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A STRATEGIC MODEL AND FRAMEWORK FOR INTELLIGENT PROCESS AUTOMATION

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Thesis presented as partial requirement for obtaining the master's degree in Information Management, Specialization in Information Technologies, and Systems Management

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by

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ABSTRACT

Digital Transformation has been growing within companies and impacting the economy and society. The main challenges are regarding people, knowledge, and motivation to change. Different companies can be at different levels of digital maturity, but to deal with Digital Transformation, they must align their Business and Information Technology Strategies.

Operations are one of the nine Enterprise business dimensions where Digital Transformation can be significantly accelerated, and companies are already exploring several Technologies related to Artificial Intelligence to improve it. There are some studies about Robotic Process Automation, but Intelligent Process Automation is recent and consulting companies have been doing most of the research and selling it as a service and have economic interests.

Helping companies going through Digital Transformation using Intelligent Process Automation, this study seeks to develop a strategic model that gives guidance regarding how to take benefit of Artificial Intelligence to automate their processes intelligently. The main research goal of this study is to build an Intelligent Process Automation Strategic Model that gives organizations a framework to follow, accelerating their digital transition and increasing competitiveness. Consequently, this study aims to contribute to the digital economy evolution and accelerate digital society growth.

KEYWORDS

Strategic Model; Digital Transformation; Artificial Intelligent; Intelligent Automation; Intelligent Process Automation; Design Science Research.

INDEX

LIST OF FIGURES

LIST OF ABBREVIATIONS

AA, Autonomous Agent

AI, Artificial Intelligence

AIPA, Augmented Intelligent Process Automation

API, Application Programming Interface

AR, Augmented Reality

BI, Business Intelligence

BPA, Business Process Automation

BPM, Business Process Management

BT, Business Transformation

CC-DIV, Customers, Competition, Data, Innovation, and Value

CDO, Chief Digital Officer

CEO, Chief Executive Officer

CIO, Chief Information Officer

CNC, Computer Numerical Control

COBIT, Control Objectives for Information and related Technology

CRM, Customer Relationship Management

DSR, Design Science Research

DSC, Digital Supply Chain

DT, Digital Transformation

DTO, Digital Twin of an Organization

ERP, Enterprise Resource Planning

GPS, Global Positioning Systems

KM, Knowledge Management

IA, Intelligent Automation

iBPMS, Intelligent Business Process Management Suites

IDC, International Data Corporation

IoT, Internet of Things

IPA, Intelligent Process Automation

iPaaS, Integration Platform as a Service

ISACA, Information System Audit and Control Association

IS, Information systems

IT, Information Technology

ML, Machine Learning

MVP, Minimum Viable Product

N, Nanotechnology

NIT, New Information Technologies

NLP, Natural Language Process

OCR, Optical Cognitive Recognition

RAN, Radio Access Networks

RPA, Robotic Process Automation

SMACIT, Social, Mobile, Analytics, Cloud, and IoT

SMO, Service Management and Orchestration

VR, Virtual Reality

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1. INTRODUCTION

1.1. BACKGROUND AND PROBLEM IDENTIFICATION

One concept to consider when predicting how an enterprise will look in the future is Digital Transformation (DT), which has been increasing in companies, and the more recent advances in technology which have impacted the economy and society. The International Data Corporation (IDC) considers the rapidly growing digital economy and the recent digital disruption caused by the COVID19 pandemic to be the main drivers in the urgent need of DT, as a requirement for organizations' subsistence (IDC, n.d.). This new digital economy affects organizations across all industries and emphasizes the importance of DT for businesses to remain relevant in their market (Morakanyane et al., 2020).

DT impacts user experience, business processes, and business models (Henriette et al., 2016). However, organizations may encounter some challenges such as DT concepts, employees' resistance to new ways of working, a solid closed culture, a lack of knowledge and skills management, and low motivation to change and take risks (Schwertner, 2017). Cybersecurity and data privacy are also two main concerns regarding DT (Ustundag & Cevikcan, 2018).

When organizations start to consider DT, they must first assess their digital maturity (Rogers, 2016). Companies at a higher level of digital maturity integrate digital technologies in order to transform their business, while companies with less digital maturity focus on solving individual technological problems (Morakanyane et al., 2020).

In order to succeed, organizations must align their Business and Information Technology (IT) Strategy accordingly. Based on this concept, the Information System Audit and Control Association (ISACA) has created the Control Objectives for Information and related Technology (COBIT) framework to guide companies on IT governance and management, considering the entire organization from the perspective of functional areas to view the business process (Andry & Setiawan, 2019).

Operations are one of the nine enterprise business dimensions where DT can be significantly accelerated (IDC, n.d.). Digitalization within organizations is how information or digital technologies can improve business processes (C. Verhoef et al., 2019). Companies are exploring several systems and technologies such as process mining, Robotic Process Automation (RPA), chatbots, cognitive computing, internet of things, data analytics, and Artificial Intelligence (AI) to improve their processes (Siderska, 2020).

These technologies were brought about by the fourth industrial revolution, and companies must combine them in order to leverage the digitalization of their processes and accelerate their DT (Ribeiro et al., 2021).

However, the literature and scientific research on these areas is not extensive. Only a few studies appear to exist that provide frameworks for the use of specific technologies and industries. There is generally still an absence of comprehension regarding what technologies companies should focus on and how they could integrate all these technologies in a unique Intelligent Process Automation (IPA) model that could accelerate their DT and thus bring value to the organization (Siderska, 2020).

1.2. MOTIVATION

Having digital business models and processes is key to a company's survival (Morakanyane et al., 2020), and the use of Intelligent Automation (IA) and other recent advanced technologies can improve the process of digitalization (Siderska, 2020). Thus, companies need to have an awareness of which are the leading technologies they can incorporate into their business (Ward-Dutton, 2018). It is also essential that they have a strategy for using those technologies (Burnett, 2017).

AI and its related technologies can equip organizations with the necessary efficiency to cope with the digital economy and its rapid changes, but it is most valuable when it is properly used, essentially, when and where it is needed most (Berruti et al., 2017).

There is no standard definition for IPA, but the topic has been extensively researched by consultancy companies. For instance, Gartner has developed the concept of Hyperautomation, a framework called DigitalOps toolbox that integrates several technologies for companies to use to accelerate their DT, and a Roadmap to guide them with this (Ray et al., 2019).

Other authors give other names to the use of IA technologies in an integrated way (Bornet et al., 2021), but there is still lack of scientific studies and perspectives. There is some research about RPA, but research into IPA is more recent and has largely been conducted by consultancies selling it as a service and who therefore have potentially biased economic interests (Ng et al., 2021).

This study aims to use a scientific lens to determine the AI technologies companies should incorporate in order to digitalize their processes, increase efficiency, and advance DT. In addition, this study seeks to develop a strategic model which guides organizations on how to benefit from AI in order to automate their processes and build a more intelligent route to DT.

1.3. OBJECTIVES

Intelligent Automation affects all functional areas in an organization. This study is focused on business operations and proposes IPA as a contributor to DT acceleration. The main research goal is to present a new scientific approach regarding IPA, sustained in a Strategic Model and Framework, that organizations can use to accelerate their digital transition and increase competitiveness.

Thus, the research question is "How can companies accelerate their Digital Transformation through Intelligent Process Automation?". Three objectives are established to answer this question:

1. To complete a scientific literature review concerning the fundamental and novel findings in Digital Transformation and Intelligent Process Automation.

2. To propose an Intelligent Process Automation Strategic Model and Framework that will help organizations accelerate their Digital Transformation.

3. To evaluate the strategic model and framework proposed using expert analysis and a use case.

1.4. STUDY RELEVANCE AND IMPORTANCE

We already live in a digital economy and are part of a digital society, so it is important for enterprises to be digital (Morakanyane et al., 2020). It is in this context that this study brings value. Its relevance is in exploring the concepts, drivers, impacts, challenges, and approaches to DT in a Business Process Management (BPM) context, and how these subjects and new AI technologies are related to IPA. Moreover, it proposes an IPA Strategic Model that combines those technologies and provides companies with a Framework with which to accelerate their DT through IPA.

Additionally, it represents an alternative to studies conducted by consultancies in the industry who have financial interests. Considering these, it employs a scientific lens to reach important conclusions about the use of IPA in organizations. Furthermore, this scientific study responds to the lack of scientific research on the general use of AI technologies in Business Process Automation (BPA). Finally, it offers a new strategic model and framework to the scientific community which other authors can continue to use to study this subject.

Overall, this study will contribute to digital economical evolution, and accelerate growth in a digital society through organizations' education regarding DT and IPA. The scientific nature of this study also gives credibility to its usage in organizations. The model and framework proposed aim to be considered as a competitive advantage for companies.

2. METHODOLOGY

According to March & Smith (1995), the Design Science Research (DSR) methodology is the most appropriate approach when the research output is an artifact. In this study, the research outputs are conceptual artifacts that will be designed and called "Strategic Model" and "Framework", two constructions which will be developed and evaluated as a proposal to put into practice by organizations. Therefore, DSR seems to be the most appropriate methodology for this research.

2.1. DESIGN SCIENCE RESEARCH (DSR)

A DSR methodology is used to study a specific problem, seeking the knowledge to understand it and then answering it by creating new artifacts that could solve it (Winter, 2008).

Using Järvinen's taxonomy (Figure 1), it is possible to classify this study's research approach as an approach to studying reality, stressing the utility of artifacts and focusing on building (Järvinen, 2004).

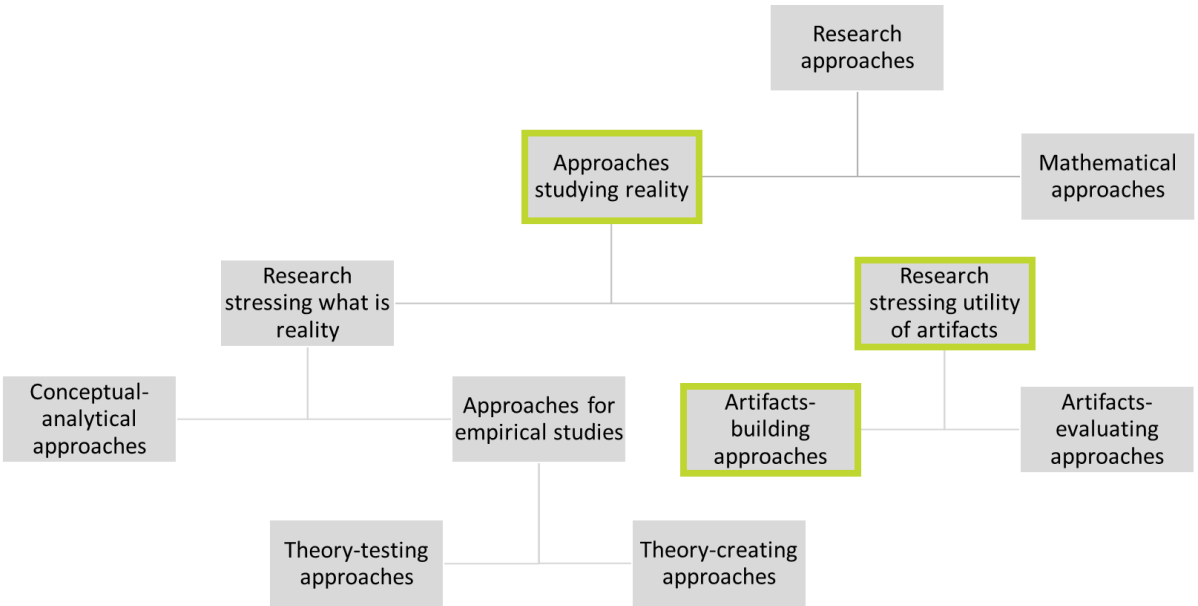

Figure 1: Järvinen's taxonomy of research methods (adapted from Järvinen, 2004)

The Gericke & Winter (2008) Analysis Framework for Information Systems (IS) DSR (Figure 2) also supports this approach. This study will apply DSR to construct and evaluate a situational artifact, more specifically a model and a framework intended to help organizations use IPA to accelerate their DT, based on scientific research and theory.

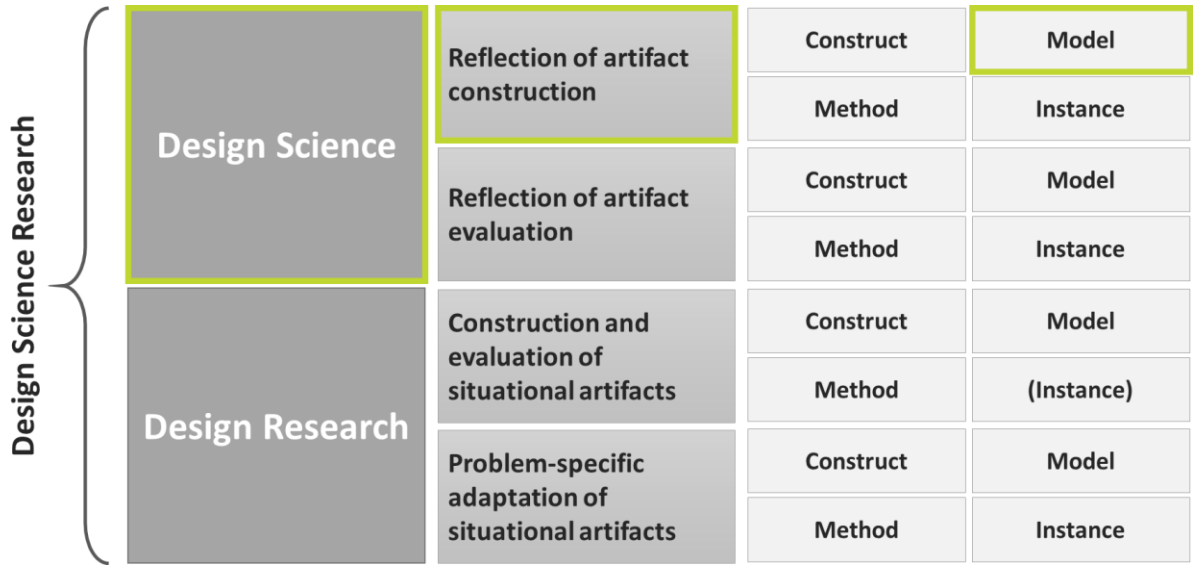

Figure 2: Gericke & Winter analysis framework for IS DSR (adapted from Winter, 2008)

Using the Hevner, March, Park, and Ram (2004) example and principle, the Business Strategy and IT Strategy must be aligned. Through design activities, these two areas can be effectively transformed into aligned Business and IT Infrastructures. In DSR, these activities produce an innovative artifact to solve a problem. The designed artifact must be evaluated to understand the problem better and improve both its design process and the artifact itself (Hevner et al., 2004).

2.2. RESEARCH STRATEGY

For the production and presentation of this DSR, the Hevner et al. (2004) Seven Guidelines will be considered as a methodology, and the Peffers, Tuunanen, Rothenberger, and Chatterjeew's (2007) DSR Process (Figure 3) as a framework to follow:

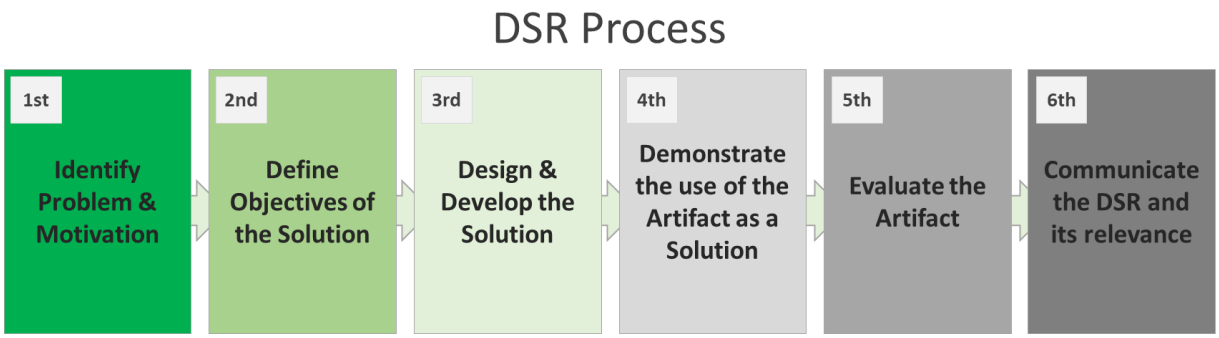

Figure 3: DSR Process (adapted from Peffers et al., 2007)

The first step is to identify the research problem and explain the value of the proposed solution, describing the motivation behind it. The second step is to define the research artifact's objectives based on the knowledge acquired in the problem identification and motivation activity (Peffers et al., 2007). These two steps are based on the DT and IPA literature review.

The third activity that will be conducted is the "Design" and "Development" of the artifacts, in this case, of the Strategic Model and Framework, that will solve the research problem, based on the literature review conducted in the first and second steps of the process (Hevner et al., 2004). These artifacts will be created in line with the existing research design literature regarding IPA, academy, and industry approaches.

Once a Strategic Model and a Framework have been well defined, it is crucial to demonstrate its use. To this end, a business case will be used to experiment and simulate the value of the artifacts created. Although the proposed solution is already assessed in the fourth phase of this process, it is in the fifth phase that it will be adequately evaluated. Expert analysis will be conducted to do this. The results of these two steps will lead to conclusions about the artifacts' effectiveness and an understanding of its limitations, implications, and future work (Peffers et al., 2007).

The final DSR phase is to communicate. Communication will be realized through scholarship publications, journals, and DSR repositories. It will include the problem identification and the artifact proposed as a solution, explaining its relevance, originality, effectiveness, and its contribution to the research community, society, and business.

3. LITERATURE REVIEW

3.1. DIGITAL TRANSFORMATION

3.1.1. CONCEPTS

Digital Transformation is a broad subject which has been studied by many researchers and executives since the emergence of New Information Technologies (NIT). Its definitions are still debated, and there is not a consensus on its exact meaning (Andal-Ancion et al., 2003; Durão et al., 2019; Henriette et al., 2016; Hinterhuber & Nilles, 2021; Kotarba, 2018; Schwertner, 2017; Vial, 2019). Some consider DT to be a long-standing concept which has reached a higher importance in recent years, once a trend that has now become a requirement for the development and survival of organizations (Kotarba, 2018; Oswald & Kleinemeier, 2016).

Understanding the distinction between what is meant by 'digital', 'digitization', 'digitalization', and 'transformation' is essential in order to better understand DT and avoid confusion between these concepts. The word 'digital' has different meanings in different contexts. In IT, 'digital' relates to technology; in marketing, it is used to explain new ways in which to engage with customers; and in management, it means new ways of doing business (Dorner & Edlman, 2015).

'Digitization' is the conversion of information into a digital format (for example, scanning a paper document and saving it as a digital document), while 'digitalization' refers to the use of new technologies in order to improve business processes and enhance operational performance. This does not in itself make a company 'digital'; to be digital in a business context means to use new technologies to innovate, to create digital offerings, and to enhance the value proposition for customers (Baker, 2014; C. Verhoef et al., 2019; Findling & Vesset, 2019; Hinterhuber & Nilles, 2021; Oswald & Kleinemeier, 2016; Ross et al., 2019; Vial, 2019; Wessel et al., 2021). A company's 'transformation' refers to its change. It is a process which is based on a strategy to transform business models, processes, offerings, procedures, and company culture (Henriette et al., 2016; Kotter & Schlesinger, 2008; Ross et al., 2016; Ustundag & Cevikcan, 2018).

From this literature review, it is possible to conceptualize DT as a process undertaken by companies who strategically use new technologies to progressively transform their business models, processes and procedures, products and services, culture, and people in an integrated way, aligning each of these elements to innovate and to create a better value proposition to all stakeholders (C. Verhoef et al., 2019; Hinterhuber & Nilles, 2021; Oswald & Kleinemeier, 2016; Ross et al., 2019; Vial, 2019).

3.1.2. DRIVERS

Developments in digital technology brought about technologies which quickly became powerful and whose usage has increased exponentially, allowing for easier and stronger connections between people and organizations, increasing value for both (C. Verhoef et al., 2019; Oswald & Kleinemeier, 2016).

The main drivers for DT are intrinsically related to the advancement of technology and the recent digital disruption caused by the COVID-19 pandemic. In addition, new technologies have emerged and increased other factors which have contributed to the growth of the digital market and, consequently, to the need for DT within companies (C. Verhoef et al., 2019; IDC, n.d.; Ulas, 2019). These technological and economic factors consist of the following:

- **Innovation:** The digital economy has low barriers to entry. Anyone with internet access and a good idea can start a business, even with low capital. Innovative competitors have emerged in unexpected markets and rapidly overtaken incumbents by accessing global digital platforms that help them with research, marketing, development, sales, and distribution. Quality, speed, and price investments enable new business models and customer value propositions. Innovation is essential to economic growth, makes technology cheaper, and contributes to many entrepreneurs working in digital areas. The new digital economy enables small businesses to be born in a global market, benefitting from innovations in products and services and improved processes (Ebert & Duarte, 2018; Hinings et al., 2018; Kotarba, 2018; Oswald & Kleinemeier, 2016; Ulas, 2019; Ustundag & Cevikcan, 2018; Vial, 2019). Online platforms have disrupted industries' business models and enabled a redefinition of existing markets. They enable cross-industry collaboration to grow value (Hinings et al., 2018; Ustundag & Cevikcan, 2018; Vial, 2019).

- **Changes in customers' behaviors, attitudes, and expectations:** The speed with which new technologies are adopted has increased, as well as the changes in needs, environments, methods of communication, planning, decision-making, acting, sharing experiences, selling, and buying. The emergence of Generation Z has also brought a new type of consumer with different expectations affecting the market. This is a generation born into a digital world with digital devices, and it has different preferences. Members of Generation Z want to be considered individuals, prefer online communication, subscribe to channels, follow vlogs, create entertainment videos, contribute to viral marketing, influence decisions, and contribute to the design process of its products. In work environments, employees' attitudes, behaviors, and expectations have changed too, forcing companies to adjust how they treat, attract, and

retain their workforce (C. Verhoef et al., 2019; Kotarba, 2018; Oswald & Kleinemeier, 2016; Ulas, 2019).

- **Mobile, social media, and E-commerce:** The use of smartphones has greatly increased over recent years, resulting in constant communication with customers who expect to have access to anything, anywhere, anytime, using any device. Social media has been a cheap vehicle with which to reach customers and encourage online sales. People want to be connected, share experiences and emotions, and seek information before buying anything, allowing companies to influence their customers. Social media has also promoted public, collaborative, circular, peer-to-peer economies, allowing consumers to become producers and offer their own products and services, sometimes even items that they no longer need to others, in a quick and efficient way, with or without expectations of value (C. Verhoef et al., 2019; Kotarba, 2018; Oswald & Kleinemeier, 2016; Uhl & Gollenia, 2016; Ulas, 2019; Ustundag & Cevikcan, 2018; Vial, 2019).

- **Globalization:** New technologies have enabled companies to enhance market intelligence and access the global market without significant investment. They have also contributed to advances in the mobility of products, services, capital, communication, and interaction between people and organizations around the world, expanding operations and sales across borders, and integrating market economics (Brynjolfsoon & McAfee, 2016; C. Verhoef et al., 2019; Oswald & Kleinemeier, 2016; Ulas, 2019; Ustundag & Cevikcan, 2018).

- **Industry 4.0:** The most recent and well-known revolution is the digitalization of the manufacturing process. Machines are now able to be connected, enabling the creation of digital factories that are becoming more flexible, adaptable, and safe, resulting in higher performance and personalized manufacturing and products. It also contributes to a less polluted environment, as it saves on water and energy use(Ebert & Duarte, 2018; Kotarba, 2018; Uhl & Gollenia, 2016; Ulas, 2019; Ustundag & Cevikcan, 2018).

