problems (Peffers et al., 2007a) and can be applied to accounting modules in information systems, as well as potentially solve the identified issues. According to (Peffers et al., 2007b), the DSR methodology helps in the production of rigorous and high-quality research, which includes three elements, viz., "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". To obtain robust data about the real-world environment to fortify the artefact. In addition, to produce the artefact, six sequential activities will be followed (Peffers et al., 2007b**):1 - Identification of Problem and Motivation** is the definition of the research problem and justification of the relevance of the desired solution, that means defining the problem in the digitalisation of accounting documents, obtaining data regarding accounting processes, and discerning the struggles and opportunities in the automation process. Besides this, research about Intelligent interfaces, existing architectures for accounting processes and the integrated software will be done; **2 - Define Objectives of the Solution** focuses on defining the quantitative or qualitative objectives for the proposed solution, which is recurring to the knowledge gathered during the problem identification and evaluation of what is feasible to develop, which will lead to the definition of the main goal and sub-objectives, that will include the definition of the required platforms for the architecture, tasks that will be automated and require human intervention, and document classification strategies based on success criteria; **3 - Design and Development:** the artefact will be created based on the knowledge gathered from the two previous steps and the desired functionalities that meet the defined objectives, meaning the development of a software architecture for automatically processing physical or digital accounting according to the functionalities and necessities to solve the identified problem; **4 - Demonstration:**

how the artefact could solve the problem recurring to simulations, experimentations, or case studies, will be presented recuring to an use case diagram to demonstrate how the proposed artefact can be applied and which functionalities will be included.; **5 - Evaluation:** observation and measurement of the artefact will be conducted using the defined objectives in activity two and the results obtained from the previous activity. To measure the artefact a presentation, followed by an interview, will be performed with a group of specialists that have been working in the accounting and software area more than 5 years, to allow us to understand if the produced artefact is feasible and will help accountants or needs adjustments and improvements; **6 - Communication:** The importance of the artefact and its utility and effectiveness will be communicated to researchers and other relevant audiences by producing a structured paper that contains detailed information about the artefact produced, as well as the research, the reached conclusions, limitations, and future improvements.

4. Software Architecture

After carrying out the study for the literature review, the required knowledge is gathered to produce the artefact that will be presented 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, some of the gathered concepts regarding accounting and accountants, as well as the currently used technologies and their interrelation, will be briefly described to inform us that it is possible to have a symbiosis between humans and machines that will benefit organisations. Lastly, the literature review was fundamental for gathering this knowledge that will enable us to propose an artefact that will be divided into two parts: **Architecture proposal:** a concept of an architecture for document automation will be presented; **Guidelines, technologies, and software selection:** a set of guidelines and a selection of the software that will integrate the architecture based on the existing offers will be presented.

4.1. Assumptions

The research carried out in background has provided the necessary knowledge to enumerate several assumptions: 1- 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; 2- introducing emerging technologies like AI, machine learning, and process automation will affect the role of accountants and push them to change and adapt to these tools and products so they can continuously provide meaningful inputs;3 -the selection of the right tools and products for accounting has to consider the balance between humans 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; 4 - accounting will benefit from using new technologies and products by improving the efficiency and accuracy of processes, flexibility, velocity, and security to share information, and cost reduction; 5 - the market already has a set of intelligent accounting tools available that will provide intelligent solutions to be applied to business processes (Sousa, 2022) and help the accounting arena and accountants prosper; 6 -connection and interrelation

between accounting systems is possible as Primavera allows a connection to e-Fatura. However, to connect invoices or purchase orders to an ERP, one must recur to other technologies such as RPA or IPA or implement these connections with customised development. Also, the integration between the previously mentioned products and ERP systems can be limited to their portfolio; 7 -I-ERP enables data gathering from several business processes, provides real-time analysis from huge volumes of data, and adapts to the user's experience (Morris et al., 2016), even though it is insufficient to cover the whole of the accounting documents automatization process; 8 - even though a massive set of accounting processes are covered and automated, they still do not cover all the existing types. 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; 9 -regarding the software providers, it will be necessary to have an API or pre-programmed robot to connect several systems, 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. Architecture

This architecture comprises four stages and transversal modules that will include several systems and technologies such as OCR, rule-based systems, and machine learning to capture the information from the accounting documents and proceed to its classification. It will also include a document management system where all the data is stored and available for accountants to consult. Finally, process automation will enable the transition of the information between the proposed stages. This proposal of four stages is presented due the existence of physical documents and it's use in several companies, that haven't fully digitized their process and need to start the automation process with a paper. For companies where the invoices already are in digital format and receive the document in a pdf format or image plus a file in XML (that can contain the XBRL markup), JSON or other format with the metadata information, the first stage (that includes the OCR) will not be required, and the process will start with the second stage.

The first stage starts with the arrival of a physical document or a in digital format for cases where the file with the metadata is not present. Despite not being part of the architecture, in the implementation guidelines, it will be exported 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). It uses rule-based systems for document classification and converts the file into 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 complete the information that was not recognised and validated by the system. Also, this stage is where the classification rules for documents will be determined based on document templates such as invoices, purchase orders, credit memos, or delivery notes, and the system will be trained to archive the desired recognition rate.

The second stage can be with entering the files exported (accounting document in pdf format and another with the metadata, that can be a raw XML file or based on XBRL

markup, or JSON) from the OCR system into a document management system, where the files and data will be stored, organised, 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 cases where the stage one is not required such as, the organization already receives an accounting document in digital format along with another that has the metadata information or 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, three crucial models will be present in the second stage. These are the automatic relation module, which will automatically connect documents such as invoices to credit notes recurring to ML and rule-based systems to relate them by using their metadata; the workflow module will manage all the flows and will automatically process documents as previously mentioned; 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 a robot will be used to retrieve the information from stage 2, log in on the ERP system, and insert this information based on specific criteria. Using 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, it will be possible to use another solution besides process automation by recurring to a customised API that will use rule-based systems and ML to perform the tasks as the robot.

The fourth and final stage is the analytic system 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 the dashboard module that will provide a set of reports with crucial information for decision-makers, as well as 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. This stage will also have information not appearing in the other stages since it will receive data that only exists in ERP Systems, such 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 not be able to cover one hundred per cent of the cases. For that reason, human intervention will always be required in the proposed stages and cases where an approval decision is required. But on another side will also allow access to information and the possibility to execute actions in the required workflows at any time, place, or device; Safe, secure, and controlled access to each document's information and digital version: language profile

according to customer necessities; a 360 overview of every process and stage from the document arriving at the OCR until it reaches the ERP; and documents and respective processes are to be processed in parallel, regardless of the stage they are in. To represent the proposed architecture, the technological architecture, which displays a holistic view of the several platforms that will be used and how users integrate with the different platforms, is depicted in Figure 1. Also, the architecture presented in Figures 2 and 3 represents several organisational processes through a set of diagrams using BPMN to provide a simple and clear reading of each process incorporated through the proposed architecture.