- **Digital Supply Chain (DSC):** Companies' digital systems support activities in the supply chain such as buying, producing, storing, moving, and selling. Together, these systems form the DSC, which aims to increase companies' efficiency(Oswald & Kleinemeier, 2016; Ulas, 2019). The DSC comprises seven dimensions: Suppliers, Production Systems, Logistics and Inventory, Human Resources and Talent, IT and Technology, Performance Measurement Systems, and Customers. In addition, some technology trends that are affecting the DSC are Mobility and

Social Media, Big Data and Predictive and Prescriptive Analytics, the Internet of Things, 3D Printing, and Robotics (Oswald & Kleinemeier, 2016; Uhl & Gollenia, 2016).

- **Internet of Things (IoT):** Using the internet, is it possible to transfer data between devices, for example to connect to a machine or other device with internet access using a smartphone or wearable device. Connecting devices to automatic systems enable real-time communication, data collection, monitoring and decision-making, and process optimization. However, the dissemination of IoT is only possible with the equipment of devices with technology such as electronics, software, and network connectivity, and this process is still in development (Ebert & Duarte, 2018; Kotarba, 2018; Schwertner, 2017; Sousa & Rocha, 2019; Uhl & Gollenia, 2016; Ulas, 2019; Vial, 2019).

- **Blockchain, hyperledger, or distributed ledger technology:** There is a technology based on a peer-to-peer network which enables the creation and management of digital records on distributed databases in computer systems, can be signed through cryptographic signatures in order to prevent modification or inappropriate use (Ebert & Duarte, 2018; Hinings et al., 2018; Kotarba, 2018; Oswald & Kleinemeier, 2016; Ulas, 2019; Vial, 2019). This technology is based on data and behavior integrity and security (Boritz, 2005; Hinings et al., 2018), guarantees the reduction of the cost and time of transactions (Hinings et al., 2018), and enables decentralized digital infrastructures (Hinings et al., 2018; Vial, 2019).

- **Cloud computing, storage, and services:** Following the advancement of the internet, an internet-based information service was developed which provides computer storage that is shared between people and organizations. This is a way to distribute software in real-time from the internet, with no installation required. It enables the archive of all types of documentation which can be accessed through the internet anywhere, using any device (Baker, 2014; Kotarba, 2018; Oswald & Kleinemeier, 2016; Schwertner, 2017; Stone, 2019; Uhl & Gollenia, 2016; Ulas, 2019; Vial, 2019). It also enables companies to become more independent from IT outsourcing services who provide, manage and maintain software and applications to their internal or external employees and partners (Oswald & Kleinemeier, 2016; Rogers, 2016; Vial, 2019).

- **Nanotechnology (N):** The concept of N is based on the use of technology at one-billionth of physical unit level, using nanomaterials to manipulate and control matter to reduce the size and weight of products (Ulas, 2019; Ustundag & Cevikcan, 2018), enabling companies to produce innovative products which are smaller and lighter.

- **Big Data:** With the progression of technology, social media, operational systems, and IoT, a large amount of structured, semi-structured, or unstructured data is created in real-time, which is essential information but is impossible to be processed by a human (Baker, 2014; Kotarba, 2018; Oswald & Kleinemeier, 2016; Rogers, 2016; Schwertner, 2017; Stone, 2019; Uhl & Gollenia, 2016; Ulas, 2019; Ustundag & Cevikcan, 2018; Vial, 2019; Westerman et al., 2014). In transforming big data into intelligent analytics by using new technologies, organizations can start to work based on prescriptions, rather than predictions, thereby improving their products and services, processes, and business models to create a better value proposition (Baker, 2014; Ulas, 2019; Ustundag & Cevikcan, 2018). Of course, companies must have a data strategy and skilled employees to benefit from these opportunities (Rogers, 2016).

- **Additive manufacturing and 3D printing or scanning:** The advancement of technology has enabled machines to print 3D products using different materials, based on a design made on 3D software. It benefits from low design and production costs, so the manufacturing process is more efficient than the traditional method (Brynjolfsoon & McAfee, 2016; Ebert & Duarte, 2018; Kotarba, 2018; Oswald & Kleinemeier, 2016; Rogers, 2016; Ulas, 2019; Ustundag & Cevikcan, 2018; Westerman et al., 2014). This technology is capable of productivity disruption in the market where it is used (Ebert & Duarte, 2018), and allows for the personalization of products according to their buyers' needs (Uhl & Gollenia, 2016). Other advanced manufacturing technologies are cyber-physical, manufacturing and automation systems, autonomous robots, intelligent sensors, Computer Numerical Control (CNC), and AR or VR (Ebert & Duarte, 2018; Ulas, 2019).

- **Augmented or Virtual Reality (AR or VR):** Developments in technology have led to the visualization and simulation of images, sounds, and even smell to the extent of physical reality. Any virtual object, text, music, and smell can be seen, heard, and smelled in the natural environment, using a mobile device that receives Global Positioning Systems (GPS) information and produces images, sounds, and smells, according to a programmed system. This technology can be used in several industries and has different applications in each (Ebert & Duarte, 2018; Kotarba, 2018; Oswald & Kleinemeier, 2016; Sousa & Rocha, 2019; Stone, 2019; Uhl & Gollenia, 2016; Ulas, 2019; Ustundag & Cevikcan, 2018; Westerman et al., 2014).

- **Robots and Chatbots:** The word 'robot, or 'bot', refers to a system capable of doing a task automatically, reducing any related time and costs. A chatbot is a software application developed to aid organizations in customer service. It can imitate written and verbal human speech in order to answer customers' questions (Ulas, 2019). Service industries refer to robots

as Robotic Process Automation (RPA), a system developed to reduce human intervention in recurring and time-consuming activities, allowing employees to focus on more social or strategic work. In manufacturing industries, robots are physical machines capable of navigating and interacting with the natural world and completing tasks in real environments (Kotarba, 2018; Ulas, 2019; Ustundag & Cevikcan, 2018). In many factories, tasks are completed through human-robot collaboration, and with the continuing progress of such technology, robots will continue to be better at performing manufacturing tasks (Kotarba, 2018; Oswald & Kleinemeier, 2016; Sousa & Rocha, 2019; Uhl & Gollenia, 2016; Ustundag & Cevikcan, 2018). Other robots are drones, machines that perform tasks using instruction from a mobile device or automation program while sending data to the cloud (Ebert & Duarte, 2018; Uhl & Gollenia, 2016).

- **Artificial Intelligence (AI):** The science of investigating the human brain's way of thinking, learning, making decisions, and solving problems, with the advancement of technology, has made AI possible. The use of an intelligent software system enables the imitation of human brain activity. This software learns, makes decisions, performs tasks, and continuously learns how to do it better (Sousa & Rocha, 2019; Ulas, 2019; Ustundag & Cevikcan, 2018). It refers to a set of technological tools including machine learning (ML), recognition of optical characters, patterns, voice, and emotions, voice response technology, natural language process (NLP), digital twins, and others that try to artificially reproduce human experience, learning and intelligence (Ebert & Duarte, 2018; Stone, 2019). More and more companies are using AI functionalities for data analytics, manufacturing, process improvement, automation, customer service, and other functions (Haleem et al., 2021; Kotarba, 2018; Oswald & Kleinemeier, 2016; Ustundag & Cevikcan, 2018). The more AI emerges within companies, the more rapidly development costs will decrease, outcomes will improve, and automation and robots will increasingly facilitate human life (Brynjolfsoon & McAfee, 2016; C. Verhoef et al., 2019).

Throughout recent years, different researchers have outlined the many technologies that have been developed and contributed to DT. Of all the technologies referred above, the most well-known list is SMACIT: Social, Mobile, Analytics, Cloud (including cloud computing, cloud storage, and services), and IoT (Durão et al., 2019; Ebert & Duarte, 2018; Henriette et al., 2016; Kane et al., 2017; Ross et al., 2019; Schwertner, 2017; Stone, 2019; Ustundag & Cevikcan, 2018). Companies must invest in SMACIT technologies in order to digitalize and enhance their business processes and operations. Once these technologies are applied, the company is digitalized in terms of its operations, although it is not yet ‘digital’. Rather, part of the journey to becoming digital has been completed, and the company is then

ready to use SMACIT to innovate and work to deliver digital offerings, enhancing the customer value proposition (Ross et al., 2019; Schwertner, 2017; Vial, 2019).

It is vital that organizations integrate these leading technologies to improve processes, retain talent, and create new business models, responding to their strategy and needs, and to compete and thrive in the digital market, economy, society, and world (Durão et al., 2019; Schwertner, 2017; Vial, 2019). They need agile development (Back & Schacker, n.d.; Baker, 2014; Durão et al., 2019; Ebert & Duarte, 2018; Kotarba, 2018; Oswald & Kleinemeier, 2016; Schwertner, 2017; Stone, 2019; Uhl & Gollenia, 2016; Westerman et al., 2014), and to consider collaborative technologies and changes in their methods of working (Ebert & Duarte, 2018; Henriette et al., 2016; Kane et al., 2017; Oswald & Kleinemeier, 2016; Uhl & Gollenia, 2016; Westerman et al., 2014), and risk tolerance (Kane et al., 2017; Uhl & Gollenia, 2016). More than enabling the creation of a new value proposition, these new technologies allow companies to create value networks and digital channels for customers, bringing agility (Rogers, 2016; Vial, 2019) and data availability to the organization itself (Vial, 2019).

3.1.3. IMPACTS

DT impacts user experience, business processes, and business models (Henriette et al., 2016).

The main positive impacts of DT on organizations are processes improvement, automation, and elastic resources enabling operational efficiency and cost savings. In addition, cloud computing and AI allow big-data provisioning, management, and maintenance, supporting better decision-making and real-time response to market changes, organizational performance, financial growth, employee satisfaction, and customer engagement. All of these effects on the organization contribute to higher profits, flexibility, and ability to adapt, maximizing its chances of survival (C. Verhoef et al., 2019; Ebert & Duarte, 2018; Kotarba, 2018; Oswald & Kleinemeier, 2016; Rogers, 2016; Schwertner, 2017; Stone, 2019; Uhl & Gollenia, 2016; Ustundag & Cevikcan, 2018; Vial, 2019).

Meanwhile, some organizations are now facing the challenges of DT and being part of the digital economy, as companies who do not embrace digitization risk being surpassed by competition (Oswald & Kleinemeier, 2016).

The DT of organizations' business processes with digital technology leads to DT of the economy (Nosova et al., 2021; Ustundag & Cevikcan, 2018). A digital economy is characterized by the development and distribution of internet technologies, the migration of socio-economic activities to the internet, and the transformation of traditional organizations into network structures (Nosova et al., 2021). Furthermore, digital products emerge in order to satisfy the needs of digital customers across sectors, and intelligent factories are created based on technology that allows mass production

of personalized products (Vial, 2019). Digitalization has lowered the barriers to entry to markets, increasing competition, creating new types of business models and industries, bringing together global supply and demand, increasing collaborative innovation, changing customer expectations, and creating new jobs (Durão et al., 2019; Ebert & Duarte, 2018; Henriette et al., 2016; Hinings et al., 2018; Nosova et al., 2021; Oswald & Kleinemeier, 2016; Vial, 2019).

For society in general, DT brings positive impacts including improving quality of life, as well as potentially negative effects associated with security, privacy, and safety (Durão et al., 2019; Vial, 2019).

3.1.4. CHALLENGES

Organizations have been met with some challenges on the path to DT. DT strategy must be aligned with business strategy, but it has been difficult for some companies to recognize the distinction between IT and DT strategies. Such companies may not understand how to align IT, DT, and business strategies to achieve shared goals (Kane et al., 2017; Matt et al., 2015; Uhl & Gollenia, 2016; Vial, 2019).

Another challenge for companies lies in understanding that DT is not a set of projects or programs focused on technology. It must represent a new way of doing things, a new mindset, new business models, and it must be adaptable to each industry, market, business, and company (Henriette et al., 2016; Kane et al., 2017; Nosova et al., 2021; Oswald & Kleinemeier, 2016).

Some companies focus on automating existing business processes without assessing if they are ready to be automated. Processes should be re-engineered and optimized to facilitate new business models before being automated. A technological approach to DT usually separates IT from business aspects, causing resistance to change, and does not consider the alignment between people, processes, organizational structures, and culture, especially people. Employees need to be engaged, comfortable, and motivated to change. Other ways to enable new ways of working and collaboration should be considered before technology (Durão et al., 2019; Henriette et al., 2016; Kane et al., 2017; Oswald & Kleinemeier, 2016; Schwertner, 2017; Vial, 2019).

Companies' inertia and resistance are also two key barriers to changing business models and, consequently, the value creation process. Some well-established companies with rigid cultures and identities have difficulty innovating and integrating new digital technologies and do not consider DT as a potential benefit for the organization. Despite an organization's intentions regarding DT, employees' resistance to new technologies and changes, cultural issues, and a lack of awareness of the benefits of DT are also elements to deal with (Kane et al., 2017; Oswald & Kleinemeier, 2016; Vial, 2019).

Other challenges are cybersecurity, data privacy, misuse of personal information, and financial abuse. In addition, there can be concerns regarding the regulation and management of third-party risk related to shared information. Regarding management, there can be a lack of IT and leadership skills (Durão et al., 2019; Kane et al., 2017; Oswald & Kleinemeier, 2016; Remane et al., 2017; Ustundag & Cevikcan, 2018), unclear roles and responsibilities, no sense of urgency, lack of business cases vision, no organizational units alignment, not enough funding, or IT systems' limitations (Oswald & Kleinemeier, 2016). Generally, organizations can face difficulty converting technological innovation into financial profits and understanding how best to utilize the latest technologies in order to sustain or develop business excellence (Uhl & Gollenia, 2016),

3.1.5. ASSESSMENT

Generally, while many companies have already invested in new technologies, some are reaping better benefits than others. This is because, to become digital, in addition to just investing in specific technologies, organizations also need to have good leaders who are engaged, have a vision for the future, and can motivate employees to work to that purpose (Hinings et al., 2018; Schwertner, 2017; Westerman et al., 2014).

According to Westerman G., Bonnet D., and McAfee A. (2014), there are four levels of 'Digital Mastery'. It is possible to understand which level companies are at, and the path they must follow in order to become Digital Masters, using this framework as shown in Figure 4.

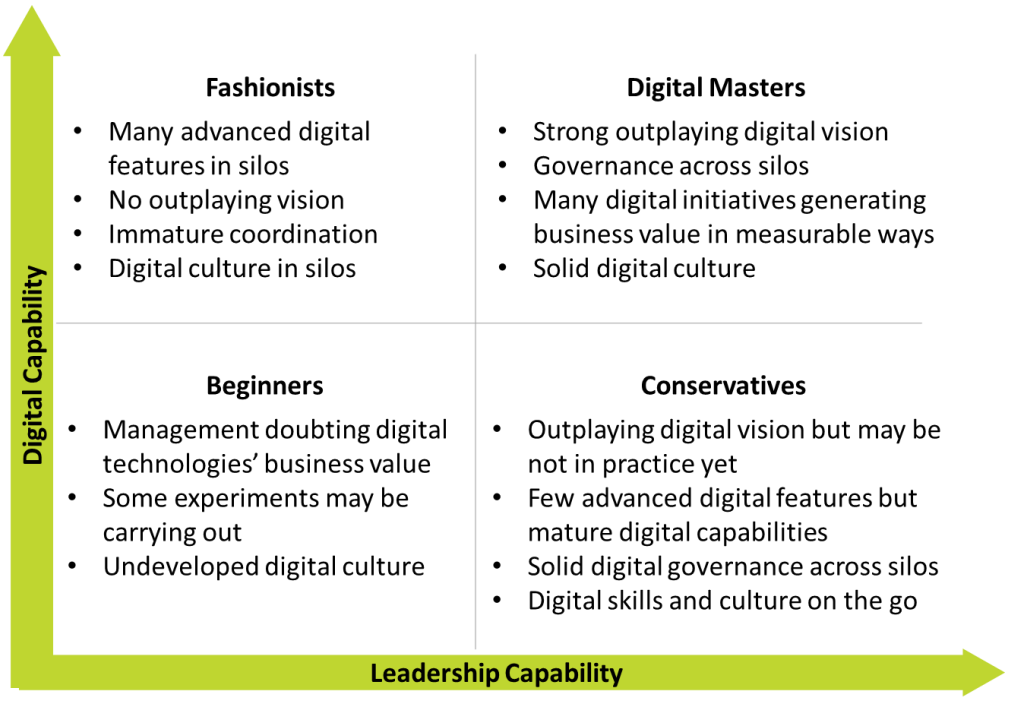

Figure 4: Four Levels of Digital Mastery (adapted from Westerman et al., 2014)

Companies are classified as ‘Beginners’ if they doubt the value of digital technologies, are simply experimenting and have almost no digital culture. They have weak digital and leadership capabilities. Alternatively, the organization may have begun to invest in technology and digital culture may be emerging, but this is happening in silos, not in an integrated way, and there is no digital vision.

If the organization has a solid digital capability but is still weak in its leadership capabilities, they are classified as ‘Fashionists’.

A company fitting the classification ‘Conservatives’ has a weak digital capability but a strong leadership capability, has a digital vision for the future, has started to skill up employees, promotes a digital culture, and has integrated digital governance, although it has made few digital investments.

Finally, an enterprise which has a solid digital vision, excellent and integrated governance, robust digital culture, and has already made many diverse investments in digital technologies, has strong digital and leadership capabilities, and is therefore considered a ‘Digital Master’ (Westerman et al., 2014).

Rogers (2016) proposes another method of companies’ self-assessment about their readiness for DT. Using a scale of 1 to 7, it evaluates the organization in 22 criteria, divided into two main areas: Strategic Thinking (Figure 5) and Organizational Agility (Figure 6).

Strategic Thinking

We are focused on selling to and interacting with customers through the usual channels.	1 2 3 4 5 6 7	We are focused on our customers' changing digital habits and path to purchase.
We use marketing to target, reach, and persuade customers.	1 2 3 4 5 6 7	We use marketing to attract, engage, inspire, and collaborate with customers.
Our brand and reputation are what we communicate to our customers.	1 2 3 4 5 6 7	Our customers' advocacy is the biggest influence on our brand and reputation.
Our sole competitive focus is beating our rivals.	1 2 3 4 5 6 7	We are open to cooperating with our rivals and to competing with our partners.
We look to create value exclusively through our own products.	1 2 3 4 5 6 7	We look to create value through platforms and external networks.
We are focused primarily on own industry and on direct competitors.	1 2 3 4 5 6 7	We view our competition as broader than our current industry.
Our data strategy is focused on how to create, store, and manage our data.	1 2 3 4 5 6 7	Our data strategy is focused on how to turn data into new value.
We use our data to manage day-to-day operations.	1 2 3 4 5 6 7	We manage our data as a strategic asset we are building over time.
Our data stays in the division or business unit where it is generated.	1 2 3 4 5 6 7	Our data is organized to be accessible by all divisions of the company.
We make decisions by analysis, debate, and seniority.	1 2 3 4 5 6 7	We make decisions through experiments and testing wherever possible.
Our innovation projects always go over time or over budget.	1 2 3 4 5 6 7	We innovate in rapid cycles, using prototypes to learn quickly.
We try to avoid failure in new ventures at all costs.	1 2 3 4 5 6 7	We accept failure in new ventures but look to reduce cost and increase learning.
Our value proposition is defined by our products and our industry.	1 2 3 4 5 6 7	Our value proposition is defined by changing customer needs.
We assess new technologies by how they will impact our current business.	1 2 3 4 5 6 7	We assess new technologies by how they could create new value for our customers.
We are focused on executing and optimizing our current business model.	1 2 3 4 5 6 7	We aim to adapt early to stay ahead of the curve of change.

Figure 5: Strategic Thinking Statements (adapted from Rogers, 2016)

Organizational Agility

Our IT investments are seen as operational.	1 2 3 4 5 6 7	Our IT investments are seen as strategic.
It is hard to allocate resources away from existing lines of business.	1 2 3 4 5 6 7	We are able to invest in new ventures even if they compete with our current business.
Our key performance metrics relate only to sustaining our existing businesses.	1 2 3 4 5 6 7	Our business metrics adapt to suit changes in strategy and the maturity of a line of business.
Managers are accountable and rewarded for immediate results on past objectives.	1 2 3 4 5 6 7	Managers are accountable and rewarded for long-term goals and new strategies.
We have difficulty developing new ventures far from our existing business.	1 2 3 4 5 6 7	We are able to seed and develop new ideas that are unusual for our business.
The sharing of best practices across our organization is slow and inconsistent.	1 2 3 4 5 6 7	We are skilled at taking successful new ideas and integrating them across the organization.
Our first priority is maximizing shareholder return.	1 2 3 4 5 6 7	Our first priority is creating value for customers.

Figure 6: Organizational Agility (adapted from Rogers, 2016)

Each criterion is composed of two statements that could characterize the company. The statements on the left represent more traditional business models, while on the right are statements at which companies ideally want to arrive. This assessment allows companies to understand the main areas that they need to improve, transform, and become digital (Rogers, 2016).

This assessment also proposes that, to become digital, companies need social media marketing, open innovation, data management focused on value creation, a balance between mind and machine, product and platform, and core and crowd, and finally, the ability to develop new business ideas and disseminate them across the organization (Hinings et al., 2018; Rogers, 2016)

There are other researchers (Aslanova & Kulichkina, 2020; Kane et al., 2017; Remane et al., 2017; Ross et al., 2019; Rossmann & Reutlingen, 2018; VanBoskirk & Gill, 2016; Zhu, 2014) studying and proposing models to assess companies' digital maturity. In his research, Roman Teichert identifies, examines, and compares twenty-two digital maturity models and concludes that there is no consensus between models and, in general, they are incomplete to overall industries (Teichert, 2019).

3.1.6. STRATEGIES

In 2014, Westerman et al. presented the 'Digital Transformation Compass' as guidance for companies on the journey to becoming digital, composed of twelve steps and four areas of action: (1) Framing the digital challenge, (2) Focusing investment, (3) Mobilizing the organization, and (4) Sustaining the transition (Figure 7).

Figure 7: Digital Transformation Compass (adapted from Westerman et al., 2014)

A company must start with (1) framing the digital challenge, building awareness, assessing the company's digital maturity to know their starting point, shaping a vision, and aligning the top team. It then goes on to (2) focus on investment, where it must translate the vision into a roadmap of activities, build the governance structure, and prepare funds for the transformation. The next area of action is to (3) mobilize the organization, which includes defining the ambition, engaging employees, and setting new behaviors and a digital culture. Lastly, it must (4) sustain the transition by developing fundamental skills, establishing incentives and rewards to overcome traditional mindsets, measuring and monitoring transformation progress, and redoing any steps if necessary (Westerman et al., 2014).

Matt C., Hess T., and Benlian A., in 2015, clarified the distinction between DT strategy and IT strategy and stated that the DT strategy must be aligned with other corporate strategies (Figure 8), while the IT strategy is focused on IT management, defining activities, applications systems, and infrastructures to satisfy business operation's needs, which have a slight impact on creating innovations to business

development. DT strategy aims to bring the company the right digital technologies in order to transform products, processes, and business models.

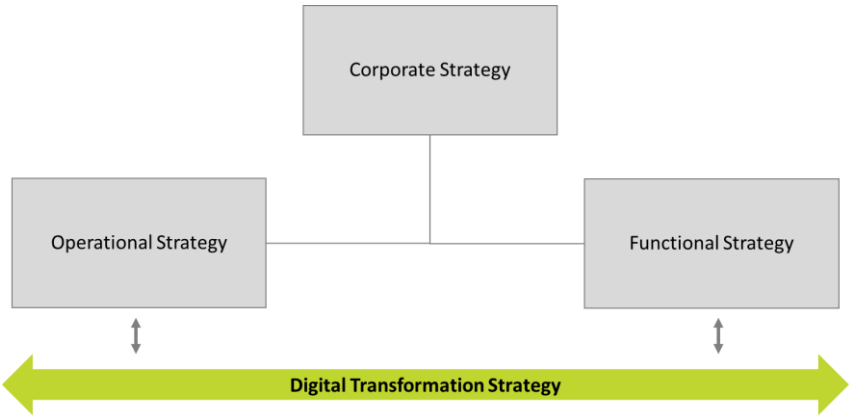

Figure 8: DT strategy and corporate strategy alignment (adapted from Matt et al., 2015)

They propose that companies establish their DT Transformation Strategy based on four aligned dimensions: (1) Use of technologies, (2) Changes in value creation, (3) Structural changes, and (4) Financial aspects (Figure 9).

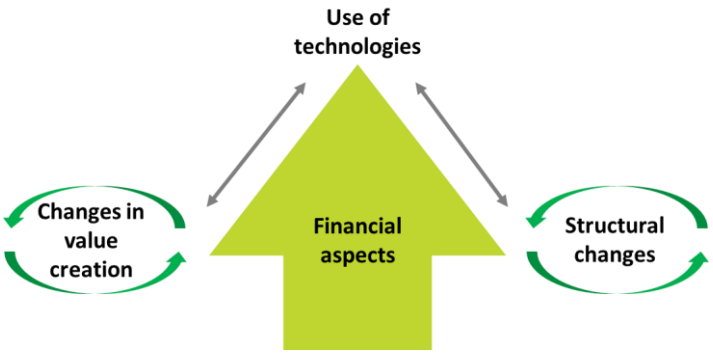

Figure 9: Four dimensions of DT strategy (adapted from Matt et al., 2015)

Organizations must decide upon their ambition and attitude towards (1) the use of new technologies, and whether to be a market leader or a follower which relies on other companies' standards. Regardless of how the organization establishes its adoption and exploration of technologies, this will lead to (2) changes in value creation, bringing opportunities to develop new and digital products, services, and business models. The use of different technologies and the application of different ways of value creation will lead to the necessity for (3) structural changes. Thus, the DT strategy must define what structural changes may occur. To work on these three dimensions, companies will need to evaluate (4) financial aspects, which depend on two main factors: how important DT is for its leaders, and its capacity to finance DT. The person leading the DT must have experience in transformational projects, although there is no defined consensus on which type of senior manager (ex.: CIO, CEO, or a new role CDO) should lead DT (Matt et al., 2015).

Ross J., Sebastian I., Beath C., Mocker M., Moloney K., and Fonstad N., in 2016, claimed that a DT strategy is a business strategy which takes in part from new digital technologies to innovate business offers and change market conditions constantly. Taking this perspective, they proposed two types of DT strategies to create a new value proposition: Customer Engagement or Digitized Solutions.

The authors argue that while companies must choose one of these two types of strategy to define the DT strategy, this does not mean that they should not invest in the other. For example, companies who choose customer engagement as a DT strategy should also invest in digitized solutions, though the customer engagement strategy will guide decisions. Conversely, if the company chooses the digitized solutions strategy, it can also strengthen its solutions with excellent customer service.

Organizations choose a digital customer engagement strategy to transform their go-to-market approach, with the aim of cultivating loyalty, trust, and passion by delivering an innovative, personalized, superior, and gradually more integrated customer experience. The goal is to offer an omnichannel experience that allows customers to order, enquire, pay, and receive support constantly and reliably at any time from any channel.

Meanwhile, a digitalized solutions strategy is chosen when the main goal is to redevelop products and services and transform the company's business model. In addition, the objective is to offer continuing value-added services related to the main product or service, moving the revenue stream from the unique sale of a product or service to the recurring revenue from ongoing services (Ross et al., 2016).

Furthermore, in 2016, Rogers D. introduced the Five Domains of Digital Transformation, also called CC-DIV: Customers, Competition, Data, Innovation, and Value (Figure 10).

Figure 10: Five Domains of Digital Transformation (adapted from Rogers, 2016)

The 'Customers' domain is about developing customer networks to enable new offers, new ways of purchase, and new forms of contact and relationship with customers. 'Competition' is the domain that emphasizes how companies can cooperate with their competitors in order to benefit from such collaborations, for example, by developing and using digital platforms. 'Data' is the third and fundamental domain of DT because it highlights the power of information and the possibility of turning data into new sources of value. The 'Innovation' domain is related to the rapid development of new ideas through minimum viable prototypes, experimenting and testing them in the market, making decisions based on real customer needs, and achieving customer satisfaction faster. The final domain is 'Value', which is about the transformation of the value proposition using digital technologies that allow companies to develop new ways of value creation for customers (Rogers, 2016).

In 2017, Schwertner K.'s research presented three approaches for companies becoming digital: (1) The transformation of the customer experience, using market segments, consumer behavior and loyalty studies to sustain new digital products and services, and the enablement of iterative and constant communication with customers using many digital contact points; (2) The transformation of the organization's business processes using digital technologies to increase capacity and expand work areas, automate processes, and retain data to sustain production levels and customer relationships; and (3) Transforming the business models using digital technologies to innovate and create new digital solutions and consequently new digital business models (Schwertner, 2017).

Ross J., Beath C., and Mocker M., in 2019, established a road map for DT based on the concepts of 'Five Building Blocks' that companies must develop: 'Operational backbone', 'Shared Customer Insights', 'Digital Platform', 'Accountability Framework', and 'External Developer Platform' (Figure 11).

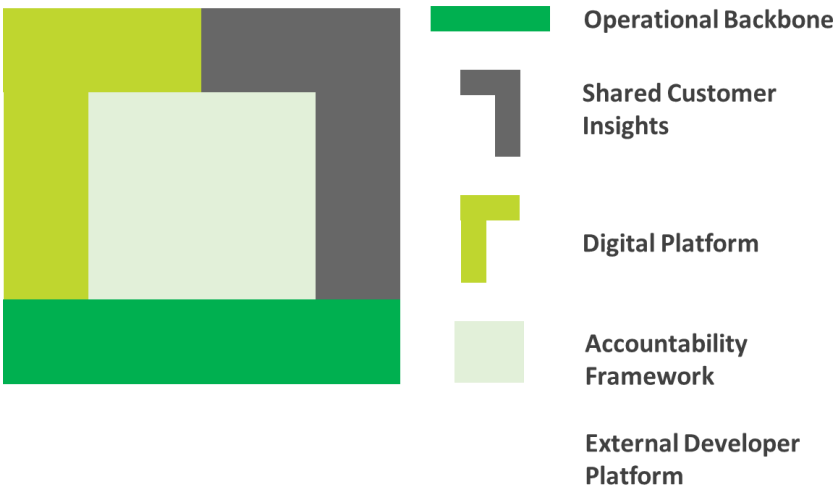

Figure 11: Five Building Blocks (adapted from Ross et al., 2019)

These blocks represent the five capabilities that companies must have to become digital. The 'Operational Backbone' is the capability to identify the needs of operational processes integration and standardization. 'Shared Customer Insights' are about knowing which digital solutions the company can develop and customers want. It is also essential to develop a 'Digital Platform' that establishes a digital offering to collect customer information. Another capability that companies must have is the 'Accountability Framework' to define roles, decision rights, and all the procedures of the digital platform development and its use. Finally, the company must have an 'External Developer Platform' to share technology, processes, and roles with external partners in a digital way (Hinings et al., 2018; Ross et al., 2019; Schwertner, 2017)

Other researchers have proposed different frameworks, roadmaps, and methodologies for DT (Baker, 2014; Bygstad & Øvrelid, 2021; C. Verhoef et al., 2019; Hinterhuber & Nilles, 2021; Kettinger et al., 1997; Oswald & Kleinemeier, 2016; Rogers, 2016; Stone, 2019; Uhl & Gollenia, 2016; Zaoui & Souissi, 2020) but there is no single strategy which is valid for all companies.

According to most researchers, a DT strategy must consider having one platform which connects all business units and is supported by new technologies that enable business process re-engineering and optimization (Bygstad & Øvrelid, 2021; C. Verhoef et al., 2019; Rogers, 2016; Ross et al., 2019; Schwertner, 2017; Stone, 2019; Ulas, 2019). Additional important factors to consider are the organizational structure and culture, leadership, employees' roles and abilities (Baker, 2014; C.

Verhoef et al., 2019; Oswald & Kleinemeier, 2016; Ross et al., 2019; Stone, 2019; Vial, 2019), and barriers to change such as inertia and resistance (Ross et al., 2019; Vial, 2019).

Overall, the main areas that most organizations are digitally transforming are customer experience, processes, and business models (C. Verhoef et al., 2019; Durão et al., 2019; Ross et al., 2019; Vial, 2019). Some companies may call it Digital Business Strategy, with the view of DT as a path instead of a project. Others call it Digital Transformation Strategy, from the perspective of the organization's transformation (Vial, 2019).

3.2. INTELLIGENT PROCESS AUTOMATION

3.2.1. CONCEPTS

Considering the literature review regarding **IA**, a shared understanding of what it is or what it includes does not exist. However, one standard reference in all studies and on technology companies' web sites referring to this subject is that IA is not one technology. Instead, it is a concept that includes all technologies which enable automation of business processes, and consequently business transformation, by combining software robotics, cloud, AI, and intelligent machines. Using Robotic Process Automation (RPA) and different AI technologies that process historical data, it handles business processes exceptions, makes judgments to resolve specific problems, and gives workers the knowledge needed to support new understandings (KPMG International, 2019).

It is also called **Hyperautomation** and includes not just technology but also methods and techniques to create digital workers that mimic human knowledge workers' capabilities to perform activities and execute business processes automatically. The main goal is to achieve better outcomes with minimal or no human intervention by increasing process speed and resilience, reducing costs, optimizing decisions, and enhancing compliance and quality. Consequently, this will improve customer and employee satisfaction and raise revenues (Bornet et al., 2021).

Intelligent Automation can be used in all of an organization's functional areas, but this study is focused on business operations, so the following concepts were chosen to understand where and how **IPA** fits in an organization:

Automation is a software program or machine action performing tasks that were previously performed by a human. IA relates to knowledge work, which means software-based automation and not physical machines. According to Kommera (2019), there are five types of automation: Process Automation,

Service Automation, Workload Automation, Infrastructure Automation, and Application Build & Release Automation. In this study, Process Automation is the key type.

BPA is part of the BPM discipline (Jovanović et al., 2019). It aims to improve processes and reduce inefficiencies, using Process Mining Systems to collect data and discover, enhance, and monitor processes (Celonis, n.d.; Geyer-Klingeberg et al., 2018; OSMAN, 2019). It also enables companies to identify where processes can be automated, integrated with other systems, or how specialized process software can be used (Asquith & Horsman, 2019; OSMAN, 2019).

Process Mining Systems are included in IA because they have some form of intelligence. They are capable of data integration from other solutions like Enterprise Resource Planning (ERP) and Customer Relations Management (CRM) to design the actual process and identify deviations from the ideal process, helping to detect inefficiencies and their root causes (Celonis, n.d.; Jovanović et al., 2018) If it uses a data model to store data in a database, this development can result in high costs, long duration, complex solution integration, and the limitation of legacy systems (Jovanović et al., 2018). Using Cloud Computing and **Application Programming Interfaces** (APIs), companies can access real-time data (Jovanović et al., 2018; OSMAN, 2019), but depending on the systems or applications, the use of APIs can also require high programming skills. Developers need to know the applications involved in detail and IT staff is typically involved. (Asquith & Horsman, 2019; Kommera, 2019; Willcocks et al., 2015). RPA is an alternative to API in these cases (Geyer-Klingeberg et al., 2018).

RPA is focused on creating digital workers to do repetitive tasks with structured data input (Huang & Vasarhelyi, 2019; Ng et al., 2021; Siderska, 2020; UiPath, 2021) but does not need to store any transactional data (OSMAN, 2019). Although it implies physical robots, it is a software-based solution, like Uipath, which is used to program software robots that can imitate humans' actions and interact with other systems (Kommera, 2019; OSMAN, 2019; UiPath, 2021; Willcocks et al., 2015). A software robot is comparable to one software license. Defining rules and configuring activities in sequences or workflows, this intelligent automation can be autonomously executed without human intervention with the same result. However, human intervention is needed for exception management because, as it is developed based on rules, unpredictable situations can occur (Kommera, 2019; OSMAN, 2019; Willcocks et al., 2015).

RPA can be triggered manually or automatically. Some examples of activities that can be performed are data manipulation, transaction processing, communication, documenting of audit trails, and calculations. It is designed for non-programmers' use and does not impact on existing systems. It is developed and deployed by business operations that need to automate small tasks, where IT developments may not be justified (Willcocks et al., 2015).

According to Komera (2019), RPA is the sum of two parts: Robotic Desktop Automation (RDA) as toolbars and wizards to assist employees, especially in the front and back-office departments; and Robotic Process Automation (RPA), which is capable of distributing work in the front-office department and replacing 100% of some back-office operational processes (Kommera, 2019).

While BPA tools help organizations simplify processes and eliminate non-value activities (OSMAN, 2019), RPA tools help to improve efficiency and effectiveness. Replacing human intervention in process activities, RPA reduces the costs and completion duration of these activities. Additionally, this automation can run perpetually, the accuracy of the tasks is improved since there are no human mistakes, and it can be flexible and scalable. As a result, many companies have adopted this technology because of its low costs and high benefits (Huang & Vasarhelyi, 2019).

RPA and BPA complement each other. RPA can be used to collect and integrate data into Process Mining Systems, enabling the understanding of the business processes' maturity and allowing the identification of RPA opportunities, which will enhance the process with the results seen in Process Mining Systems (Geyer-Klingeberg et al., 2018).

The advancement of new AI technologies has contributed to RPA's evolution to another level and its integration with other technologies and systems (Huang & Vasarhelyi, 2019). AI is the development of software that automates knowledge work, imitating human behaviors and capabilities. Key features are ML, Anomaly Detection, Computer Vision, NLP, and Conversational AI (Bornet et al., 2021; Microsoft Docs, 2021b). AI combines all of these cognitive features to reproduce human behavior and intelligence, but alone it cannot execute cognitive tasks (Bornet et al., 2021). It needs automation programs and data to achieve this (Microsoft Docs, 2021b).

Business Intelligence (BI) combines several technologies, methods, and tools that enable interactive access to data, sometimes in real-time, and manipulation. Historical and current data analysis facilitate the transformation of data into information, allowing for better decisions and actions, made either by business managers and analysts (Sharda et al., 2018) or, using AI, by software-based automation, which is what makes Big Data so crucial to IPA and consequently to DT (Uhl & Gollenia, 2016).

According to Ng, Chen, Lee, Jiao, and Yang (2021), IA technology applied in BPA can be classified as RPA, IPA, Augmented Intelligent Process Automation (AIPA), and Autonomous Agents (AA) (Figure 12).

RPA has a low process complexity, exception handling, and zero or limited cognitive capabilities. Furthermore, it has minimal smartness because its decision logic is developed using rule-based decisions (Ng et al., 2021; Siderska, 2020). To benefit from AI developments and address current RPA limitations, specialists have proposed IPA as an extension of RPA, which combines RPA with AI, ML,

and Big Data to create and perform superior processes and process models (Huang & Vasarhelyi, 2019; Jovanović et al., 2018; Siderska, 2020).

IPA uses AI and Soft Computing (SC), including ML, above RPA, and BI providing prescriptive analytics and cognitive decision-making based on structured or unstructured data, such as image, text, videos, and voice. Together, these technologies can imitate human decisions and act upon them, which requires a higher level of exception handling in decision logic than RPA because the decision-making process is not rule-based. Based on historical data, it is a model that only needs human intervention to ensure quality (Huang & Vasarhelyi, 2019; Microsoft Docs, 2021b; Ng et al., 2021).

Online customer chatbots are examples of IPA applications based on RPA software. These use AI to analyze customer preferences based on the content of their text conversations with the chatbot. Another use of IPA is the merge of RPA with NLP and voice recognition to provide customer service (Huang & Vasarhelyi, 2019; Ng et al., 2021).

An AI learning model can run with or without supervision, but initially, it will always require experts to fine-tune the accuracy and performance of the model. If the model achieves a higher level of cognitive decision quality, it is called an **AIPA**, meaning it can enable deductive analytics with rapid judgment close to human intelligence, learning from human decisions. AIPA reaches the next level of cognitive decision quality and enables a holistic approach regarding creating and managing digital processes (Ng et al., 2021).

If the model achieves a learning level that enables better decisions than human intelligence, it is called **AA**, a software that makes decisions without human interventions and orientations. It is capable of exception handling, quality control, and self-learning to reach high levels of decision smartness with zero human interventions or orientations (Ng et al., 2021).

RPA	IPA	AIPA	AA
• Uses structured data • Applicable to process parts • Decisions based on rules • Triggering initiation • Partial human supervision	• Uses historical data, structured or unstructured • Prescriptive analytics • Decision engines • Periodic improvement of decisions logic • Little human intervention for assurance	• Decision engines based on deductive analytics • Fast judgement and Reasoning • Engineering of knowledge • Learns from human decisions	• Engines of Self-learning decisions • Capability for exception handling • Zero or almost zero human intervention • Decisions superiors to human

Figure 12: Types of AI technology (adapted from Ng et al., 2021)

Some risks regarding AI development that organizations must be aware of are the "bias" impact on results, errors which can cause harm to people, the exposition of data, solutions that do not work for everybody, the need for trust in complex systems, and their responsibility for AI decisions (Microsoft Docs, 2021a). Regarding this last risk, organizations must understand and apply Responsible AI based on the main principles of fairness, reliability, safety, privacy, security, inclusiveness, transparency, and accountability (Microsoft Docs, 2021c).

3.2.2. BENEFITS

Several benefits were discussed while describing important IPA concepts. These will now be re-enforced and clarified, focusing on the organizational and operational advantages.

IPA brings operational improvement by solving problems, accelerating end-to-end processes, lowering costs, increasing productivity, optimizing the data-driven approach, enhancing process performance visibility, enabling prediction analytics, and bringing error prevention and regulatory compliance (Ng et al., 2021).

It enables different solutions for organizations' business and processes. Software robots, combined with intelligent technologies, improve organizations' process learning rate. Integrating RPA with technologies like ML, NLP, and Data Analytics enables streaming process analysis and predicts competition and customer behaviors. This technological advancement allows companies to be assisted by digital software that can control, manage, and improve business processes in real-time and optimize their efficiency (Siderska, 2020).

IPA goes beyond the imitation of how people perform recurring tasks and uses AI to learn how people make decisions in order to perform complex tasks faster and better than humans (Huang & Vasarhelyi, 2019).

IPA enables DT because it combines several technologies, methods, and techniques to identify and develop improvements related to critical success factors such as efficiency, speed, agility, and compliance. It supports business processes' transformation, product development, and new business models. AI and ML enable software robots to learn new skills and extend the scope of their work beyond rules-based action to conclusions and decision-making tasks. As a result, the software can act intelligently, can be involved in risky processes of human life, and allows space for employees to be involved in more strategic tasks that require creativity and bring more value to the organization (Geyer-Klingeberg et al., 2018; OSMAN, 2019; Siderska, 2020).

Haleem, Javaid, Singh, Rab, and Suman (2021) outline the following main benefits of IPA:

- Business procedures improvement and better outcomes through business automation.
- Increased human skills and completion of tasks more effectively, quickly, and with a smaller number of errors.
- Scalability of operations through cooperation between automation and other technologies.
- The flexibility enabled by different automation technologies.
- Operational efficiency improvement with low expenses enabled by analytical tools and skills.
- Risk and opportunities detection through real-time updated and centralized data and the possibility of making quick decisions.
- Enabling the efficient functioning of robots and humans.
- Automation of repeated operations' processes and better judgments.
- Speeds up the digital journey and creates the basis for critical future developments.
- Customer life cycle automation and compliance measurement.
- Workload automation to make progress on the path of digital transformation.

Ng et al. (2021) propose the following points as IPA benefits:

- The use of cognitive technologies with human-like capabilities to solve problems, and IA model adjustment when facing errors or wrong decisions.
- Data-driven operational efficiency optimization, cost-effectiveness, and increase in productivity and skill capabilities.

- Process visibility and transparency enhancement through the automation of workflow and its processes.
- Adaptation strategy under uncertainty and exception, handled through AI features that can obtain environment information in real-time and perform prediction.
- Effective monitoring and error reduction in BPM is achieved through the accuracy and efficiency of the digital worker.

The IA characteristics referred by Bornet, Barkin, and Wirtz (2021) complement this list of IPA benefits:

- Universality: it can be applied to several industries.
- Scalability: once one program is developed it can be used for different business needs.
- Constant availability: it can deliver service continually, on-demand, at any time and day.
- Reliability: based on the same input, will always produce the same outcome.
- Economically attractive and accessible: AI technologies are inexpensive, usually need less than a year to create payback, and it is easy to acquire the skills needed.

Other authors note that IPA contributes to business process performance, efficiency, and quality of service. Intelligent robots can reduce work and risks to humans, enabling faster tasks completion, integration, risk management, compliance, and social media and public matter analysis (Coombs et al., 2020; Vajgel et al., 2021).

3.2.3. CHALLENGES

To use IA, companies must change their current systems and business management in order to maximize the benefits. Ng et al. (2021) note in their research that companies are dealing with the following challenges regarding IPA:

Expert trust and dependency problems: A generic IPA framework is missing thus far, so practitioners must be careful in defining AI models to perform cognitive decisions because these are dependent on data pattern, problem formulation, and process complexity. Companies must be continuously aware of their situation and context in near-time decisions to enhance the decision logic of AI models, which need to respond to changes in business activities, unpredictability, and complexity. To transform processes, companies will need the collaboration of different function areas and AI experts to design and develop a good AI solution, as it requires specific expertise and knowledge about the process itself, cognitive procedures, current IT infrastructure, and user experience.

Cultural readiness and staff reskilling: Using intelligent software and disruptive IA technology, companies can adapt their business to environmental changes and digitalize their processes and

judgments in decision-making. Due to technological advancement in cognitive computing, most cognitive tasks can be automated with little human intervention, and consequently, technological acceptance and adoption must be achieved through a human-robotic collaboration environment. Senior management must provide education, time, and training to their employees and encourage them to recognize IA as a digital worker. Managers must be aware that IA adoption is not a replacement for employees, but an opportunity to use human resources in other tasks. Digital workers must be considered as supportive and collaborative, and human workers must be supervisory in IA performance management and exception handling. While manual and basic cognitive tasks can be completed by software, higher-level cognitive, emotional, social, and technological tasks should be done by human workers. A human-robotic collaboration environment is essential for providing knowledge and improving process management.

Integration with legacy systems: IA enables real-time decision-making that can provide companies with the benefits of positive image and lower customer turnover. To achieve a good system integration, organizations need to ensure the continuous action of business processes while they are being automated. Legacy systems may be regenerated to avoid inactivity and enable the consistency and quality of the activities' logs, event triggers, and data. A data governance framework which is automated and comprehensive is needed to reduce the risks from IA adoption and ensure its analytical performance. The current systems need APIs or RPA to allow IA and ML to perform data extraction and retrieval and triggers. IA systems also require sensing technologies to perform context-aware computing and collect enough operational data for future IA improvements and retraining. After the adoption of IA, good integration with legacy systems will offer soft IT upgrades.

In their studies, other authors also identify some new challenges as barriers to change, the complexity of transformation, privacy and information security, and ethical and moral issues about AI judgment, decisions, and responsibilities (Bornet et al., 2021; Coombs et al., 2020). In addition, there are several gaps in IPA research and limited evidence regarding its use, which makes its adoption difficult (Coombs et al., 2020). Due to this difficulty, Vajgel et al. (2021) also comment on the lack of:

- Support for the collection and monitoring of its benefits.
- Models for organizational readiness, infrastructures and capability assessment.
- Methodological support for adoption and implementation.
- Techniques for task selection and for managing scalability.