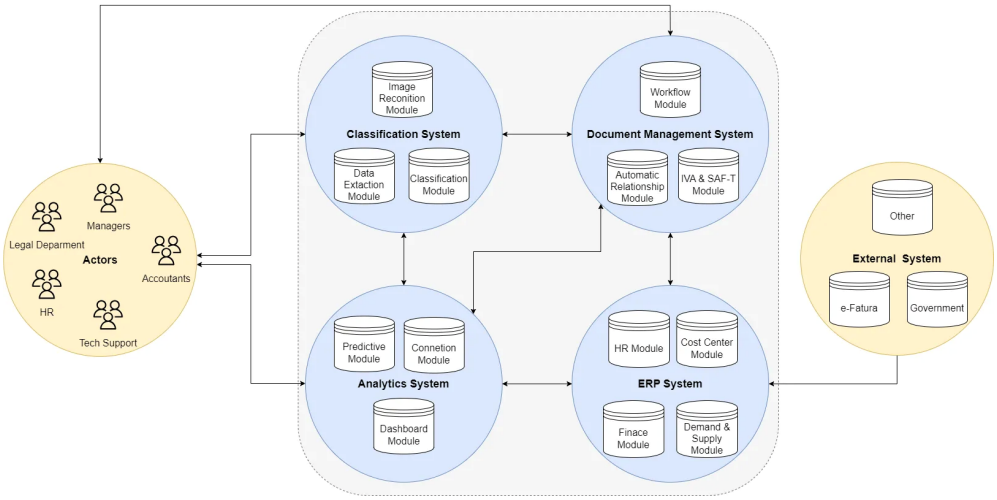

Figure 1 – Technological Architecture

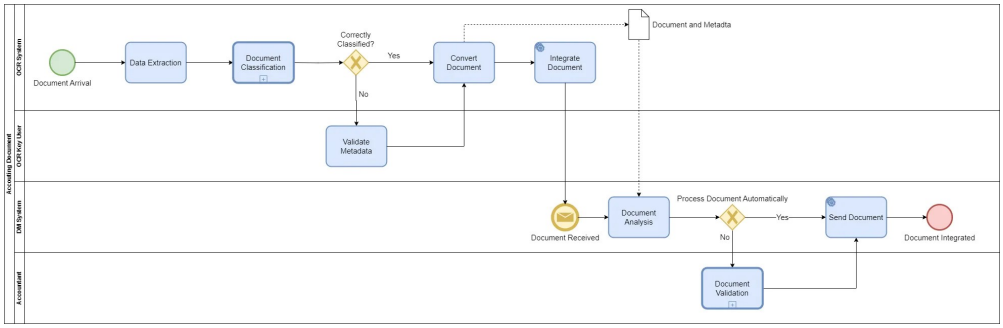

Figure 2 – Process Architecture

The process architecture 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 is 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 records are going to be analysed and automatically processed if the requirements are met, in case this circumstance does not occur, a document validation workflow is going be performed by the accountant in the fourth lane, and only then is the document sent to the ERP by an RPA that will represent the stage three.