3.2.4. READINESS

There are no specific frameworks or models to measure the IPA readiness of organizations (Vajgel et al., 2021), but there are some critical initial implementation considerations to take into account, outlined by Berruti, Nixo, Taglioni, and Whiteman (2017) and Ng et al. (2021):

Roadmap and strategy:

- A transition roadmap should be defined to automate the non-critical processes first and the critical processes later, based on risk control matrices and risk assessment maps where critical processes are identified according to their importance and the likelihood of system failure.
- An IPA roadmap must include automation enhancement opportunities and an overview of current tasks, resources, and capabilities needed.
- The first stage of IPA will make fundamental changes to the company's current processes, and the systems integration must be at scale.
- System designers and business managers must work together to carefully configure and align IA systems with the business's current workflows and processes.
- The introduction of IA must be step by step, and companies must assess the risk and uncertainties during the transition from manual to automated business processes and its management.
- A strategic plan for IA adoption is needed, based on a clear understanding of the overall business strategy, identifying the required executives, management, and IT professionals to implement the next-generation operating model.
- When gradually adopting IA, system engineers must be aware of the process vulnerabilities and compliance in order to design decision logic solutions without over-impacting process action or stakeholder experience.

Technology readiness:

- Companies need a digitalized process discovery platform that allows for seeing the process workflow design and documentation, and RPA technology implemented to automate repetitive and routine tasks.
- In an AI introductory stage, companies should investigate improvements to the process standardization and digitalization that allow for decision making.

- Digitalized and streamlined processes enable the identification of tasks that can be automated through RPA.
- Besides transparent and digitalized business processes workflows, companies need a large amount of historical data to train AI engines, and expertise is required to supervise performance and fine-tune the parameter setting on AI engines.
- Significant infrastructure investment is not required if companies already have robust information systems, enabling rapid implementation without changing the IT back-end.

Human resource capabilities:

- IA adoption requires the synergy of robotic efficiency with human judgment and human resource re-engineering.
- Employee engagement must be improved by allocating the workforce to mission-oriented work and collaboration while software agents handle repetitive work. This work distribution is critical to enable employees to feel comfortable and mitigate resistance to IA.
- AI errors, system failure at runtime, and exception cases are inevitable, so companies must consider human supervision and identify exception cases for further cognitive improvement by retraining AI engines.
- IA evolution initiatives, human supervision, and exception management contribute to the business process improvement and transformation and enables competitiveness.
- Based on problem-dependent applications, stakeholders' concerns can help the IA development to achieve successful automation of processes and a changing business environment.

Change management:

- The automated processes should not deviate too much from the previous processes, so as to maintain technological acceptance.
- A digital data infrastructure, employee education and training, system development, and IT support are required in order to support the management of change to new IA technology.
- The design quality of AI engines' performance and accuracy mainly depends on the context-awareness and data trade between companies and their clients.

- To benefit from IA, companies need to have strong business process re-engineering and a flexible management style.
- An IA team must be formed to redesign processes and group workflows based on a deep understanding of business and IA implementation.
- A good communication plan will be required to help with the management of reorganization, to create enthusiasm and align new IPA initiatives with business strategy.
- The success of new business models depends on the alignment achieved between the organization's culture and its employees' motivation to adapt to agile practices.
- Change champions programs are an excellent incentive to engage the workforce and achieve successful digital transformations.

Maximize impact through full use of IPA solutions portfolio:

- Companies must implement a holistic IPA program to maximize investment return, as the most advantageous benefits come as a result of IPA technologies working together.
- A structural process redesign is required to transform companies' business models.

Build rapid minimum viable products (MVPs):

- Companies must select an end-to-end process or customer journey to redesign and enhance using IPA, and focus on delivering the MVP of this initiative, rapidly testing what works and what does not, and incorporating changes.
- Early IPA pilots can deliver rapid returns by leading to fewer errors and less repetitive work for employees, ensuring support from stakeholders and executive sponsors to move forward with the complete IPA transformation.

With lower costs, companies can use IPA to invest in and develop new platforms, engage with customers, and overcome competitors. However, to go to the next level, companies must embrace IPA capabilities as part of an upgrading operating model that allows rapid value creation for stakeholders (Berruti et al., 2017).

3.2.5. RESEARCH DIRECTIONS

A **Holistic IPA strategy**, based on real-time data-driven and self-learning and re-training AI models, is the goal of this research, but there are other possible research directions regarding automation mentioned by Ng et al. (2021) in their study:

Self-adaptation to environments: IA provides companies with self-adaptation to environmental changes through context-aware data and custom services in business processes that recognize circumstances and react accordingly, with limited human intervention. However, there is a lack of other promising solutions for cognitive decision-making during runtime.

User-centricity: To value co-creation and user experience in automated business processes, companies must understand their users' needs, expectations, comments, and queries, which is possible through text mining, NLP, voice recognition, and analytics, but to improve customer service interactions, a more powerful AI system that handles user requirements is needed to be investigated in future research.

Real-time cognitive decision: The main benefit of AI systems is that they enable real-time decisions, providing proactive customer services, engaging customers, and offering virtual interactions. However, analytical and prediction powers remain the same, and soft computing techniques are still a growing research trend.

Human interaction and collaboration: IA systems can further enhance productivity and achieve efficiency by performing tasks of low-level judgment of cognitive decision, while high-level cognitive decision-making and exception handling require human workers' participation. However, in future human-automation interaction and collaboration, there are expected to be trust issues, confusion, and changes. Research is needed regarding workforce and system interaction and collaboration redesign for future business processes.

Emotional computing: Advanced pattern examination via text, audio, video, or image is now possible, but affective computing is the key to a future decision support system capable of undertaking complex and unclear cognitive decisions. By identifying a customer's attitudes and emotions via automated sentimental analysis, companies can reduce the impact of human trust issues or confusion.

3.2.6. APPROACHES

The Academic View:

The scientific literature review illuminated many exciting studies regarding IPA and its applications in specific industries, sectors, work areas and as a solution for technical or generical problems in organizations (Agostinelli et al., 2020; Cardoso, 2021; Coito et al., 2019, 2020; Durão et al., 2019; Micle et al., 2021; Nunes et al., 2020; Rajawat et al., 2021; Rizk et al., 2020; Vajgel et al., 2021; Zhang, 2019). However, it was only possible to find two general scientific approaches guiding companies in IPA adoption.

Haleem, Javaid, Singh, Rab, and Suman (2021) use the term 'Hyperautomation' to describe the integration of several technologies to strategically create and optimize end-to-end processes, increasing efficiency and productivity and decreasing errors and time consumption. They propose six technologies that must be aligned, as we can see in Figure 13: RPA, Process Mining, AI and ML, NLP, Optical Character Recognition (OCR), and Digital Twin of the Organization (DTO).

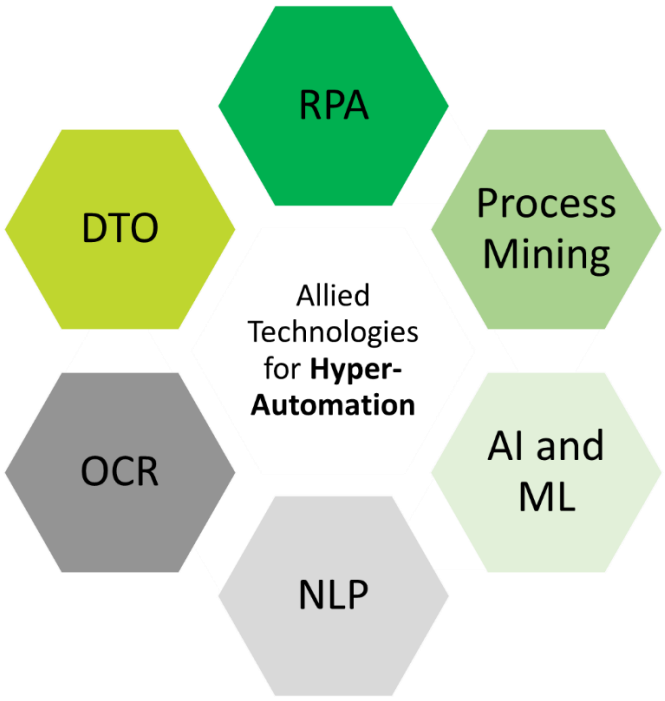

Figure 13: Hyperautomation technologies (adapted from Halleen et al., 2021)

They propose that with this alignment, it is possible to go beyond automation and discover and optimize business processes end-to-end and design, plan, develop, use, and monitor automation systems with no impact on the customer experience during the process. The process proposed starts with the problem identification; it then moves to information extraction using RPA; the third step is

details' validation and verification by ML models; and the final stage is a double check and validation (Figure 14).

Figure 14: Steps for Hyperautomation (adapted from Halleen et al., 2021)

The general use of this approach and process is not very clear; it gives guidance to companies, but it lacks a business case demonstration and expert evaluation.

Bornet et al. (2021) published a book called 'Intelligent Automation'. While it is not specific to IPA, it includes a chapter which discusses how to succeed in IA transformation and gives guidance to organizations. The main ideas of their approach reinforce what is written in previous chapters of this thesis:

- Because IA brings structural changes, organizations must have senior management support and governance combining business and IT.
- Organizations must define an enterprise-level vision, a roadmap, and start with a pilot, learning from the experience, adjusting, and implementing to other business cases in order to scale it gradually.
- It is essential to understand that this transformation involves the entire organization and is continuous.

They propose a roadmap to each business case composed of three phases: (1) Launch, in a maximum of four weeks; (2) Preparation, in a maximum of three weeks; and (3) Scaling, in a maximum of three months. The Scaling phase also has three parts: (a) Process redesign, (b) Deployment sprints, and (c) Production. Change and talent management will be needed during the Preparation and Scaling phases.

Bornet et al. (2021) also argue for the need for an IA Center of Excellence for IA implementation and innovation, and an Automation Operation Center to maintain automation programs.

Organizations which do not have senior management support and governance combining business and IT will find it challenging to follow these recommendations.

The Industry View:

Many consultancies already work with IA, studying and developing models, frameworks, roadmaps, and toolkits on order to sell it as a service to companies who want to excel and need help regarding the adoption of IPA. Therefore, it is vital to understand some of these consultancies and their expertise.

Gartner: Gartner has introduced the term Hyperautomation to describe an approach to evaluating and automating companies' business and IT, and proposes the following leading technologies and tools to be integrated: AI, ML, event-driven software architecture, RPA, BPM, Intelligent Business Process Management Suites (iBPMS), Integration Platform as a Service (iPaaS), low-code and no-code tools, and packaged software, among other types of decision, process and task automation tools (Gartner, 2021a). Gartner also refers to Hyperautomation as one of the top trends on the "Gartner Top Strategic Technology Trends for 2022" (Gartner, 2021b).

Gartner defines three rules in the adoption of Hyperautomation: (1) Define a strategy, (2) Prioritize and define a roadmap, and (3) Mobilize resources.

In terms of strategy, Gartner proposes the Hyperautomation Building Blocks, composed of three primary and integrated blocks, as we can see in Figure 15: Operations, Knowledge Work, Customer Experience, and AI technologies.

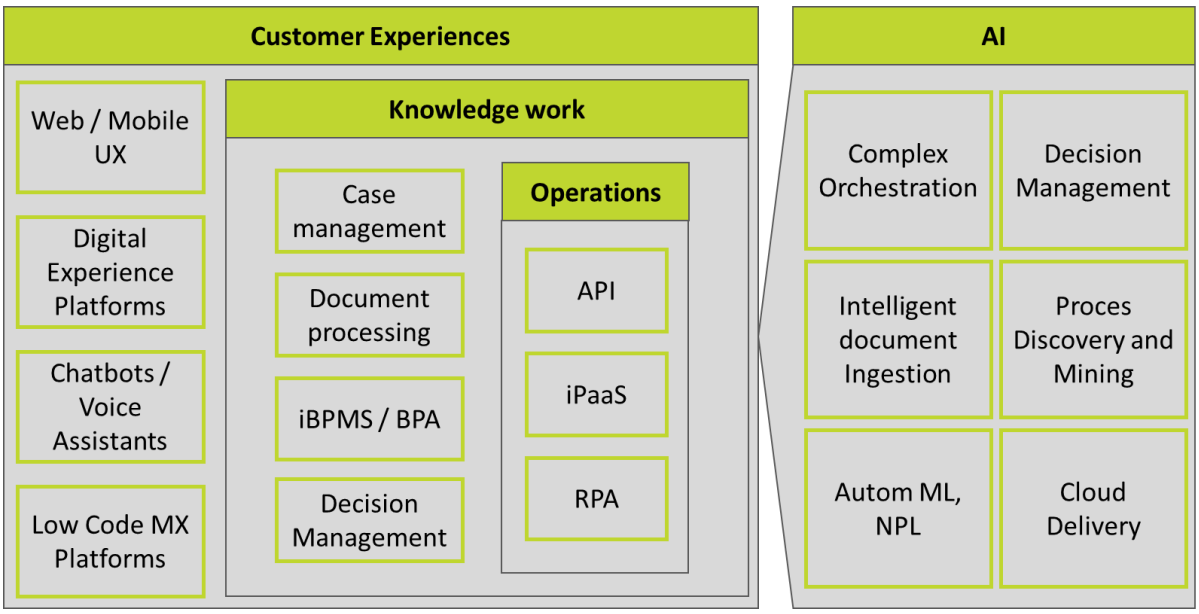

Figure 15: Gartner Hyperautomain Strategy (adapted from Ray, 2021)

It also presents a Decision Management tool to help companies decide what type of automation they need for specific cases answering some questions about the process, as seen in Figure 16. This tool can be adapted according to organizations' needs and requirements.

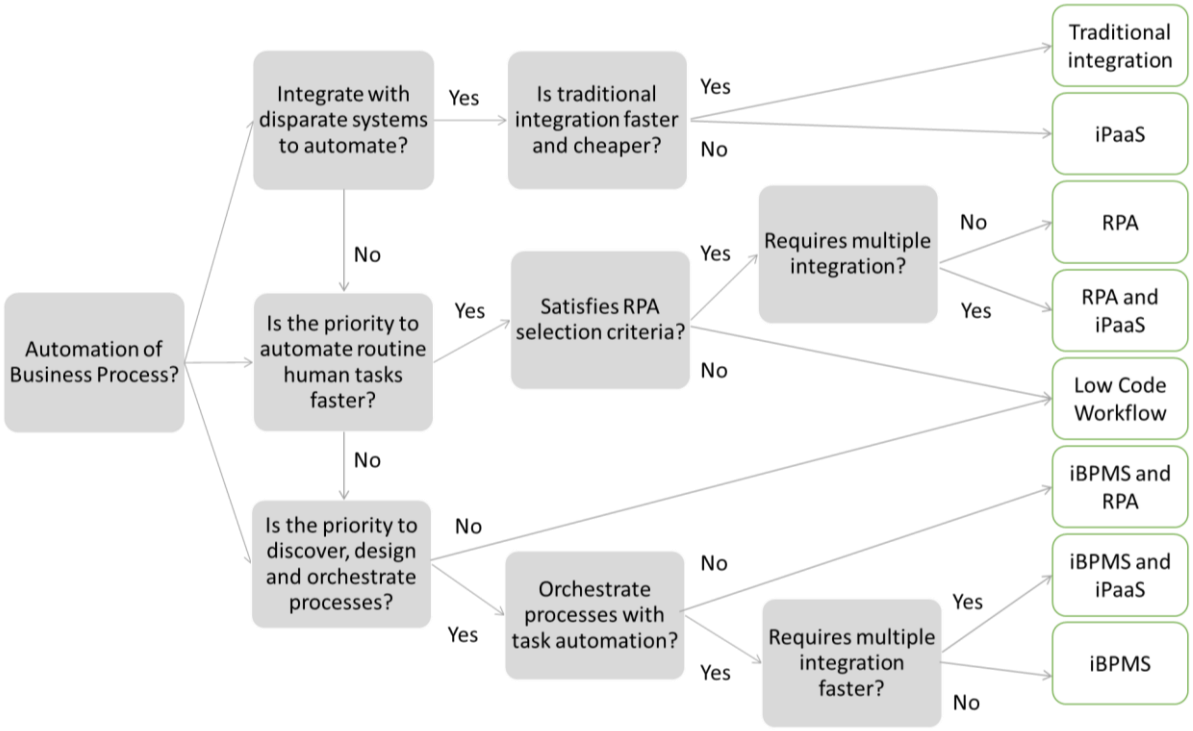

Figure 16: Decision path to complex automation choices (adapted from Ray, 2021)

As a roadmap for companies' implementation of Hyperautomation, Gartner proposes four steps (Figure 17):

1. Case identification: iBPMS identifies cases of automation need, RPA collects data from systems, and OCR extracts information from documentation.
2. Preparation: a decision management tool identifies the automation need type, and decision models assess and prepare policies, and predict results and implications.
3. Evaluation: iBPMS presents data related to the case chosen. This step is the first where human intervention is needed to review and refine results.
4. Changes: iBPMS calls RPA to update legacy systems and communicate with stakeholders, and ML captures and refines policies.

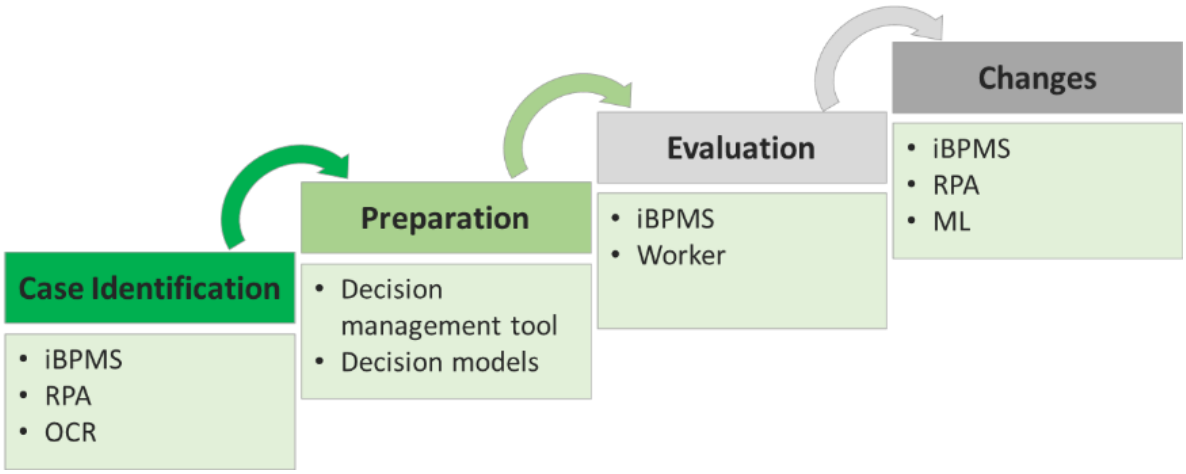

Figure 17: Roadmap for Hyperautomation action (adapted from Ray, 2021)

Regarding resource mobilization, Gartner proposes that companies define their governance model, being centralized, hybrid, or federated, mobilizing people around specific technical and management skills to build communities about technologies for engagement, acknowledgment, and skill up (Ray et al., 2019).

Be Informed: This digital transformation agency also offers a Hyperautomaion solution, an integrated strategy with end-to-end process focus, business logic centricity, and a hybrid human and digital workforce (Figure 18). This solution is named “Robo Orchestrator" and provides management, automation, and orchestration of augmented RPA tasks and AI implementation. It allows processing discovery and assessment, control, customization, integration with other systems, scalability, agile methodologies, and real-time insights to optimize end-to-end processes (Be Informed, n.d.b).

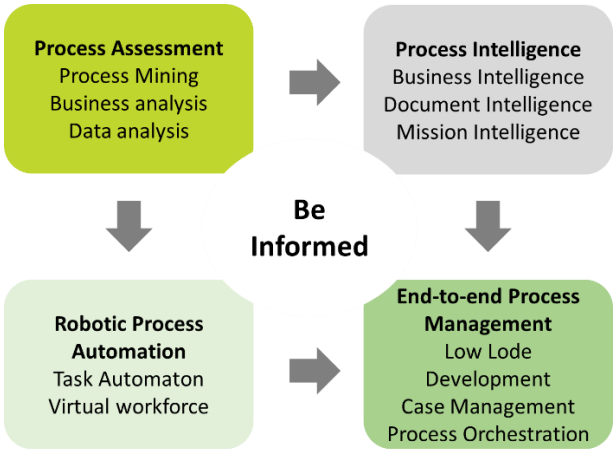

Figure 18: Robo Orchestrator Solution (adapted from Be Informed, n.d.a)

Appian: This company was awarded the 2021 Customer's Choice for Enterprise Low-Code Application Platforms by Gartner Inc. (Appian, 2021). They offer the Low-code Automation Platform to orchestrate people, technologies, and data, accelerating business by building apps and accessing data rapidly and efficiently, and scale (Appian, n.d.).

Ericsson: Presents the Ericsson Intelligent Automation Platform to implement and support Service Management and Orchestration (SMO) for open Radio Access Networks (RAN). This platform aims to bring automation to open RAN using SMO and apps development and allows handling multi-vendors, multi-technology, innovation, and end-to-end experience (Ericsson, 2021b, 2021a).

IBM: This well-known company offers the IBM Cloud Pack for Business Automation as an AI-Powered Automation solution, a single platform for business and IT automation having modular capabilities to deal with complex environments. These main capabilities are business automation, Watson AiOps, integration, and network automation. In addition, as components, this solution has work orchestration, process mining, task mining, RPA, foundation assets, and a single event hub (Jyoti & Szurley, 2021).

Automation Anywhere: Considers Hyperautomation and Intelligent Automation as different services and offers the Automation 360 Platform as a cloud-native end-to-end intelligent automation platform combining RPA and AI technologies to Discover, Digitize, Automate and Optimize processes end-to-end. This solution is focused on entrenched legacy apps, the need for cloud, employee experience, customer experience, security and governance, AI and ML, pre-built bots, and rich partner ecosystems (Automation Anywhere, 2021a, 2021b, 2021c).

AuraQuantic: AuraQuantic Digital Platform delivers an entire orchestration of processes to coordinate users, systems, and information from start to finish using intelligent structures. It can also operate as a platform for integration between systems because it has Simple Object Access Protocols for web services and connectors that the processes themselves can launch. In addition, this platform contains AI mechanisms for automatic decision-making based on produced data (AuraQuantic, n.d., 2021).

Accenture: This consulting company offers myWizard, an integrated automation platform that uses AI and a plug-and-play architecture. This platform aims to accelerate the automation transformation journey, maximize data-driven and business-aligned results, introduce continuous innovation into companies' automation DNA and push agile and resilient automation (ACCENTURE, 2020).

Deloitte: Deloitte defines the Hyperautomation Ecosystem based on RPA, process mining, AI, iBPMS, and advanced analytics and proposes three steps of action: Imagine, Deliver, and Run. It also refers to

Automation with Intelligence as a service that includes strategy, mining and monitoring, cloud and automation, and augmenting workers (Agrawal, 2020; Deloitte, 2021).

CGI: Presents CGI's Intelligent Automation Framework that offers IA strategy and assessment work, IA sprints, IA production and scale, IA change management, and IA managed service (CGI, 2021).

Softtek: This company presents a Framework for Intelligent Digital Automation (FRIDA). FRIDA is described as offering quality and cost savings, productivity and speed, cognitive enablement, strategic optimization, business and IT process automation, and business value (Softeck S.A., 2021).

PEGA: Offers a low-code and cloud-native process automation platform, responding to companies' intelligent automation needs of building fast and scaling. This platform's primary capabilities are low-code application developments, RPA, and BPM (Pegasystems, 2021).

KOFAX: Presents an Intelligent Automation Platform as a low-code, integrated and end-to-end solution to unlock document intelligence, connect diverse systems and orchestrate human and digital workers to intelligent process automation (Kofax, 2021).

Capgemini: This consulting company offers a purpose-built, plug-and-play Intelligent Automation Platform with the promise of effective IT, application services, and intelligent operations delivery. The main goal is to provide the full potential of intelligent automation and ensure maximum value across the entire business (Capgemini, 2021).