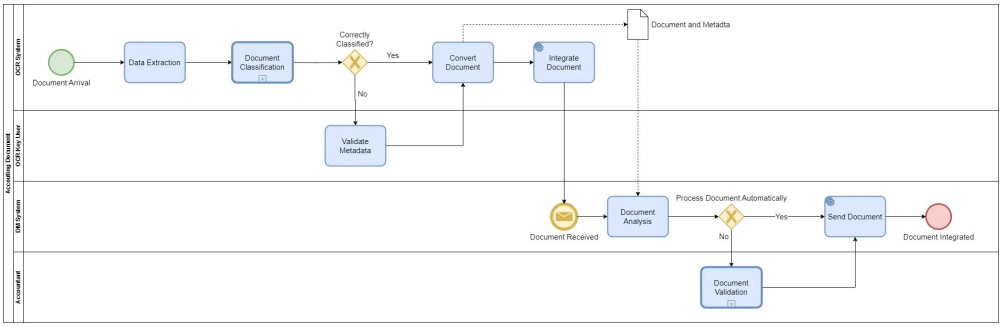

Figure 3 – Process Architecture without a document

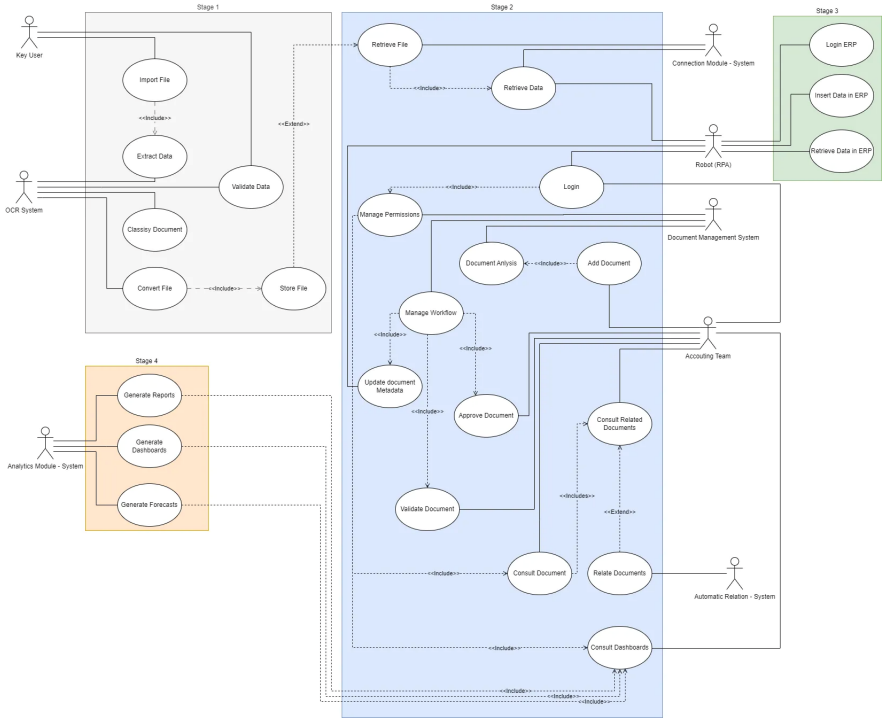

Figure 4 – Use Case Diagram

For other business processes without the presence of a document, such as payroll or a bank reconciliation, Figure 3 represents the process architecture, which does not contain stage one due to the inexistence of a document. The process starts in stage two with the metadata submission through a form into the DM System, which will be analysed and automatically processed if the requirements are met. If this outputs an error, the accountant will perform a metadata validation workflow in the second lane, and then the metadata will be sent to ERP using an RPA.

A use case diagram is displayed in Figure 4 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. As can be seen, stage one is represented in grey and has actions such as import file (by a key user) or data extraction and document classification performed by the OCR System. With the blue background we have stage two and is presented action as validate or approved documents by the accountant or update document metadata performed by the RPA. The third stage is represented in green and can be seen actions performed by the RPA as insert or retrieve data in ERP. Lastly, the fourth stage is represented with a orange and show the actions that the analytics system do to produce reports and dashboards with meaningful information.

4.3. Implementation Guidelines

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

1. Select which business process will be migrated to understand what requirements and functionalities will be required; otherwise, it will lead to a faulty implementation that does not meet the predefined goals.
2. Perform an analysis of the solutions and software that have already been acquired to verify which can be integrated into the new architecture and reduce the required financial investment.
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 incorporating new business processes or expand to other areas of the organisation is required.
4. Select a few software suppliers to mitigate risks between integrations, improve customer support, and lower costs. However, it is 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 is a viable option since it is 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.

5. Evaluation

As we need evaluation techniques and metrics to evaluate the proposed artefact, this solution was introduced to a group of specialists in the areas of information technologies and accounting to fulfil this criterion. The authors in the form of a presentation followed by an interview where the following questions were answered:

Question 1 (Is the proposed architecture useful for the work of an accountant? If not, please explain): Three interviewees thought that the proposed architecture is useful and has the correct approach to automatise accounting documents. Two of them mentioned that it would help to improve and facilitate the processes of an accountant, releasing them to perform other tasks while these autonomous processes are running. Also, a third element mentioned the necessity of adapting this architecture to the organisation's reality and defining the requirements for success. Nevertheless, one of the interviewees thinks this architecture will not be helpful for accountants since it will reduce the necessity of having many accountants in the organisation, as we have today since AI will reduce the need for human interactions. On the other hand, the interviewee said it would 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? If yes, why and what are the differences and similarities?): All interviewees confirmed they had worked with automated solutions, which were fully customised, 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 interviewees mentioned the similarities between the proposed artefact, one regarding the automatization performed SAFT-T Online, where an Excel worksheet is sent, and information about its integration is returned. The other interviewee mentioned that they have already worked with several automatic document processing solutions, such as KOFAX, 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; nonetheless it is suitable for medium-sized enterprises. Meanwhile, another interviewee pointed out the necessity of direct integration between stages one and two, but also controlling the permissions to access sensitive information should be paramount 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 stored information 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. Finally, they suggested that these teams should use the agile methodology.