DATAMATICS: Also offers an integrated Intelligent Automation Platform capable of task and process automation and dealing with unstructured and semi-structured data in different types of documents. This platform merges the capabilities of Datamatics TruBot RPA and TruCap+IDP with AI, ML, and NLP models. Another characteristic is that developers and business users can use it, and the software can be deployed on-premises or in the cloud (DATAMATICS, 2021).

4. STRATEGIC MODEL AND FRAMEWORK PROPOSAL

Following the DSRM process, we now reach the objective of providing a mental model, a design of the reality constructed using imagination and based on the literature review (Peffers et al., 2007). This construction builds an IPA Strategic Model and a respective Framework to guide organizations on IPA adoption. The model is strategic because it represents the concepts behind a strategy to accelerate DT. The strategy itself relates to IPA adoption, described step by step through the related IPA framework.

These proposed artifacts consider all of the author knowledge collected regarding DT and IPA achieved with the literature review, which was the first objective of this master thesis.

4.1. ASSUMPTIONS

The literature review regarding DT and IPA supports an IPA Strategic Model and Framework construction. The reader should consider the entire literature review to understand these artifacts, but the following assumptions are defined as a reminder of some key points:

- DT is a process undertaken by companies who strategically use new technologies to progressively transform their business model, processes and procedures, products and services, culture, and people in an integrated way, aligning all of these elements to innovate and to create a better value proposition for all stakeholders (C. Verhoef et al., 2019; Hinterhuber & Nilles, 2021; Oswald & Kleinemeier, 2016; Ross et al., 2019; Vial, 2019).
- To succeed, organizations must align their Business and IT Strategy (Andry & Setiawan, 2019), and DT strategy must be aligned with other corporate strategies (Matt et al., 2015).
- DT strategy must consider new technologies that enable business process re-engineering and optimization, organizational structure and culture, leadership, and employee roles and abilities (Baker, 2014; C. Verhoef et al., 2019; Oswald & Kleinemeier, 2016; Ross et al., 2019; Stone, 2019; Vial, 2019), the barriers to change being inertia or resistance (Ross et al., 2019; Vial, 2019), cybersecurity and data privacy (Ustundag & Cevikcan, 2018).
- Operations are one of the nine enterprise business dimensions where DT can be significantly accelerated (IDC, n.d.).
- BPA is part of the BPM discipline (Jovanović et al., 2019), and it aims to improve processes and reduce inefficiencies, collecting data to discover, enhance, and monitor processes (Celonis, n.d.; Geyer-Klingeberg et al., 2018; OSMAN, 2019).

- Process Mining Systems are capable of data integration from other applications like ERP and CRM (Asquith & Horsman, 2019; OSMAN, 2019).
- Using Cloud Computing and APIs, companies can access real-time data (Jovanović et al., 2018; OSMAN, 2019).
- Depending on its applications, APIs can require high programming skills, and developers must understand the applications involved very well (Asquith & Horsman, 2019; Kommera, 2019; Willcocks et al., 2015). RPA is an alternative to APIs in these cases (Geyer-Klingeberg et al., 2018).
- RPA is a software-based solution focused on creating digital workers to do repetitive tasks with structured data input (Huang & Vasarhelyi, 2019; Ng et al., 2021; Siderska, 2020; UiPath, 2021). It can be used to collect and integrate data into Process Mining Systems (Geyer-Klingeberg et al., 2018).
- Process mining enables the understanding business processes' maturity and allows for the identification of RPA opportunities (Geyer-Klingeberg et al., 2018). Process enhancement results will be seen in Process Mining Systems (Celonis, n.d.; Geyer-Klingeberg et al., 2018).
- BI combines several technologies, methods, and tools that enable interactive access to data, sometimes in real-time, and its manipulation (Sharda et al., 2018).
- Big Data analysis facilitates the transformation of data into information, allowing for better decisions and actions, made either by business managers and analysts (Sharda et al., 2018) or, using AI, by software-based automation (Uhl & Gollenia, 2016).
- AI is the development of software that automates knowledge work to imitate human behaviors and capabilities, but alone it is not capable of cognitive tasks execution (Bornet et al., 2021). It needs RPA and Big Data to achieve this (Microsoft Docs, 2021b).
- A chatbot is a software application developed to help organizations in customer service. It can imitate written and verbal human speech in order to answer customers' questions or needs (Ulas, 2019). In combination with AI, it can be used to analyze customer preferences based on the content of their text conversations with the chatbot (Huang & Vasarhelyi, 2019; Ng et al., 2021).
- IPA uses RPA, Big Data, and AI models to provide prescriptive analytics and cognitive decision-making based on structured or unstructured data, such as images, text, videos, and voice. These technologies together can imitate human decisions and act upon (Huang & Vasarhelyi, 2019; Microsoft Docs, 2021b; Ng et al., 2021).

- Before adopting IPA, companies must consider a roadmap strategy, technology readiness, human resource capabilities, change management, have an IPA solutions portfolio, and consider MVP developments (Ng et al., 2021).

4.2. IPA STRATEGIC MODEL

The second objective of this master thesis is to propose an IPA Strategic Model and Framework that helps organizations accelerate their Digital Transformation. This strategic model is designed to conceptualize IPA adoption in organizations, accelerate DT, and explain its strategy.

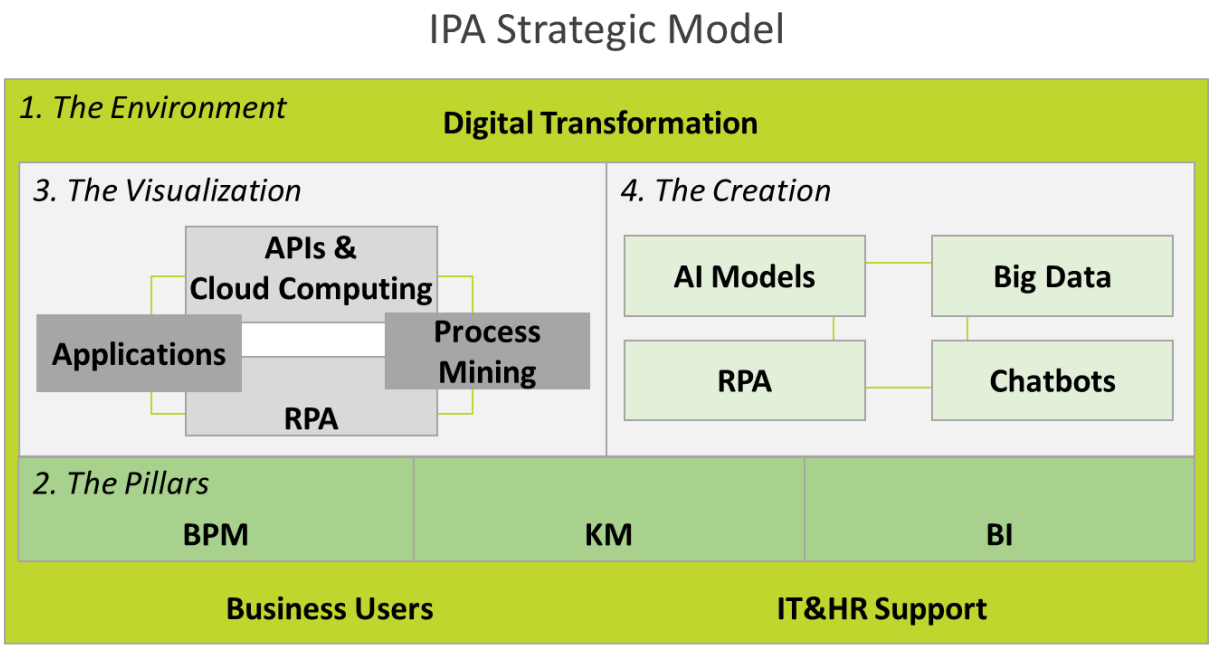

Figure 19: IPA Strategic Model (created by the author)

To better understand the IPA Strategic Model concepts, these can be separated into four strategic groups: (1) the Environment, (2) the Pillars, (3) the Visualization, and (4) the Creation.

1. The Environment

IPA is only possible in an environment where Business and IT work together to achieve DT. For example, if a DT strategy is on course, then business users can use this Strategic Model with IT support to accelerate it.

Digital Transformation: Organizations are already at a particular digital maturity level, and their DT strategy is aligned with their Business and IT strategies. IPA adoption must take place in an

environment where the change is managed, employees' needs and worries are considered, customers do not notice a loss of quality regarding process changes, and concerns regarding cybersecurity, data privacy, and ethical and moral issues are handled.

Business users and IT&HR support: IPA is developed by and for business users, but IT support is needed to integrate organizations' IT infrastructures. HR needs to contribute to DT's management and upgrading of employees' skills, promoting a digital, open, and forward-looking mindset and culture. IT and HR business areas can work together to create IT communities relating to AI technologies, Agile methodologies, and automation capabilities, among others, which can support employees and ensure a suitable environment for IPA adoption.

2. The Pillars

This IPA Strategic Model is sustained by three pillars which allow all other elements to function and support organizational change during IPA adoption and DT acceleration.

BPM: Organizational processes must be documented and managed with consideration of continuous control and enhancement. BPM and BPA methods and techniques help organizations to remain operational while improvements are being implemented, and to ensure high quality and digital maturity.

KM: Procedures, commercial offers, and all of the knowledge that employees need to execute operations must be readily available to ensure the quality of products, services, and customer service. IPA can be developed based on this knowledge, reducing costs and increasing efficiency and employees' satisfaction, allowing them to focus on more creative, social, and strategic work. Knowledge Management (KM) systems also enable employees to be updated regarding process changes each time intelligent automation is implemented, making digital and human work collaboration easy.

BI: To introduce AI in an organization, BI methods, techniques, and specialists are required. Companies can refer to external consultation at the beginning of IPA adoption, but it is essential to have internal employees with the skills needed to ensure the continuity and scalability of IPA implementations. Data analysts can use BI systems to transform data into the information needed to make decisions based on descriptive, prescriptive, and predictive analysis.

3. The Visualization

The following four elements combine to identify IPA opportunities and visualize IPA implementation benefits inside the organization:

Applications: Organization's value chain is supported by different applications, like ERP and CRM, that collect the data required to discover, enhance, and monitor processes. There are also other applications whose primary goal is to monitor business indicators or KPIs, which give businesses and analysts the information to make decisions and allow for the identification of IPA opportunities and the Visualization of IPA implementation results.

Process Mining: This technique is used by systems like Celonis to discover, enhance, and monitor processes by integrating value chain applications and collecting their data to digitalize processes. These systems enable a better BPM and allow process owners and business analysts to identify IPA opportunities, visualize the results and benefits from its implementation.

APIs and Cloud Computing: To achieve real-time data integration, companies can use APIs and cloud computing to integrate applications with process mining systems and have process discovery, visualization, analysis, and monitoring in real-time. Some integrations between applications and process mining do not need this kind of technology because the applications already have this capability. Some applications are not integrated with process mining systems because they are not used to monitor processes, but rather to monitor other relevant key business factors and KPIs.

RPA: When APIs are not available, and integration of the legacy system is needed, RPA can be used as an alternative to data extraction and uploading, thus facilitating this integration.

4. The Creation

RPA, chatbots, big data, and AI models are the four elements that make Intelligent Process Automation creation possible.

RPA: An intelligent automation is just capable of cognitive tasks execution using RPA software. RPA is the base of IPA. The use of AI models achieves cognitive tasks that mimic human analysis and decision-making and act, considering this learned knowledge. Depending on the problem to solve or need to satisfy, organizations will configure the AI models that answer those questions and use RPA to perform the required intelligent tasks. It can substitute human knowledge work or enhance operations by adding new activities.

Chatbots: Chatbots are RPA software used for interactions with humans. They can have more or less intelligence, but if they use AI to analyze text or voice through NLP or voice recognition, they will understand people's needs and give answers based on that analysis. Chatbots can support employees' activities or enable good customer service while collecting preferences and purchase patterns.

Big Data: Data availability is fundamental for AI models' quality and performance. The more data that is accessible, better results will be achieved. At the beginning of IPA adoption, organizations will need data engineers to analyze their data to understand whether it is suitable for AI model configuration or if other arrangements are first required. BI methods and techniques are helpful in this analysis.

AI Models: Depending on the organization's needs, data scientists apply their expertise to statistics and machine learning models to make predictions and answer those questions. They build, configure, and test AI models. These will be integrated with RPA or chatbots to solve problems and enhance processes. These models need data availability to be accurate and improved over time. At the beginning of IPA adoption, organizations will need time to build these models, but they must be scalable to future business cases, decreasing the implementation effort over time.

4.3. IPA FRAMEWORK

An IPA Framework is proposed to complement the Strategic Model for organizations, setting out a plan for moving from concept to action. This framework is constructed as a process to guide organizations in IPA adoption.

4.3.1. INITIAL REQUIREMENTS

Before starting IPA adoption, companies must evaluate whether they are ready or not. Therefore, this Strategic Model and its Framework are valid only for organizations already undergoing DT, using process mining and BI systems, and familiar with RPA. These are the primary initial requirements for organizations taking the first step into IPA adoption.

Going through Digital Transformation:

To use this strategic model, companies must be aware of the DT concepts, drivers, challenges, and impacts presented in this thesis, and be at a certain level of digital maturity.

Using the Four Levels of Digital Mastery by Westerman et al. (2014), companies should be in Fashionists, Conservatives, or Digital Masters quadrants. Using companies' self-assessment by Rogers (2016) and considering Hinings et al.'s (2018) study, they may have a score of at least 4 in topics relating to social media marketing, open innovation, data management, and the ability to develop new business ideas and disseminate them across the organization.

This Framework is valuable only for companies already undergoing DT who require guidance to take the next step towards IA, which means having their Business, IT, and DT strategies already defined and, from now on, applying them in a holistic approach.

Using Process Mining and Business Intelligence Systems:

BPM implementation is essential to use this Framework. Organizations must document their processes and procedures in process and knowledge management systems. In addition, they must have already completed the first steps of BPA and analytics, having at least one or two processes in process mining systems, and using BI to analyze data and produce relevant information. Using these systems will make it easier and more efficient to manage the company's changes, identify IPA opportunities, and visualize and monitor results from IPA implementations.

Familiar with Robotic Process Automation:

Regarding IPA concepts, it is impossible to have IPA without having RPA, so companies must also be comfortable with RPA development, orchestration, and management, having some automation already in production, helping them to transform and improve their processes. They will now need AI to help them solve problems and increase efficiency in areas where RPA is not capable. Only at this stage can AI features be introduced and integrated with automation to answer stakeholders' needs, creating value for the company. Once it is scalable, IPA will enable new business models, accelerating companies' DT.

4.3.2. IPA ADOPTION PROCESS

Considering the Strategic Model and the Initial Requirements, an organization can initiate IPA adoption in six steps: (1) IPA needs Identification, (2) Prioritization and Planning, (3) Data Analysis and AI models Configuration, (4) Testing and Learning, (5) Intelligent Automation Development, (6) Deployment and Benefits Tracking. Communication is the foundation of all these activities, as it involves different areas of the organization and requires strong collaboration between them.

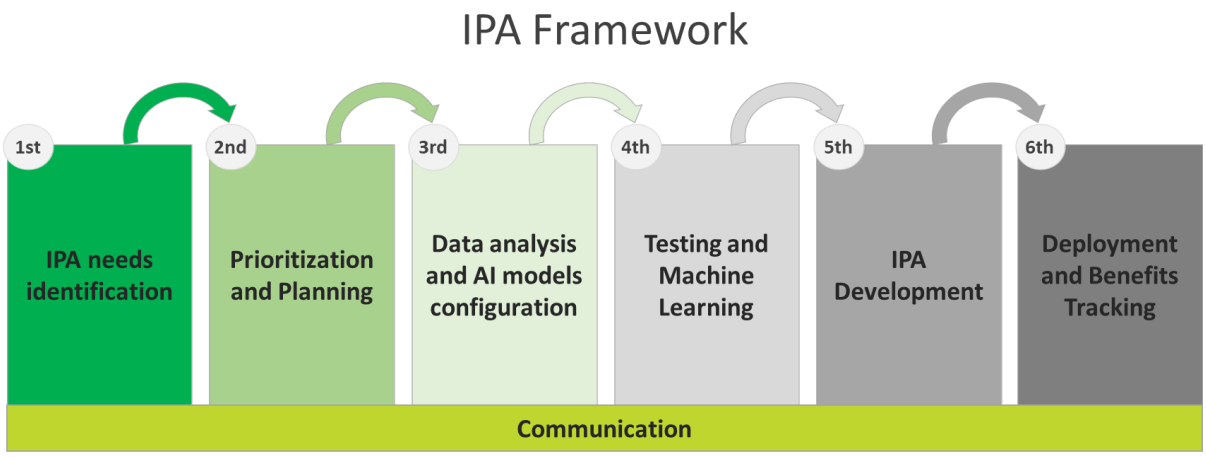

Figure 20: IPA Framework (created by the author)

1st - IPA needs Identification: Process mining and BI systems allow process owners and business analysts to identify IPA opportunities. In this first step of IPA adoption, building a detailed business case and identifying the related data used in IA model's configuration is crucial. These needs can emerge from a process enhancement or to answer a specific business problem or question.

2nd - Prioritization and Planning: Once several needs are identified, organizations must prioritize them taking into account data availability, likelihood of failure, level of scalability, and predicted benefits. Having an IPA business case portfolio helps organizations better understand their IPA needs and predict the scalability of future developments, enabling better comparison, prioritization, and planning. Companies must start with a pilot, an MVP of IPA implementation that enables rapid learning and experience gaining. Then, a roadmap should be established considering the opportunities portfolio and the main related activities, resources, and capabilities needed.

3rd - Data analysis and AI models configuration: BI specialists need to perform data analysis after choosing the better business case to start IPA implementation. Different AI models can be compared to identify the most suitable, considering the business case and AI features needed. Then this model

is configurated to perform the expected cognitive decision-making activities. Data scientists will need business managers' knowledge to support IA models configuration aligned with business context.

4th - Testing and Machine Learning: AI models must be tested, trained, and retrained, using data and human decisions as sources of knowledge for machine learning. These tests and machine learning are repeated until the responsible data scientist considers that the model has a reasonable confidence interval. IA models must be maintained and should be reviewed over time.

5th - IPA Development: Depending on the IPA complexity, RPA, chatbots, or other software-based automation can be developed during the third, fourth and subsequent steps. Nevertheless, the fifth step combines the knowledge automation with the action automation to develop the IPA capable of performing the cognitive tasks needed to solve the business case. Besides this integration, the fifth step includes all phases relating to software-based automation development that organizations are familiar with, like testing and documentation.

6th - Deployment and Benefits Tracking: If the goal of the IPA is to introduce activities that humans do not complete due to high costs and effort, its deployment is easy because it does not interfere with actual processes, while still resulting in their enhancement or future improvement. If the goal of the AI is to substitute human action, its use should be tested first in the production environment as a pilot, without changing the course of actual processes. Depending on the business case complexity and the availability of a DTO, these tests can occur in the digital twin without any risk for business operations and customer service. Once the process owner and business analysts are satisfied, the developed IPA can substitute actual human activities. Benefit tracking can be done through process mining or BI systems, and will enable decisions regarding IPA adoption, development, and scalability.

Communication platforms must be used to facilitate and enable proper and close communication. To ensure collaboration between all functional areas involved in IPA development, it is also imperative to prepare BPM documentation and KM contents to communicate IPA developments, their business cases, process changes or new activities created, and benefits achieved. Furthermore, considering that organizations are working in an agile environment, all documentation should be digital and restricted to what is essential to the organization’s sustainability.

5. USE CASE

Following Peffers et al.'s (2007) DSR Process and to achieve the third objective of this thesis, a use case of a multinational utility company that operates in the global energy market will demonstrate the contribution of IPA adoption to a company's DT acceleration.

Due to time limitations, it was impossible to implement the Strategic Model and Framework. However, assuming that, the use case company would implement those artifacts, it is possible to describe an example of IPA creation and answer the research question of this master thesis, "How can companies accelerate their Digital Transformation through Intelligent Process Automation?", evaluating its DT maturity before and after IPA adoption.

Using the DT self-assessment questionnaire proposed by Rogers (2016), the company's DT maturity level, before and after IPA adoption, will be compared.

5.1. BRIEF DESCRIPTION OF THE COMPANY

The company behind this use case has over 40 years of history and is present in 28 markets, in three continents throughout the electricity value chain, and in the gas commercialization activity, providing energy to more than 9 million customers. Having more than 12,000 employees, this company produces 75% of the energy from renewable resources and is the fourth-largest wind energy production company globally (EDP, 2018a).

Its strategic vision is "leading the energy transition to create superior value", and its main commitments are as follows:

- Accelerated and sustainable growth, distinctive and resilient portfolio, and solid balance sheet.
- A future-proof organization achieved by being global, agile, and efficient, maintaining and attracting talented and empowered people, and being innovative and digitally driven.
- Environmental, social, and governance excellence.
- Green leadership positions and attractive returns with strong visibility (EDP, 2021).

The company's DT is on course and involves the whole company, changing how they operate in the energy sector and interact with employees, customers, and communities (EDP, 2018c).

This company has taken the first steps into IPA developments through Innovation Projects implementation, without a specific strategy in the past few years. By leveraging cloud tools and new

digital technologies, IoT, Machine Learning, and AI techniques are used to develop projects that promote innovation across the entire value chain and the exploration of the potential of data to achieve energy efficiency and new value services for the energy customer (EDP, 2018b).

5.2. IPA CREATION EXAMPLE

An IPA opportunity was found in one of the use case's subsidiaries to reduce the human work hours executing the activities of analyzing client emails, considering their data and motive for reversion, revert the client on the system if applicable, and responding to them regarding the reversion.

As shown in Figure 21, the activities in the manual process completed by humans are substituted by IPA which uses NPL AI models to analyze client emails and RPA to register client reversion on CRM, if applicable, and respond to the client to inform them about the reversion.

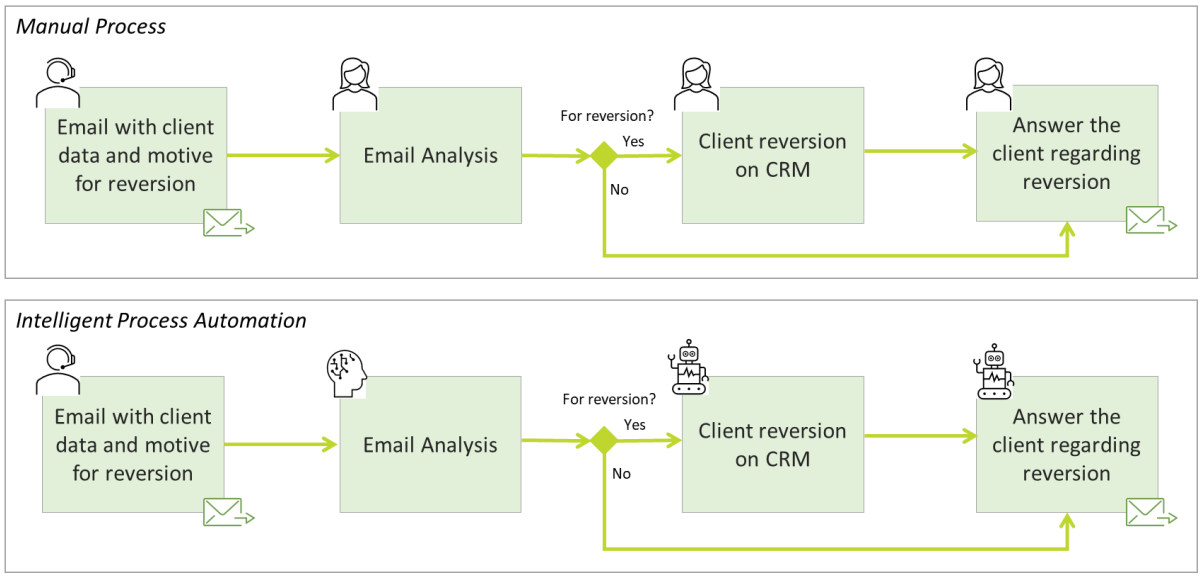

Figure 21: IPA creation example (adapted from use case company inside information)

5.3. COMPANY DT MATURITY BEFORE IPA ADOPTION

The company's DT maturity level was evaluated, before a hypothetical IPA Strategic Model and Framework implementation, considering the information published on their website and using Rogers' (2016) self-assessment questionnaire. From a possible 15 to 154 points, the company scored 100, and it was possible to identify some potential aspects of improvement through DT.

As seen in Annex 1, regarding Strategic Thinking, from a possible 15 to 105 points, the company scored 69, with the main factors to focus on being:

- Create value through platforms and external networks.
- A data strategy focused on how to turn data into new value.
- Manage data as a strategic asset to build over time.
- Organize data to be accessible by all divisions of the company.
- Acceptance of failure in new ventures but look to reduce cost and increase learning.
- The value proposition is defined by changing customer needs.
- Assess new technologies, considering how they could create new value for customers.

Regarding Organization Agility, from a possible 7 to 49 points, the company scored 31. The issues to improve were:

- IT investments being seen as strategic.
- Business metrics adapted to suit changes in strategy and the maturity of a line of business.
- Managers are accountable and rewarded for long-term objectives and new strategies.

5.4. COMPANY DT MATURITY AFTER IPA ADOPTION

Considering the hypothetical scenario that the company applies the proposed IPA Strategic Model and Framework in their client servicing operations, the Rogers' (2016) self-assessment questionnaire was applied again to evaluate its DT maturity level after IPA strategy implementation. As a result, it was possible to identify improvements in several handled aspects, raising their DT maturity level.

In this second evaluation, from a possible 15 to 154 points, the company scored 125, 25 points higher than before, demonstrating that the IPA Strategic Model and Framework application had accelerated the company's DT.

As seen in Annex 2, regarding Strategic Thinking, from a possible 15 to 105 points, the company scored 87. The main aspects improved through IPA adoption were:

- Focus on customers' changing digital habits and path to purchase.
- Create value through platforms and external networks.
- The view of competition as broader than current industry.
- A data strategy focused on how to turn data into new value.
- Manage data as a strategic asset to build over time.
- Organize data to be accessible by all divisions of the company.
- Making decisions through experiments and testing wherever possible.
- Innovate in rapid cycles, using prototypes and learning quickly.

- Acceptance of failure in new ventures but look to reduce cost and increase learning.
- The value proposition is defined by changing customer needs.
- Assess new technologies, considering how they could create new value for customers.

Regarding Organization Agility, from a possible 7 to 49 points, the company scored 38, and the main attributes improved through IPA adoption were:

- IT investments being seen as strategic.
- Business metrics adapted to suit changes in strategy and the maturity of a line of business.
- Managers are accountable and rewarded for long-term objectives and new strategies.
- Ability to seed and develop new ideas that are unusual for the business.
- Being skilled at taking successful new ideas and integrating them across the organization.
- The priority is to create value for customers.

This assessment is considered to have been done immediately after the IPA Strategic Model and Framework implementation. Some years later, the results would be even better once the company has gained experience and scaled IPA developments.

6. EVALUATION

An expert analysis was conducted to evaluate the IPA Strategic Model and Framework proposed, following Peffers et al. (2007) DSR Process to achieve the third objective of this thesis. Considering the sixth Hevner et al. (2004) guideline, those artifacts were presented to three IA experts who answered four quality evaluation questions. The methodology applied to these evaluation sessions was individual interviews. Each expert was interviewed individually and asked to accept the recording of the session to enable its transcription.

6.1. INTERVIEWS DESCRIPTION

The interviews were accomplished between 27th January and 4th February, and the experts interviewed were:

- Pedro Maia Malta (PMM): NOVA IMS Professor who studies and lectures DT and IA subjects;
- Jorge Costa Reis (JCR): IT Executive Advisor at IDC Portugal and Partner&CEO at Zertive; and
- Ricardo Hugo Henriques (RHH): Business Transformation and IPA Leader at EDP Comercial.

Each interview was followed by the artifacts' presentation (Annex 3) and included four questions:

- Question 1 (Q1): Do you consider the proposed Model and Framework useful? Please justify.
- Question 2 (Q2): Do you have any criticism towards the proposed Model and Framework? Please explain.
- Question 3 (Q3): Can the proposed Model and Framework accelerate the company's DT? Please justify.
- Question 4 (Q4): Do you have any recommendations or suggestions for further improvements to the proposed Model and Framework?

All interviewees agreed to being recorded to enable the interview transcription. The three individual interviews were therefore transcribed (Annex 4) for further discussion and artifacts improvement.

6.2. DISCUSSION

The interviews executed to evaluate the IPA Strategic Model and respective Framework proposed in this thesis enable a discussion regarding these artifacts' utility, quality, and contribution to companies' DT acceleration.

Q1: Do you consider the proposed Model and Framework useful? Please justify.

All interviewees agreed that the proposed IPA Strategic Model and Framework are applicable considering some modifications.

PMM emphasizes that this model identifies a set of concepts and areas that support the framework's construction. “I start by thinking about a strategic model to build implementation steps, as results from the strategic model.” The pre-requirements are essential, mainly regarding the DT process and RPA implementation, although the model needs clarification regarding the need for RPA in visualization and creation parts.

JCR reinforces that organizations are at different maturity stages and do not know where to start regarding IPA, so this model and framework may take some adjustments but are “a handy tool for organizations” as “an established practice on the market” does not yet exist. “Is beneficial that these types of frameworks appear to show results and tend to move to a generalized good practice”.

RHH also justifies his answer with the problem statement regarding the availability of “impartial frameworks”. “There are only models or frameworks related to consulting companies, it is good to exist these frameworks detached from any interest, and the academic world helps a lot.”

Q2: Do you have any criticism towards the proposed Model and Framework? Please explain.

Regarding the **Strategic Model**, JCR founds the “ideas very well structured and tidy”. “The model is highly comprehensive and gives a holistic view of what IPA is”, and “there is an excellent job here”. However, he thinks that the perspective focused only on the human task may eventually reduce the potential of IPA further down because, according to IDC, there are three layers of IPA: Systems Integration, with more intelligence and more automation; Workflows Platforms Automations, where there is more space to give intelligence; and Human Tasks Automation, where RPA and chatbots play a significant role. JCR says that AI, ML, Data, BI, and all the technologies aiming to generate intelligence in process automation are parallel to the various layers, and this IDC vision seems interesting to be incorporated into the model.

Related to this criticism, RHH also mentions that if the need is just human mimetic behavior in the Creation, there is no need for IA because not all operations need intelligence. There is automation that mimics only human behavior, the end-work automation, and intelligent automation, and this duality should be clarified in this model.

The model can be improved to show some concepts' correlation clearly. However, when describing the Visualization part, it is mentioned that applications, process mining, APIs, cloud computing, and RPA refer to the first layer of systems integration, and process mining represents the second layer of workflow platforms automation. This model intends to fulfill the lack of academic research that, as stated in chapters 1.1. and 1.2., is related to how companies can integrate all these technologies in a unique IPA model, considering that it entails automating human tasks, as outlined in chapter 3.2.1. and described in the Creation part.

RHH has some additional notes regarding the Environment. First, since companies only do DT because they intend to transform the business somewhere in the model, DT and Business Transformation (BT) should be related because it is impossible for DT to exist without BT, and there is a direct relationship here. This relationship is described in chapter 3.1.1. Although it is not designed into this model, it could be considered as an improvement for future work.

Another note is regarding HR, where RHH would mention the future of work because the Framework resulting from the Strategic Model will interfere with how people will work after IPA implementation. This awareness is mentioned when describing the element of DT because, as seen in the literature review, a DT strategy involves change management, through which employees' needs and worries are considered.

Additionally, regarding Environment, RHH notes that the business users are not the developers or maintainers of the automation in all cases. It is true in some more decentralized models, but there are also cases where companies opt for centralized models where only RPA developers do this work and are not precisely business users, and in these cases, business users consume automation as they consume IT. Therefore, this will be considered to improve the model.

The last RHH note is regarding Visualization. He thinks it should be more evident whether applications are essentially about the core IT or operational systems because, sometimes, they can be confused with other things.

Regarding the **Framework**, PMM finds the communication task appealing but too transversal. He thinks this task should be split between Communication 1 and Communication 2. The Communication 1 one only regarded the needs because identifying the suitable needs is essential for the following phases. If there is no context, it does not go further. PMM suggests that in the first step, companies could have a pre-team that knows the client language well, only for the purposes of needs identification and specification. Then, a Communication 2, to supports the senior IT, SI, and business team work on the company’s needs across all other phases of the framework. So, when explaining the

task communication, these two phases of communication must be referred to, highlighting the focus on the communication of the needs in the first step.

RHH adds that communication should be complemented with change management, “Eventually, another layer, in parallel with communication”, since it is very relevant from the beginning to ensure the success of these six steps presented. As this model requires a DT Strategy in implementation, this vast Environment already ensures change management.

JCR fully endorses this framework because “it is very well structured, the several steps”, and this is one of the things that he is asked often: “how to identify opportunities for automation”, “how to evaluate” and “implement them”, “and process mining and task mining play a key role here”. However, he gives a note related to the prioritization step because there is an aspect that he thinks is fundamental that was not mentioned in the interview presentation: the value of IPA implementation for the business. He says that companies can have data and low risk, so it can be effortless to implement, and therefore it will be automated, but if it does not bring value to the organization, it is not worth investing in this automation. Therefore, he suggests including the Business Case analysis at the prioritization step because technological decisions are increasingly based on value for the business. Moreover, PMM also mentioned the importance of value demonstration in Q3.

The importance of an IPA Business Case, which entails prediction of benefits, although not mentioned, is part of the framework step one description, and the importance of IPA value analysis is described in step two by the expression “predicted benefits”, which comes from Business Cases organized in an IPA portfolio. However, considering JCR’s opinion, the expression “value of IPA implementation for the business” can be added to the prioritization step description to clarify the importance of this analysis, besides the data availability, the likelihood of failure, and the level of scalability.

Q3: Can the proposed Model and Framework accelerate the company’s DT? Please justify.

All interviewees agreed that the proposed Model and Framework contribute to companies’ DT acceleration, although PMM and HRR gave some warnings.

PMM thinks “for sure” that “any company has access to a best practice, they implement faster” because they do not need to think about it and “do not waste time conceptualizing”. He has no doubts about this, but notes that it depends on the organization's mindset, business culture, and people being open, essentially senior management. He highlights that it is essential to demonstrate to those in management that this IPA implementation is worth it through simulations or a predictive model, and this will be considered for future work.

JCR thinks the relationship between IPA and DT is evident because a company's DT is based on transforming their operations and processes, and one way to make this transformation is through IPA. Furthermore, he considers that a company's transformation naturally involves changing processes, working in different ways, and this is where automation comes in, doing the same processes in a more automated, faster, and above all, more intelligent way. Thus, he would say that it is difficult to have DT without having IPA.

HRR thinks that the framework is an excellent reference for acceleration but alone cannot accelerate progress, although it provides stimulation. He thinks it acts as an enhancer of that acceleration, but he submits that stating concretely that it accelerates may be excessive because, for example, this framework requires process mining, which not all companies have already invested in. Therefore, he says, "although it is a good recommendation, and even decisive", there will be no such acceleration if companies do not use process mining. This opinion reinforces the need for the "existing tools" requirement, as PMM calls it, in order to apply this framework.

Q4: Do you have any recommendations or suggestions for further improvements to the proposed Model and Framework?

Regarding the **Strategic Model**, PMM mentioned that some issues could be correlated. The first is that the business culture is one of the subjects that must be part of this mindset. The second correlation is regarding BPM and KM. Therefore, any studies that sustain this correlation scientifically are a good contribution. These suggestions will be considered for future work.

When JCR made the two comments in Q2 he offered suggestions but added that if this model is focused more on that upper layer of automation, this must be assumed. Responding to Q2 criticism, he suggests clarifying that automation is more extensive than described in the presented model, although this model is focused on this layer for specific reasons, a clarification is made in chapter 3.2.1. This opinion can also be considered a time limitation of this research, considering that this model would be more extensive and would specify the implementation of all three layers if there was sufficient time.

RHH thinks that when companies do process mining and task mining to a process, they will see the digital twin of the process, and that part could be included here as an improvement. The DTO is mentioned when describing step six of the framework, which recommends using this digital twin to test the IPA developed in a production environment. When the IPA is regarding one specific process, the digital twin of the process can be visualized through workflow platforms that use the process and task mining techniques.

Regarding the **Framework**, PMM notes that it was interesting to better understand which tools companies should use. However, it would be clearer if the requirements were: organizational model or business culture, as requirement one; existing tools for requirement two; and human skills for requirement three. These would be the three considerations that the company will take in this framework support.

A suggestion from PMM for future work is to validate this framework using a use case demonstration to ask the opinion of some ML experts regarding how this model and framework can work. Then, having the need and knowing that it will go through these six steps, the question would be whether the company can reach the desired result.

Regarding the business case issue mentioned in Q2, JCR added that this is a good area for future academic research. There is little material at this level, but it is a vast area of research, so the suggestion is to propose the subject of Automation's Business Case for a Ph.D., for instance.

RHH recommends the orchestration of human and digital work: “More mature companies will need to orchestrate human work, and the work of robots, in a given time”. For further investigation, then, it would be interesting to understand how this orchestration would be included in this model and framework. According to RHH, “usually this orchestration results from the combination with BPM; where are the workflows and where can we have robots giving work to humans and humans giving work to robots?”.

Overall, all interviewees commended the investigation and resultant proposal. The presented IPA Strategic Model and Framework was considered relevant. According to the interviewees, this investigation can materialize ideas through research and is essential to improve this academy and industry area of research, which reflects an excellent job.

6.3. REVISED MODEL AND FRAMEWORK

The expert interviews allowed for the validation and revision of the proposed IPA Strategic Model and Initial Requirements for IPA Framework application.

Firstly, regarding the Environment, the IPA developers were added together with the business users, responding to criticism that the business users are not the developers or maintainers of the automation in all cases. There are cases where companies opt for centralized models whereby only IPA developers complete this work and are not business users. In these cases, business users consume IPA developments as they consume IT.

The second and third amendments added were related to the Visualization. One amendment was changing the word 'Applications' to 'Business Applications', responding to the criticism that "it should be more evident whether 'Applications' are essentially about the core IT or operational systems, because sometimes they can be confused with other things". The other amendment aims to respond to criticisms regarding unclear considerations of Process Mining, Task Mining, and Workflow Platforms. In order to clarify that the proposed model considers all these concepts, the expression 'Process Mining' was substituted with 'Workflow Platforms', that use Process and Task Mining techniques, and 'IA', to create the digital twin of the process and allow its visualization, and to represent the second layer of IPA, not evident in this model because it is not its purpose.

Finally, the fourth and fifth added revisions were related to the use of IA in systems integration and the difference between the Visualization's RPA element and the Creation's RPA element. As previously stated, this model does not aim to focus on IPA layers (mainly systems integration, where IA can help by making this integration more intelligent and automated) but rather intends to consider this integration between different business applications and between applications and workflow platforms (process mining systems). Therefore, to clarify, the AI technology 'Cloud Computing' was substituted by AI, and the reference 'systems integration' was added into the elements of APIs & AI. Furthermore, to clarify the difference between RPA in the Visualization, where RPA is used for data integration between business applications and workflows platforms, and RPA in the Creation, where it is used to conceptualize that IPA creation needs RPA development, the reference "data integration" was added to the Visualization RPA element, and "conceptualization" was added to the Creation RPA element.

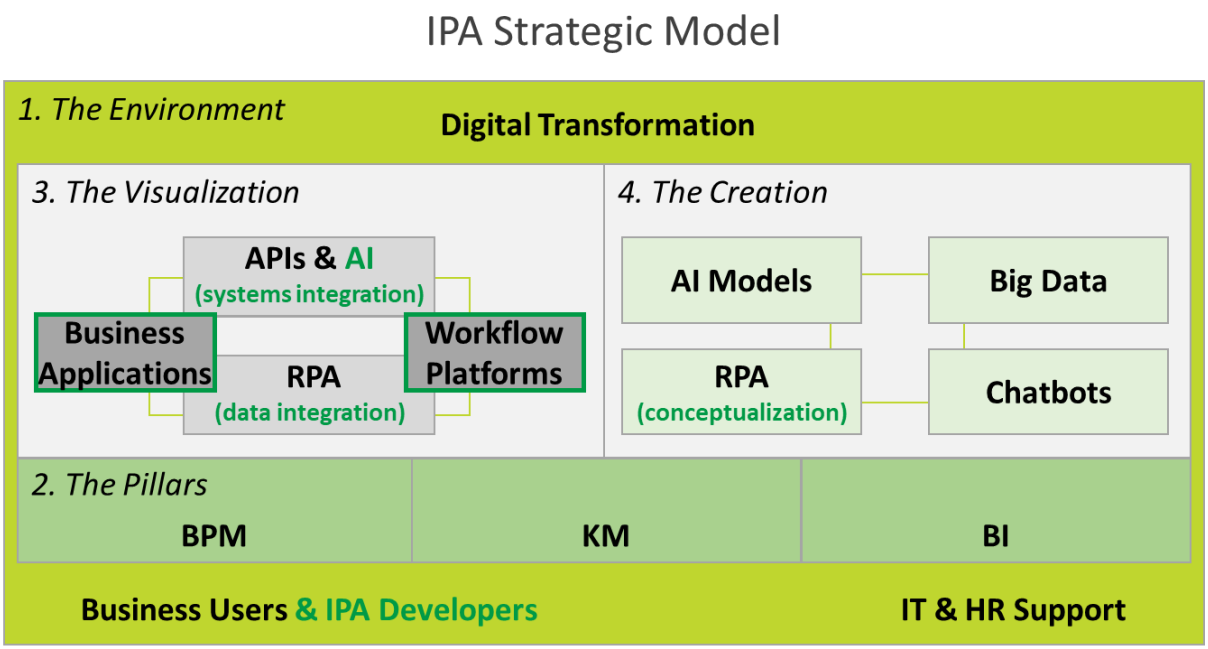

Figure 22: Revised IPA Strategic Model (created by the author)

Regarding the IPA Framework, the designed artifact does not change, but the interviewees' suggestions must be considered in the description of the Initial Requirements, the Prioritization step, and the Communication task.

The name of the three requirements was changed. 'Going through Digital Transformation' was replaced with 'Organizational Model' to emphasize that companies must not only be going through DT but must also have a digital business culture and senior management awareness of DT's value for the business. 'Using Process Mining and Business Intelligence Systems' is replaced with 'Existing Tools', and its description is not as focused on the Process Mining and BI Systems, being more flexible to other tools that the company may have that achieve the same objectives. Finally, 'Familiar with Robotic Process Automation' is replaced with 'Human Skills', considering that this requirement is related not only to RPA expertise but with other human skills regarding IPA development, which companies must possess in order to ensure the success of the IPA's implementation.

In first step of the Framework, 'IPA needs Identification' description, the clarification is added that the Business Case must include IPA implementation value analysis that predicts the benefits for the business. Moreover, in the second step, 'Prioritization and Planning', after the expression "predicted benefits", it is added that the analysis of IPA's implementation value is fundamental in this step because technological decisions are increasingly related to value for the business.

In the Framework Communication task, the importance of having two phases of communication is added: a first communication phase, related to the first step, 'IPA needs Identification', where companies can have a pre-team that knows the client language well and which is only for needs identification and specification; then, a second communication phase across all other IPA implementation steps, where Business Users, IPA developers, IT, and SI will work on the business needs.

7. CONCLUSIONS

7.1. SYNTHESIS OF THE DEVELOPED WORK

The new digital economy warns organizations about the importance of DT to remain relevant in their market, and the emergence of new technologies applied to business operations brings the IPA concept to organizations as one factor to accelerate their DT.

However, the literature and scientific research on IPA implementation is not extensive, and there was no general comprehension regarding what technologies companies should focus on and how they could integrate all these technologies in a unique IPA model that could accelerate their DT and bring value to the organization (Siderska, 2020).

An investigation was conducted to fill this academic research gap and help companies with this task. Considering operations as one of the nine enterprise business dimensions where DT can be significantly accelerated (IDC, n.d.), a scientific lens was employed to explore what AI technologies companies should use and incorporate to digitalize their processes, gain efficiency, and accelerate their DT.

Using Järvinen's taxonomy (2000) and the Gericke & Winter (2008) Analysis Framework for ISDSR, this study's research approach was classified as an approach to studying reality, stressing the utility of artifacts and focusing on building. Furthermore, this research used a DSR methodology to study the identified problem, seeking the knowledge to understand DT and IPA, and then answering it by creating an IPA Strategic Model and Framework for IPA implementation that could resolve it. Overall, its focus was on combining new technologies to automate intelligent human tasks in processes, considering this factor to be the academic research gap in conceptualizing IPA implementation strategy in organizations.

Applying DSR, an IPA Strategic Model and Framework were constructed, based on scientific research and theory, and then evaluated and improved. Moreover, for the production and presentation of this DSR, the Hevner et al. (2004) Seven Guidelines was considered for methodology, and the Peffers, Tuunanen, Rothenberger, and Chatterjeew's (2007) DSR Process as a framework to follow.

This investigation started with identifying the research problem identified and explaining the value of the IPA Strategic Model and Framework proposed, describing the motivation behind it. Then, the research question "How can companies accelerate their Digital Transformation through Intelligent Process Automation?" was defined, and three objectives were established to answer this question.

The first objective was accomplished through a scientific literature review regarding DT and IPA. The second objective was achieved by designing a proposal of an IPA Strategic Model and Framework that could help organizations accelerate their DT, sustained by the literature review. Moreover, to attain the final objective, which facilitates a more concrete answer to the research question, a use case was applied to demonstrate IPA adoption contribution to companies' DT acceleration. An expert analysis was conducted to evaluate the proposed IPA Strategic Model and Framework.

7.2. LIMITATIONS

The limitations of the proposed solution are mainly due to time and scope, since this research was conducted to complete a master thesis and was driven by its deadline.

One limitation was the impossibility of thoroughly implementing the proposed solutions within organizations, giving more robustness and scientific proof of its value. A consequential limitation from this was that the Rogers' DT self-assessment questionnaire, used to evaluate the company's DT maturity level before and after IPA, was only possible to perform assuming the hypothetical scenario that the use case company had implemented the proposed artifacts. Thus, its conclusions should be discussed bearing in mind its subjectivity.

Considering that there are three layers of IPA, Systems Integration, Workflows Platforms Automations, and Human Tasks Automation, another limitation of the proposed solution is its focus on the third layer. This focus is justified by the fact that this third layer was considered to be the academic research gap in achieving IPA implementation, reinforcing the motivation to research this area. However, it may reflect the reduced importance of IPA's first and second implementation layers. Furthermore, AI and Big Data are parallel to the various layers, implicit but not specified. Therefore, if there was more time and the scope was larger than that of a master thesis, the proposed solution would be more extensive and would specify each layer with more detail, particularly explaining more how AI and Big Data are used across the three layers to make IPA implementation in organizations possible.

One final limitation is regarding the initial requirements; only by applying this solution is it possible to understand whether there are organizations capable of IPA implementation without the initial requirements. These requirements are proposed to a successful IPA implementation, which does not mean that it is impossible to implement IPA without the three initial requirements. On the other hand, a DTO was not considered a requirement because it entails having digital twins of all processes, and most organizations are not at this level of DT maturity. Although, not having a process digital twin to

test the developed IPA on a production environment can be a deployment limitation for more complex IPA initiatives, risking impacts on operations' quality and client services.