Based on the feedback received from the interviewees, as well as their answers to question one, it can be concluded that the architecture meets the proposed objectives and will be useful for accountants, even though concerns regarding the future employment of accountants were mentioned. As for the second question, half of the interviewees commented that they found similarities with the solutions they were using. Meanwhile, no objections were found to the third question. However, several improvement points have been noted from some of the answers in question three and all in question four. They will be interpreted as limitations and opportunities for future work.

6. Conclusion

This work aims to create an architecture that enables organisations to use accounting solutions to process physical or digital documents automatically, thereby making accountants more effective and productive while also lowering costs, optimising procedures, and enhancing decision-making. To answer the proposed work's central question, "What should I do to process accounting documents automatically?" a research study was carried out in the field of accounting, related technologies, and products already available on the market. Before the research study was carried out, the DSR methodology was selected due to its capacity to help produce rigorous and high-quality research (Peffers et al., 2007b). After this, a strategy was defined with six steps on the DSR activities that started with problem identification and data gathering, followed by solution identification and artefact development, and finished with a use case demonstration, a set of interviews to evaluate the proposed artefact that will include the present document to communicate the obtained results. The carried-out study for accounting 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 organisation (International Monetary Fund, 2016). Areas and sub-areas, such as payroll, accounts payable or bank reconciliation, were researched since technologies are already present and relevant to its processes. Besides this, the impacts of information systems in financial accounting were studied as the capacity to develop and utilise systems to track and record financial information (Ghasemi et al., 2011) and the current challenges as the lack of knowledge and expertise in digital tools (Möller et al., 2020). The accountants' role was also probed, 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, such as automation. The study on technologies for accounting has been made on such issues as the ERP system, 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 is implemented. Another research topic was artificial intelligence, where an overview was made, followed by the identification of several areas, such as machine learning and multi-agent coordination and collaboration (Moret-Bonillo, 2018), its

drawbacks as lack of regulation and benefits such as cost prediction. Also, regarding AI, further research was done on machine learning, rule-based systems, and OCR due to their 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 these 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 met. An architecture has begun to be developed, firstly by doing a set of assumptions on how the 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 like the automatic relation, represented by a technological architecture for an overview of the interrelation between stages and a process architecture recurring to BPMN to describe the flows of the documents. A use case diagram was developed to understand how this can be applied, and each step of an invoice automatization process was described, as well as where each system intervenes. Finally, a set of guidelines to help organisations implement this solution was presented. With the artefact 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 and the defined objective was accomplished since the feedback received was positive and demonstrated to be useful for accountants and the right approach to implement this type of solution. 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 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 more profound knowledge of artificial intelligence and its areas, enabling 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 organisations. Another one was regarding the micro/small companies that cannot invest in architectures of this scale and have fully customised systems for their necessities. Future work should start by improving this proposal based on the limitations mentioned, such as following the implementation of this architecture into an organisation to mitigate the identified constraints 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 of the technologies that already exist 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 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 seeking 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 improving this architecture to have a simpler and smaller version for a better approach and adaption to micro/small companies and their specificities. To conclude the research, it is crucial to proceed with the points previously identified as we can understand that artificial intelligence is becoming part of organisations and has a vast set of areas that need to be explored and researched to improve the systems that are in this architecture and support humans, especially accountants.

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