7.3. FUTURE WORK

Aiming to add more substance to the proposed Model and Framework evaluation, an ML&RPA experts' analysis of the last four of the framework's steps, using another use case, would be interesting to conduct to demonstrate and validate that the desired result is possible to achieve with these steps. Nevertheless, a better way to evaluate the proposed solutions would be through their application in organizations. Thus, application of the IPA Strategic Model and Framework is the primary recommendation for future work. During this application, one specific validation factor to consider would be "Which tools should companies use to succeed during IPA implementation?".

An identified need for research resulting from this investigation is "How to develop an Automation's Business Case which predicts and demonstrates its value for the organization?". Unfortunately, there is little material at this level, but it is a vast area of research, and would help companies with this crucial task of IPA implementation.

Possible evolution of the proposed Model and Framework was identified during this research. It entails studying the human and digital interaction and collaboration to deal with trust issues, confusion, and changes. A recommended research question to solve this problem is "How can companies orchestrate their human and digital work?" and "How to integrate the orchestration of human and digital workforces on the IPA Strategic Model and Framework" would result in its evolution.

According to the literature review, other possible research directions regarding IA may be interesting to investigate and would complement the proposed IPA Strategic Model and Framework.

Regarding AI decision-making, the only known technique is its self-adaptation to environments, so exploring other solutions applicable during runtime would be interesting. Moreover, research on analytical and prediction powers regarding real-time cognitive decisions is needed to improve these AI systems.

Emotional computing is another area that seeks further investigation to support AI systems undertaking complex and unclear cognitive decisions. The research question could be "How can automated sentimental analysis identify customers' attitudes and emotions to reduce the impact of human trust issues or confusion?".

BIBLIOGRAPHY

ACCENTURE. (2020). *ACCENTURE myWizard*. https://www.accenture.com/_acnmedia/PDF-138/Accenture-myWizard-brochure-reimagine-IT-for-agility-and-innovation.pdf#zoom=40

Agostinelli, S., Marrella, A., & Mecella, M. (2020). *Towards Intelligent Robotic Process Automation for BPMers*. http://arxiv.org/abs/2001.00804

Agrawal, N. (2020). Hyperautomation - The next frontier. *Deloitte Touche Tohmatsu India LLP*, *November*, 1–21. www2.deloitte.com/in/en/../hyperautomation-the-next-frontier.html

Andal-Ancion, A., Cartwright, P. A., & Yip, G. S. (2003). The digital transformation of traditional businesses. *MIT Sloan Management Review*, *44*(4), 34–41.

Andry, J. F., & Setiawan, A. K. (2019). It Governance Evaluation Using Cobit 5 Framework on the National Library. *Jurnal Sistem Informasi*, *15*(1), 10–17. https://doi.org/10.21609/jsi.v15i1.790

Appian. (n.d.). *Low-code Automation Platform - Rapidly build apps and workflows to accelerate business agility*. https://assets.appian.com/uploads/2021/03/datasheet-low-code-automation-platform.pdf

Appian. (2021). *Gartner Peer Insights "Voice of the Customer": Enterprise Low-Code Application Platforms*. https://appian.com/resources/resource-center/google/gartner-peer-insights-enterprise-low-code.html?google_ad_keyword=appian automation&matchtype=e&google_ad_campaign=14123985985&utm_source=google&utm_medium=cpc&utm_campaign=platform&gclid=Cj0KCQiA47GNBhDr

Aslanova, I. V., & Kulichkina, A. I. (2020). *Digital Maturity: Definition and Model*. *138*(Mtde), 443–449. https://doi.org/10.2991/aebmr.k.200502.073

Asquith, A., & Horsman, G. (2019). Let the robots do it! – Taking a look at Robotic Process Automation and its potential application in digital forensics. *Forensic Science International: Reports*, *1*, 100007. https://doi.org/10.1016/J.FSIR.2019.100007

AuraQuantic. (n.d.). *AuraQuantic Digital Platform*. Retrieved December 7, 2021, from https://www.auraquantic.com/bpm-digital-platform/

AuraQuantic. (2021). *What is Intelligent Automation?* https://www.auraquantic.com/what-is-intelligent-automation/

Automation Anywhere, Inc. (2021a). *Automation 360 Platform*. https://www.automationanywhere.com/products/automation-360

Automation Anywhere, Inc. (2021b). *Intelligent and Cognitive Automation*. https://www.automationanywhere.com/rpa/intelligent-automation

Automation Anywhere, Inc. (2021c). *What is Hyperautomation*. https://www.automationanywhere.com/rpa/hyperautomation

Back, A., & Schacker, M. (n.d.). *Digital Transformation Compass - A Guide to Management Methods and Tools in Digital Transformation Initiatives (Proposal of Future Work)*. Retrieved October 23, 2021, from https://www.scaledagileframework.com/

Baker, M. (2014). Digital Transformation. *Buckingham Business Monographs*.

Be Informed. (n.d.-a). *Enhance Your RPA Initiatives*. https://www.beinformed.com/wp-content/uploads/2021/10/Enhance-Your-RPA-Initiatives_Robo-Orchestrator_Whitepaper.pdf

Be Informed. (n.d.-b). *Robo Orchestrator - Hyperautomation - Be Informed*. Retrieved December 5, 2021, from https://www.beinformed.com/robo-orchestrator/

Berruti, F., Nixo, G., Taglioni, G., & Whiteman, R. (2017). Intelligent process automation: The engine at the core of the next-generation operating model. *Digital McKinsey*, *March*, 1–9. https://www.mckinsey.com/~/media/mckinsey/business functions/mckinsey digital/our insights/intelligent process automation the engine at the core of the next generation operating model/intelligent-process-automation.pdf?shouldIndex=false

Boritz, J. E. (2005). IS practitioners' views on core concepts of information integrity. *International Journal of Accounting Information Systems*, *6*(4), 260–279. https://doi.org/10.1016/J.ACCINF.2005.07.001

Bornet, P., Barkin, I., & Wirtz, J. (2021). *Intelligent Automation: Welcome to the World of Hyperautomation*. WORLD SCIENTIFIC. https://doi.org/10.1142/12239

Brynjolfsoon, E., & McAfee, A. (2016). The Second Machine Age. In *W.W. Norton & Company* (13).

Burnett, S. (2017). Automating content-centric processes with Artificial Intelligence (AI). *Everest Group Research*, 1–10. https://www.automationanywhere.com/images/lp/pdf/everest-group-automating-content-centric-processes-with-ai.pdf

Bygstad, B., & Øvrelid, E. (2021). Managing two-speed innovation for digital transformation. *Procedia Computer Science*, *181*(2019), 119–126. https://doi.org/10.1016/j.procs.2021.01.111

C. Verhoef, P., Broekhuizen, T., Bart, Y., Bhattacharya, A., Dong, J. Q., Fabian, N., & Haenlein, M. (2019). Digital transformation: A multidisciplinary reflection and research agenda. *Journal of Business Research*, *122*(2021), 889–901. https://doi.org/10.1016/j.jbusres.2019.09.022

Capgemini. (2021). *Intelligent Automation Platform*. https://www.capgemini.com/service/technology-operations/intelligent-automation/capgemini-intelligent-automation-platform/

Cardoso, A. P. de M. G. (2021). *Method to Foster Intelligent Processes Automation into an Organization Afonso Pires de Matos Gomes Cardoso Dissertation presented as a partial requirement for the degree of Master of Information Management Method to Foster Intelligent Processes Automation*.

Celonis. (n.d.). *Ultimate Guide to Process Mining*. Retrieved December 26, 2021, from https://www.celonis.com/ultimate-guide-process-mining

CGI, Inc. (2021). *Intelligent automation*. https://www.cgi.com/en/intelligent-automation

Coito, T., Martins, M. S. E., Viegas, J. L., Firme, B., Figueiredo, J., Vieira, S. M., & Sousa, J. M. C. (2020). A Middleware Platform for Intelligent Automation: An Industrial Prototype Implementation. *Computers in Industry*, *123*. https://doi.org/10.1016/j.compind.2020.103329

Coito, T., Viegas, J. L., Martins, M. S. E., Cunha, M. M., Figueiredo, J., Vieira, S. M., & Sousa, J. M. C. (2019). A novel framework for intelligent automation. *IFAC - Papers Online*, *52–13*(2019), 1825–1830. https://doi.org/10.1016/j.ifacol.2019.11.501

Coombs, C., Hislop, D., Taneva, S. K., & Barnard, S. (2020). The strategic impacts of Intelligent Automation for knowledge and service work: An interdisciplinary review. *Journal of Strategic Information Systems*, *29*(101600), 1–30. https://doi.org/10.1016/j.jsis.2020.101600

DATAMATICS. (2021). *DATAMATICS Intelligent Automation Platform (IAP)*. https://www.datamatics.com/digital/digital-experience/augmented-reality-and-virtual-reality

Deloitte Portugal. (2021). *Automação com inteligência*. https://www2.deloitte.com/pt/pt/hot-topics/automacao-com-inteligencia.html

Dorner, K., & Edlman, D. (2015). What "Digital" really means. *McKinsey Digital*, *July*, 1–3. https://digitalstrategy.nl/files/What_digital_really_means-McKinsey-July-2015.pdf

Durão, N., Ferreira, M. J., Pereira, C. S., & Moreira, F. (2019). Current and future state of Portuguese organizations towards digital transformation. *Procedia Computer Science*, *164*, 25–32. https://doi.org/10.1016/j.procs.2019.12.150

Ebert, C., & Duarte, C. H. C. (2018). Digital Transformation. *IEEE Software*, *35*(4), 16–21. https://doi.org/10.1109/MS.2018.2801537

EDP. (2018a). *About EDP*. https://www.edp.com/en/edp

EDP. (2018b). *Digital Innovation*. https://www.edp.com/en/innovation/digital-innovation

EDP. (2018c). *Digital Transformation*. https://www.edp.com/en/innovation/digital-transformation

EDP. (2021). *Strategic Update 2021-2025*. https://www.edp.com/en/edp/strategic-update-2021-2025

Ericsson. (2021a). *Ericsson Intelligent Automation Platform to RAN at scale*. https://www.ericsson.com/4ac36e/assets/local/core-network/doc/ericsson-intelligent-automation-platform-solution-description.pdf

Ericsson. (2021b). *Intelligent Automation Platform - Ericsson*. https://www.ericsson.com/en/ran/intelligent-ran-automation/intelligent-automation-platform

Findling, S., & Vesset, D. (2019). *IDC Maturity Scape: Data Excellence 1.0*. *February*, 1–16.

Gartner, Inc. (2021a). *Hyperautomation*. Information Technology Glossary. https://www.gartner.com/en/information-technology/glossary/hyperautomation

Gartner, Inc. (2021b). *Top Strategic Technology Trends for 2022*. https://www.brighttalk.com/resource/core/344063/june4sray_753325.pdf

Geyer-Klingeberg, J., Nakladal, J., Baldauf, F., & Veit, F. (2018). Process Mining and Robotic Process Automation: A Perfect Match. *16th International Conference on Business Process Management*, *July*, 1–8.

Haleem, A., Javaid, M., Singh, R. P., Rab, S., & Suman, R. (2021). Hyperautomation for the enhancement of automation in industries. *Sensors International*, *2*(100124), 1–9. https://doi.org/10.1016/j.sintl.2021.100124

Henriette, E., Feki, M., & Boughzala, I. (2016). Digital Transformation Challenges. *Mediterranean Conference on Information Systems*, 1–7. http://aisel.aisnet.org/mcis2016http://aisel.aisnet.org/mcis2016/33

Hevner, A. R., March, S. T., Park, J., & Ram, S. (2004). Design Science in Information. *MIS Quarterly*, *28*(1), 75–105.

Hinings, B., Gegenhuber, T., & Greenwood, R. (2018). Digital innovation and transformation: An institutional perspective. *Information and Organization*, *28*(1), 52–61. https://doi.org/10.1016/j.infoandorg.2018.02.004

Hinterhuber, A., & Nilles, M. (2021). DIGITAL transformation, the HOLY GRAIL and the disruption of business models. *Business Horizons*. https://doi.org/10.1016/J.BUSHOR.2021.02.042

Huang, F., & Vasarhelyi, M. A. (2019). Applying robotic process automation (RPA) in auditing: A framework. *International Journal of Accounting Information Systems*, *35*(100433), 1–11. https://doi.org/10.1016/J.ACCINF.2019.100433

IDC. (n.d.). *The Rise of the Digital Economy and the New CEO Agenda*. Retrieved May 9, 2021, from https://www.idc.com/promo/future-of-x

Järvinen, P. (2004). Research Questions Guiding Selection of an Appropriate Research Method. In *Department of Computer ans Information Sciences*.

Jovanović, S. Z., Đurić, J. S., & Šibalija, T. v. (2018). Robotic Process Automation: Overview and Opportunities. In *International Journal Advanced Quality* (Vol. 46). https://www.researchgate.net/publication/332970286_ROBOTIC_PROCESS_AUTOMATION_OVERVIEW_AND_OPPORTUNITIES

Jyoti, R., & Szurley, M. (2021). The Business Value of IBM AI - Powered Automation Solutions. *IDC*.

Kane, G. C., Palmer, D., Phillips, A. N., Kiron, D., & Buckley, N. (2017). Achieving Digital Maturity. In *MIT Sloan Management Review and Deloitte University Press* (Issue 59180). http://sloanreview.mit.edu/digital2017

Kettinger, W. J., Teng, J. T. C., & Guha, S. (1997). Business process change: A study of methodologies, techniques, and tools. *MIS Quarterly: Management Information Systems*, *21*(1), 55–79. https://doi.org/10.2307/249742

Kofax. (2021). *Intelligent Automation*. https://www.kofax.com/products/intelligent-automation-platform

Kommera, V. (2019). Robotic Process Automation. *American Journal of Intelligent Systems*, *9*(2), 49–53. https://doi.org/10.5923/J.AJIS.20190902.01

Kotarba, M. (2018). Digital Transformation of Business Models. *Foundations of Management*, *10*(1), 123–142. https://doi.org/10.2478/fman-2018-0011

Kotter, J. P., & Schlesinger, L. A. (2008). Choosing Strategies for Change. *Harvard Business Review*, *86*(7–8).

KPMG International. (2019). *Easing the pressure points: The state of intelligent automation*. *March*.

March, S. T., & Smith, G. F. (1995). Design and natural science research on information technology. *Decision Support Systems*, *15*(4), 251–266. https://doi.org/10.1016/0167-9236(94)00041-2

Matt, C., Hess, T., & Benlian, A. (2015). Digital Transformation Strategies, Business and Information Systems Engineering. *Springer*, *57*(5), 339–343. https://doi.org/10.1007/s12599-015-0401-5

Micle, D. E., Deiac, F., Olar, A., Drenţa, R. F., Florean, C., Coman, I. G., & Arion, F. H. (2021). Research on Innovative Business Plan. Smart Cattle Farming Using Artificial Intelligent Robotic Process Automation. *Agriculture (Switzerland)*, *11*(5). https://doi.org/10.3390/agriculture11050430

Microsoft Docs. (2021a). *Challenges and risks with AI - Learn*. https://docs.microsoft.com/en-us/learn/modules/get-started-ai-fundamentals/7-challenges-with-ai

Microsoft Docs. (2021b). *Introduction to AI - Learn*. https://docs.microsoft.com/en-us/learn/modules/get-started-ai-fundamentals/1-introduction

Microsoft Docs. (2021c). *Understand responsible AI - Learn*. https://docs.microsoft.com/en-us/learn/modules/get-started-ai-fundamentals/8-understand-responsible-ai

Morakanyane, R., Philip, C., Mcavoy, J., & Grace, A. (2020). Determining Digital Transformation Success Factors. *Proceedings of the 53rd Hawaii International Conference on System Sciences*, *3*, 4356–4365. https://doi.org/10.24251/hicss.2020.532

Ng, K. K. H., Chen, C. H., Lee, C. K. M., Jiao, J. (Roger), & Yang, Z. X. (2021). A systematic literature review on intelligent automation: Aligning concepts from theory, practice, and future perspectives. *Advanced Engineering Informatics*, *47*(101246), 1–15. https://doi.org/10.1016/j.aei.2021.101246

Nosova, S., Norkina, A., Makar, S., & Fadeicheva, G. (2021). Digital transformation as a new paradigm of economic policy. *Procedia Computer Science*, *190*(2021), 657–665. https://doi.org/10.1016/j.procs.2021.06.077

Nunes, T., Leite, J., & Pedrosa, I. (2020). Automação Inteligente de Processos: Um olhar sobre o Futuro da Auditoria. *Iberian Conference on Information Systems and Technologies, CISTI*, *2020-June*(15th), 24–27.

OSMAN, C.-C. (2019). Robotic Process Automation: Lessons Learned from Case Studies. *Informatica Economica*, *23*(4/2019), 66–71. https://doi.org/10.12948/ISSN14531305/23.4.2019.06

Oswald, G., & Kleinemeier, M. (2016). Shaping the Digital Enterprise: Trends and Use Cases in Digital Innovation and Transformation. In G. Oswald & M. Kleinemeier (Eds.), *Shaping the Digital Enterprise: Trends and Use Cases in Digital Innovation and Transformation* (pp. 253–285). Springer. https://doi.org/10.1007/978-3-319-40967-2_13

Peffers, K., Tuunanen, T., Rothenberger, M. A., & Chatterjee, S. (2007). A design science research methodology for information systems research. *Journal of Management Information Systems*, *24*(3), 45–77. https://doi.org/10.2753/MIS0742-1222240302

Pegasystems, Inc. (2021). *Intelligent automation solutions for the enterprise*. https://www.pega.com/products/platform/intelligent-automation

Rajawat, A. S., Rawat, R., Barhanpurkar, K., Shaw, R. N., & Ghosh, A. (2021). Robotic process automation with increasing productivity and improving product quality using artificial intelligence and machine learning. *Artificial Intelligence for Future Generation Robotics*, *August*, 1–13. https://doi.org/10.1016/b978-0-323-85498-6.00007-1

Ray, S., Tornbohm, C., Kerremans, M., & Miers, D. (2019). Move Beyond RPA to Deliver Hyperautomation. *Gartner*, *December 2019*, 1–16. https://www.gartner.com/doc/reprints?id=1-1Y6UALAZ&ct=200123&st=sb

Remane, G., Hanelt, A., Wiesböck, F., & Kolbe, L. (2017). Digital Maturity in Traditional Industries-An Exploratory Analysis. *Twenty-Fifth European Conference on Information Systems (ECIS)*. https://www.researchgate.net/publication/316687803

Ribeiro, J., Lima, R., Eckhardt, T., & Paiva, S. (2021). Robotic Process Automation and Artificial Intelligence in Industry 4.0 - A Literature review. *Procedia Computer Science*, *181*(2019), 51–58. https://doi.org/10.1016/j.procs.2021.01.104

Rizk, Y., Isahagian, V., Boag, S., Khazaeni, Y., Unuvar, M., Muthusamy, V., & Khalaf, R. (2020). A Conversational Digital Assistant for Intelligent Process Automation. *Lecture Notes in Business Information Processing*, *393 LNBIP*, 85–100. https://doi.org/10.1007/978-3-030-58779-6_6

Rogers, D. L. (2016). *The Digital Transformation Playbook: Rethink Your Business for the Digital Age*. Columbia business School. https://books.google.nl/books?id=LsF1CwAAQBAJ

Ross, J. W., Beath, C. M., & Mocker, M. (2019). *Designed for Digital - How to Architect Your Business for Sustained Success* (p. 208). MIT Press. https://books.google.com/books/about/Designed_for_Digital.html?hl=pt-PT&id=ZmquDwAAQBAJ

Ross, J. W., Sebastian, I. M., Beath, C., Mocker, M., Moloney, K. G., & Fonstad, N. O. (2016). Designing and executing digital strategies. *2016 International Conference on Information Systems, ICIS 2016*, 1–17.

Rossmann, A., & Reutlingen, H. (2018). Digital Maturity: Conceptualization and Measurement Model. *Thirty Ninth International Conference on Information Systems*. https://assets.kpmg.com/content/dam/kpmg/pdf/2016/04/ch-digital-readiness-assessment-en.pdf.

Schwertner, K. (2017). Digital transformation of business. *Trakia Journal of Science*, *15*(Suppl.1), 388–393. https://doi.org/10.15547/tjs.2017.s.01.065

Sharda, R., Delen, D., & Turban, E. (2018). Business Intelligence, Analytics, and Data Science: A Managerial Perspective. In *Winning with Data*. Pearson.

Siderska, J. (2020). Robotic Process Automation-a driver of digital transformation? *Engineering Management in Production and Services*, *12*(2), 21–31. https://doi.org/10.2478/emj-2020-0009

Softeck S.A. (2021). *Intelligent Automation*. https://www.softtek.com/solutions/intelligent-automation

Sousa, M. J., & Rocha, Á. (2019). Digital learning: Developing skills for digital transformation of organizations. *Future Generation Computer Systems*, *91*, 327–334. https://doi.org/10.1016/j.future.2018.08.048

Stone, S. M. (2019). *Digitally Deaf - Why Organizations Struggle with Digital Transformation*. Springer. http://link.springer.com/10.1007/978-3-030-01833-7

Teichert, R. (2019). *Digital Transformation Maturity: A Systematic Review of Literature*. *67*(6), 1673–1687. https://doi.org/10.11118/actaun201967061673

Uhl, A., & Gollenia, L. A. (2016). Digital Enterprise Transformation: A Business-Driven Approach to Leveraging Innovative IT. In *Digital Enterprise Transformation: A Business-Driven Approach to Leveraging Innovative IT*. Routledge. https://doi.org/10.4324/9781315577166

UiPath. (2021). *What is Robotic Process Automation - RPA Software*. https://www.uipath.com/rpa/robotic-process-automation

Ulas, D. (2019). Digital Transformation Process and SMEs. *Procedia Computer Science*, *158*, 662–671. https://doi.org/10.1016/j.procs.2019.09.101

Ustundag, A., & Cevikcan, E. (2018). *Industry 4.0: Managing the Digital Transformation* (Springer S). Springer. https://doi.org/10.1007/978-3-319-57870-5_7

Vajgel, B., Correa, P. L. P., Tossoli De Sousa, T., Encinas Quille, R. V., Bedoya, J. A. R., Almeida, G. M. de, Filgueiras, L. V. L., Demuner, V. R. S., & Mollica, D. (2021). Development of Intelligent Robotic Process Automation: A Utility Case Study in Brazil. *IEEE Access*, *9*, 71222–71235. https://doi.org/10.1109/ACCESS.2021.3075693

VanBoskirk, S., & Gill, M. (2016). The Digital Maturity Model 4.0 - Benchmarks: Digital Business Transformation Playbook. In *Forrester*.

Vial, G. (2019). Understanding digital transformation: A review and a research agenda. *The Journal of Strategic Information Systems*, *28*(2), 118–144. https://doi.org/10.1016/J.JSIS.2019.01.003

Ward-Dutton, N. (2018). From RPA to DPA: A strategic approach to automation. *MWD Advisors*. https://www.pega.com/system/files/resources/2018-12/from-rpa-to-dpa.pdf

Wessel, L., Baiyere, A., Ologeanu-Taddei, R., Cha, J., & Jensen, T. B. (2021). Unpacking the Difference between Digital Transformation and IT-enabled Organizational Transformation. *Journal of the Association for Information Systems*, *22*(1), 102–129. https://doi.org/10.17705/1jais.00655

Westerman, G., Bonnet, D., & McAfee, A. (2014). *Leading Digital - Turning Technology into Business Transformation*. HARVARD BUSINESS REVIEW PRESS.

Willcocks, L., Lacity, M., & Craig, A. (2015). The IT Function and Robotic Process Automation. *The Outsourcing Unit Working Research Paper Series*, *October*, 1–38. www.lse.ac.uk/management/research/outsourcingunit

Winter, R. (2008). Design science research in Europe. *European Journal of Information Systems*, *17*(5), 470–475. https://doi.org/10.1057/ejis.2008.44

Zaoui, F., & Souissi, N. (2020). Roadmap for digital transformation: A literature review. *Procedia Computer Science*, *175*, 621–628. https://doi.org/10.1016/j.procs.2020.07.090

Zhang, C. (2019). Intelligent process automation in audit. *Journal of Emerging Technologies in Accounting*, *16*(2), 69–88. https://doi.org/10.2308/jeta-52653

Zhu, P. (2014). Digital Master: Debunk the Myths of Enterprise Digital Maturity. *Google Scholar*. https://books.google.pt/books?hl=en&lr=&id=GfNaCAAAQBAJ&oi=fnd&pg=PT4&dq=digital+maturity&ots=F0rdwM1g0-&sig=VrSgi5t-nO-sAHJnIT6tNqBYVvA&redir_esc=y#v=onepage&q=digital maturity&f=false

ANNEXES

ANNEX 1 – USE CASE DT MATURITY LEVEL BEFORE IPA ADOPTION

Strategic Thinking

We are focused on selling to and interacting with customers through the usual channels.	1 2 3 4 **5** 6 7	We are focused on our customers' changing digital habits and path to purchase.
We use marketing to target, reach, and persuade customers.	1 2 3 4 **5** 6 7	We use marketing to attract, engage, inspire, and collaborate with customers.
Our brand and reputation are what we communicate to our customers.	1 2 3 4 **5** 6 7	Our customers' advocacy is the biggest influence on our brand and reputation.
Our sole competitive focus is beating our rivals.	1 2 3 4 **5** 6 7	We are open to cooperating with our rivals and to competing with our partners.
We look to create value exclusively through our own products.	1 2 3 **4** 5 6 7	We look to create value through platforms and external networks.
We are focused primarily on own industry and on direct competitors.	1 2 3 4 **5** 6 7	We view our competition as broader than our current industry.
Our data strategy is focused on how to create, store, and manage our data.	1 2 3 **4** 5 6 7	Our data strategy is focused on how to turn data into new value.
We use our data to manage day-to-day operations.	1 2 3 **4** 5 6 7	We manage our data as a strategic asset we are building over time.
Our data stays in the division or business unit where it is generated.	1 2 3 **4** 5 6 7	Our data is organized to be accessible by all divisions of the company.
We make decisions by analysis, debate, and seniority.	1 2 3 4 **5** 6 7	We make decisions through experiments and testing wherever possible.
Our innovation projects always go over time or over budget.	1 2 3 4 **5** 6 7	We innovate in rapid cycles, using prototypes to learn quickly.
We try to avoid failure in new ventures at all costs.	1 2 3 **4** 5 6 7	We accept failure in new ventures but look to reduce cost and increase learning.
Our value proposition is defined by our products and our industry.	1 2 3 **4** 5 6 7	Our value proposition is defined by changing customer needs.
We assess new technologies by how they will impact our current business.	1 2 3 **4** 5 6 7	We assess new technologies by how they could create new value for our customers.
We are focused on executing and optimizing our current business model.	1 2 3 4 **5** 6 7	We aim to adapt early to stay ahead of the curve of change.

Organizational Agility

Our IT investments are seen as operational.	1 2 3 4 5 6 7	Our IT investments are seen as strategic.
It is hard to allocate resources away from existing lines of business.	1 2 3 4 5 6 7	We are able to invest in new ventures even if they compete with our current business.
Our key performance metrics relate only to sustaining our existing businesses.	1 2 3 4 5 6 7	Our business metrics adapt to suit changes in strategy and the maturity of a line of business.
Managers are accountable and rewarded for immediate results on past objectives.	1 2 3 4 5 6 7	Managers are accountable and rewarded for long-term goals and new strategies.
We have difficulty developing new ventures far from our existing business.	1 2 3 4 5 6 7	We are able to seed and develop new ideas that are unusual for our business.
The sharing of best practices across our organization is slow and inconsistent.	1 2 3 4 5 6 7	We are skilled at taking successful new ideas and integrating them across the organization.
Our first priority is maximizing shareholder return.	1 2 3 4 5 6 7	Our first priority is creating value for customers.

ANNEX 2 – USE CASE DT MATURITY LEVEL AFTER IPA ADOPTION

Strategic Thinking

We are focused on selling to and interacting with customers through the usual channels.	1 2 3 4 5 **6** 7	We are focused on our customers' changing digital habits and path to purchase.
We use marketing to target, reach, and persuade customers.	1 2 3 4 **5** 6 7	We use marketing to attract, engage, inspire, and collaborate with customers.
Our brand and reputation are what we communicate to our customers.	1 2 3 4 **5** 6 7	Our customers' advocacy is the biggest influence on our brand and reputation.
Our sole competitive focus is beating our rivals.	1 2 3 4 **5** 6 7	We are open to cooperating with our rivals and to competing with our partners.
We look to create value exclusively through our own products.	1 2 3 4 **5** 6 7	We look to create value through platforms and external networks.
We are focused primarily on own industry and on direct competitors.	1 2 3 4 5 **6** 7	We view our competition as broader than our current industry.
Our data strategy is focused on how to create, store, and manage our data.	1 2 3 4 5 6 **7**	Our data strategy is focused on how to turn data into new value.
We use our data to manage day-to-day operations.	1 2 3 4 5 6 **7**	We manage our data as a strategic asset we are building over time.
Our data stays in the division or business unit where it is generated.	1 2 3 4 5 6 **7**	Our data is organized to be accessible by all divisions of the company.
We make decisions by analysis, debate, and seniority.	1 2 3 4 5 6 **7**	We make decisions through experiments and testing wherever possible.
Our innovation projects always go over time or over budget.	1 2 3 4 5 6 **7**	We innovate in rapid cycles, using prototypes to learn quickly.
We try to avoid failure in new ventures at all costs.	1 2 3 4 **5** 6 7	We accept failure in new ventures but look to reduce cost and increase learning.
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Our first priority is maximizing shareholder return.	1 2 3 4 5 6 7	Our first priority is creating value for customers.

ANNEX 3 – INTERVIEWS PRESENTATION

NOVA IMS Information Management School

AN INTELLIGENT PROCESS AUTOMATION STRATEGIC MODEL AND FRAMEWORK

Master Program in Information Management Thesis

Master: Information Management
Specialization: Information Technologies and Systems Management
Author: Íris Lebre Feio
Date: January 2022

Instituto Superior de Estatística e Gestão da Informação Universidade Nova de Lisboa

Acreditações e Certificações

Background

1. Organizations' urgency in taking Digital Transformation to remain relevant in the market (Morakanyane et al., 2020)
2. Companies are in different levels of digital maturity (IDC, 2021)
3. Business Strategy and IT Strategy must be aligned (Andry & Setiawan, 2019)
4. Operations are one of the nine enterprise dimensions where DT can be greatly accelerated (IDC, 2021)
5. Intelligent Process Automation is a combination of technologies that improve business processes and allow new digital business models (Ribeiro et al.,2021)

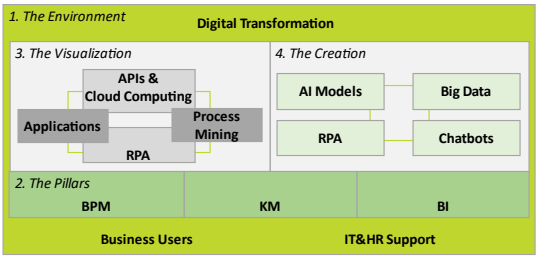
Problem Statement

1. Companies do not know which are the main technologies they can use and incorporate into their business (Ward-Dutton, 2018)
2. Companies do not know how to use Artificial Intelligence (AI) technologies (Siderska, 2020)
3. Does not exist a common definition for Intelligent Process Automation (IPA) and it lacks from scientific studies and perspectives (Ng et al., 2021; Ray et al., 2019)
4. IPA is a recent subject and most of its research has been done by big consulting companies that sell it as a service (Ng et al., 2021)
5. Organizations need guidance on how to take benefit from AI throughout the path of DT (Ward -Dutton, 2018)

Proposed Solution

IPA Strategic Model

Supported by literature review regarding DT concepts, drivers, impacts, challenges, assessment and stra
and IPA - concepts, benefits, challenges, readiness, research directions and approaches.

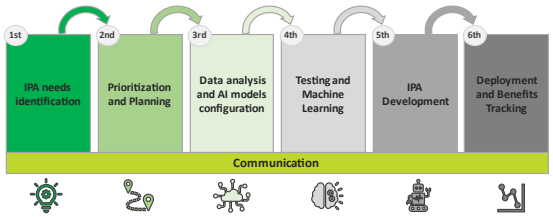


Proposed Solution

IPA Framework

Organization's Initial Requirements:

1. Going through Digital Transformation
2. Using Process Mining and Business Intelligence Systems
3. Familiar with Robotic Process Automation



Interview Questions

1) Do you consider the proposed Model and Framework useful? Please justify.
2) Do you have any criticism towards the proposed Model and Framework? Please explain.
3) Can the proposed Model and Framework accelerate company's DT? Please justify.
4) Do you have any recommendations or suggestions for further improvements of the proposed Model and Framework?

Thank you!

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ANNEX 4 – INTERVIEWS TRANSCRIPTION

First interview with Pedro Maia Malta on 27th January 2022:

Q1PMM: "I think the fact that going from a model to a framework, where the model has to do with strategy, makes perfect sense. The model identifies a set of concepts and areas that should support the construction of the framework, which I think happens. Although it would be interesting to read more about what Iris has already written, perhaps the dependence of RPA, which is the only common point in visualization and creation, is one critical concern for the framework construction itself. Companies should have exceptional attention to what is done at RPA level, which is one of the requirements to start. It is the third request you introduce. Therefore, it makes sense that there is expertise and that companies can work with BPM and process mining, which do the documentation to identify improvements in processes, to then go to the automation of whatever is worth automating.

In the Visualization part, you should clarify that RPA is used for data integration, and in the Creation part, clarify that RPA refers to conceptualization. AI has to do with the cognitive part, learning to apply, so RPA makes perfect sense for conceptualization. It is a conceptual issue under the IPA Strategic Model subject. We are not in the implementation yet.

Then, as far as the framework goes, it makes perfect sense to have these three prerequisites. If the company does not go further at the digital level, it makes no sense to use this framework. It will not result in anything. It is the same for the process mining and BI systems requirement. Companies need to use BPM to realize the issues that process mining can identify, and IPA's needs maybe come a lot from this requirement. And then, of course, companies need to have skills since the RPA arises in data integration - which is essential for all infrastructures, in last analysis, if there is no infrastructure, nothing works - either in the conceptualization, the thinking of the model itself, yes, it makes sense to have expertise here.

Considering the amendment of RPA clarification in the Visualization and Creation parts, I find the model and the framework useful. I start by thinking about a strategic model to build anything, steps that are the implementation of the results from this model. If not, it does not make sense to work. Furthermore, the requirements are essential, mainly regarding the digital transformation process. If we do not have digitalization, I think it does not make sense to apply technologies that need this cultural environment and mindset to act. And the manager themselves will not be fit. If you are not aware that you need to evolve, you are not aware that digitalization is essential, buy applications just so then they are installed on the server, that no one uses - which happened a lot in the 90s - it does not make sense. I think that companies nowadays are more complex and have more answers to solve

this complexity, although they must want it. This issue that senior management must be aligned with operational management is true. Things do not have to be dissociated. Sometimes it is difficult to justify and arrange arguments for tech projects, but some projects start from someone's stubbornness, and in the end, others recognize that it was worth it. However, it was worth it because someone had this will. They were transforming, digitalizing, doing digital transformation. It was not computerizing, it was not changing the servers. These are concepts that must be differentiated."

Q2MPM: "Regarding the framework, one of the issues that I think fundamental in projects is good communication of needs. I find it very interesting that you have put here this task of communication, transversal, but I would even divide it between communication one and communication two. The one just regarded the needs. Because identifying the suitable needs is essential for the following phases, I need to identify the requirement one soon. If you start a project of this kind and are concerned with needs, understand the needs and what is happening, I can soon stop the project if there is no context, I do not go further, I do not go to the other phases.

At the project level, I can have, for example, a pre-team only for needs, eventually with people who have the client's language. Many consulting companies, for example, hire doctors and nurses to work the requirements gathering in hospitals and other health institutions to understand better the systems and technologies that the client needs. Why are doctors and nurses talking to the client? To facilitate communication with the client when is a doctor or a nurse. Of course, some technical workers have already done many projects in this market and maybe are an added value to use also in a powerful way, but maybe at the level of project management, team management, budget reduction, I can have someone recently graduated, who is paid a lot less, but it is much more effective because it has the language of the client. It does not need much experience. What matters is to have the correct language. Then, we can have the seniors IT, SI, Business who will work the needs across all other phases from prioritization.

Therefore, put the communication as it is, and then, when explaining, refer to the two phases or steps, highlighting the need to focus on communication in the first phase. Because sometimes communication is much more than communicating what is going to be done in a new project, especially internal communication, the discussion about the project itself is crucial. It is essential to have good communication between the internal team to know the whole project. Therefore, it makes sense that this part of collecting the data for implementation should pay this special attention."

Q3PMM: "I think for sure, because any company that has access to a best practice, implement faster because they do not need to think about it. You do not waste time conceptualizing unless the model is so complicated and extensive that the amendment is worse than the sonnet. Therefore, I think yes,

and the justification is: when the company resorts to an external consultant or the internal department because it needs to systematize, if there is a model of best practice, which may not even have factual evidence yet, it has not yet been implemented, but already exists it thought, it makes perfect sense. I have no doubts about saying this. It will depend on people and the organization's mindset. The business culture that I have already spoken about is critical. The issue of people, essentially senior management, being open to it. For example, in the industry, I imagine if my company is very used to making that product that way, and it has those assembly lines, made that investment that is depreciated, we will not change. Unless someone shows that if you have this change, you will have a deficit in the first month, and in the following months, you will have twice the result. Nevertheless, it has to be shown by A plus B. There has to be a simulation, a predictive model, anything that demonstrates to those who manage and that it does its function good, which is to keep a business to invoice, that this is worth it."

Q4PMM: "Yes. There are issues here that can correlate. The business part, the business culture, is one of the subjects that must be part of this mindset. The second correlation is regarding BPM and KM. Any studies that sustain this correlation scientifically are a good contribution.

Regarding the requirements to use process mining and BI systems, it would be interesting to understand the client's tools. It would be clearer and more enjoyable to put as requirements: organizational model or business culture requirement one. Tools, existing tools, requirement two. And human skills in requirement three. These would be the three considerations that the company will have in this framework support.

These interviews will validate this framework to sustain your model and scientifically have the approval to support your dissertation. You can use the use case demonstration to ask the opinion of some ML experts regarding how this model and framework use case can work. Having the need and knowing that we will go through all these steps, question whether they can reach the desired result.

This dissertation is based on the research of the conceptual model to apply, and then a doctorate would be the investigation of its implementation. So, it makes sense that the research work is done in a pyramid. The Ph.D. needs a set of inputs, which are masters, and these masters have a set of points that can be final course works. Furthermore, these final course works may also need a set of inputs that can come from professional courses, parts of code, very applied things."

"I think you have a fascinating subject here because it can materialize ideas through research. Thank you. Good luck."

Second interview with Jorge Costa Reis on 3rd February 2022:

Q1JCR: "Yes. They are useful. What Iris says regarding the different stages of organizations' maturity is true. It is a fact. So, we have many organizations at different stages of maturity, and unfortunately, when we look at the market, we still have a low maturity at the IPA level globally. Companies typically report that they do not know where to start, they do not know how to look at the problem, and what steps they should take. This question is what most often companies ask me, and therefore, this model, how you arrange ideas and the framework as proposed in terms of steps, is advantageous. It may use some adjustments, but it is a handy tool for organizations because there is not yet an established practice on the market as it exists in other areas. There are areas where even there have been standard rules published to deal with topics, but this is not the case for IPA. Thus, it is beneficial that these types of frameworks appear to show results and tend to move to a generalized good practice."

Q2JCR: "Look, I think this could give us reason to be here all-day exchanging ideas about it, so maybe I will focus on one or two aspects that seemed relevant to what I said, but there would undoubtedly be a lot more to comment on or discuss and then adjust my opinion. Anyway, first congratulations on the model and the framework. I think the ideas are very well structured, very tidy. The model is highly comprehensive and gives a holistic view of what IPA is. So, I think this is an excellent job here.

Let me just give you two notes here that occurred to me in plain sight. One has to do precisely with the model. Another has to do with the framework.

Regarding the model, Iris is precisely right on the slide with the problem statement, which says that there is no one definition of IPA, and that is a fact. Thus, when we look at the market, we see visions more focused on RPA, AI, ML, for example, but then we also have broader visions, such as IDC's case, of what IPA is. The vision that IDC has defined, which seems an excellent vision to perhaps incorporate into your model, and is mainly all literature on which I have based my studies, is that the automation begins at the level of the system itself.

So, the first layer of automation begins precisely with integrating systems, and I say first because I am thinking about a model from the bottom up. We are not talking about substitution or automation of human tasks. We are talking about making systems integration more intelligent and more automated. Here is where concepts like APIs or Middleware Integrations come in. This first layer is the most technical level of automation, but then there is the level of workflows automation, the companies' traditional workflow platforms that are not very intelligent, and where there is much space to give intelligence. Finally, we have the automation of the human tasks where RPA and chatbots, all those technologies, play a significant role.

Thus, we are talking about various layers of automation, but from where does intelligence come? What is essential here is that there are various layers of automation, but now we need to introduce intelligence. There is something parallel to the various layers, which have to do with AI, ML, Data, BI, and all those technologies that aim to generate intelligence in the automation process. I just wanted to give this note, that does not mean that the perfect strategic model must be as comprehensive as this, although it seems that looking at the IPA from a perspective focused only on the human task may eventually be reduced to the potential that exists of automation further down. This was the first note.

The second note is due to the framework prioritization step. I review myself entirely in this framework. I think they are very well structured, the several steps. Moreover, this is one of the things that we are asked often, how do I identify opportunities for automation, how do I evaluate them, and implement them? Thus, I have no doubts about the first step, Identifying opportunities. Process mining and task mining play a key role here. But Iris did not mention an aspect that I think is fundamental in the second step. While the first comment is a more theoretical comment, namely, to try to broaden the horizons of the model a little, here no, here I think it lacks an aspect that probably you refer to in your dissertation but did not mention here in this presentation.

In prioritization, you referred to risk analysis, the existence of data, and scalability. However, there is one significant thing, which is valuable for the business, which is a fundamental aspect: we can have data, we can have low risk, so it can be effortless to implement and therefore we will automate, excellent, but if it does not bring value to the organization, it is not worth doing all the other steps and investing in this automation. So, in this second step, I think it is crucial to introduce the business sense on the decision-making. Is this important for my business? With this, what value or savings will I generate? What revenue will increase? We must do the automation business case at this step.

We have discussed the levers of value for the automation business case. The most obvious thing that always comes as first is reducing human effort and the resulting savings. However, there are many more levers, and the challenge here is to identify these levers and then explore them, go after them, try to qualify them.

To conclude, my note is to include the business case at this stage of prioritization to realize what the organization will have as a return from the automation investment. Because I think technological decisions are increasingly based on value for the business. More and more, we have managers making technology decisions, so we do not invest in technology for technology, but because of the value that this investment will bring back."

Q3JCR: "Yes, I think the relationship between IPA and DT, the digital transition of organizations, is obvious because the companies' DT is based on the transformation of their operations, their processes, and one way to make this transformation is through IPA. Therefore, in practice, what I am advocating is that there is no DT only at the level of the relationship with customers, culture, or infrastructure, the transformation must also happen at the level of operations, the business model, the way the machine, as an organization, this company, work. Furthermore, the transformation of this machine naturally involves changing processes, working in different ways, and this is where automation comes in, doing the same processes in a more automated, faster, and above all, smarter way, and thus I would say that it is difficult to have DT without having IPA."

Q4JCR: "When I made the two comments in Q2, I ended up giving suggestions.

I find particularly relevant the issue of the business case. I think it is a good area for later future academic research. There is little material, little academic research at this level, but it is a vast area of research, so I even think you can propose this subject of automation's business case for your doctoral thesis, and therefore, clearly this is a recommendation that I leave to you.

See the first suggestion more as a philosophical question about what IPA is. It is not a criticism of your model. Your model focuses more on that upper layer of automation which is not bad. It is a good model, a robust model in that layer. If it was me, I would assume that focus. I would say automation is more extensive than what I describe in this model because it is focused on this layer for this, this, and this. So this is the only note that I leave to you that can respond to that criticism, which is that there are automation subjects that are not here in your model, and the best way is to assume that it has a focus on a specific automation type."

"It was a pleasure being able to help. I always like it when I can add something to support these initiatives, and therefore it was a pleasure. It was very nice to have this conversation with you. Congratulations on the work you are doing. I think it is a fascinating job."

Third interview with Ricardo Hugo Henriques on 4th February 2022:

Q1RHH: "Yes, I find it useful, and the justification has little to do with the problem statement because there are no models of these or impartial frameworks. There are only models or frameworks related to consulting companies, it is good that these frameworks exist detached from any interest, and the academic world helps a lot."

Q2RHH: “Yes, I have some. The first is related to the Environment. I understand why DT appears because, in practice, it is to justify that the organization must be already starting its DT, but I would give a greater context. We only do DT because we intend to transform the business and, therefore, somewhere in the model, I would relate DT with BT. Without BT, it is impossible for DT to exist, so there is a direct relationship here.

Then, perhaps also regarding the Environment, considering the HR, I would mention the future of work because this framework, this model in practice, will interfere a lot with this variable also related to the Environment, which is the way people start to work after IPA implementation.

I also note that the business users are not the developers or maintainers of the automation in all cases. For example, some models are federated and more decentralized, where this is true, but there are also cases where companies opt for centralized models. Therefore, RPA developers are people who only do this work and are not precisely business users. In these cases of more centralized models, business users consume automation as they consume IT.

Additionally, when talking about Applications in the Visualization part, I believe that you should substantiate a little more if we are talking essentially about the core IT or operating systems here. I agree with the word ‘applications’ and that it is acceptable, but it can sometimes be confused with other things.

In the fourth part, the Creation, not all operations are always intelligent. There is automation that mimics only human behavior and, in practice, is end-work automation, and then there is intelligent automation, which is the so-called brain work. So, I would only give this duality because the AI models related to IA are represented, but automation is not all intelligent. If it is just human mimetic behavior, there is no need for IA.

And the last note. Regarding the framework, I would only complement the communication with what you mentioned earlier, the change management. I think another layer, in parallel with communication, becomes very relevant from the beginning, also, to ensure the success of these six steps you have presented.”

Q3RHH: “The framework is a good reference to contribute to DT acceleration, but alone, I think it cannot accelerate anything, although it provides stimulation. I think it is an enhancer of that acceleration, but to say concretely that it accelerates, I do not know if this is excessive. A concrete example is that this framework requires process mining, but not all companies have already invested in it. Therefore, although it is a good recommendation, and I would say even decisive, if companies do not use process mining, there will be no such acceleration. It is in this sense that I have this opinion.”

Q4RHH: “Yes, I think the whole part of IPA can be seen in an ecosystem concept, which I think is somehow represented here. However, you touched on a point that brings the task-mining component. Thus, when I do process mining and task mining to a process, I will see the digital twin of my process, and eventually, that part could be included here as an improvement.

Another recommendation is that more mature companies will need to orchestrate human work and the work of robots in the given time. So, I would say an aspect to think about is how this orchestration of the work would be included here. Usually, this is done and results from the combination with BPM, where is the whole part of workflows, and where we can do this orchestration having robots giving work to humans and humans giving work to robots.”

“Thank you and congratulations, there is an excellent job here.”