Best practices for business process automation description

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Abstract

To process-oriented organizations, acting in highly competitive and tightly regulated environments, strengthening business processes is a permanent necessity. Process enhancement can be boosted by adopting technological solutions capable of insuring better operational efficiency and efficacy, service's quality, and compliance and reducing risks and costs. Solutions enabling full or partial business processes' automation are becoming increasingly relevant. Each automation tool, either provided by an external supplier or developed inhouse, adopts a specific automation description. Description heterogeneity stands as a bottleneck to compatibility and interoperability, harming an enterprise's ability for innovation, cooperation and competitiveness. Adopting standard specification and description, or at least a set of commonly agreed best practices, on business process automation (BPA) provides benefits. It is in process-oriented organizations' best interest to assess its current situation based on a set of best practices. This research focuses on the search of such set of best practices and on the necessary elements to perform an alignment assessment.

Keywords: Business Process Automation, BPA, Business Process Management, BPM, Interoperability, Standard, Best practices.

Resumo

Em organizações orientadas a processos, atuando em ambientes altamente competitivos e fortemente regulados, o fortalecimento dos processos de negócio é uma necessidade constante. A melhoria de processos pode ser alavancada pela adoção de soluções tecnológicas capazes de assegurar a melhoria da eficiência e da eficácia operacionais, da qualidade de serviço, da conformidade e a redução dos riscos e dos custos. As soluções que permitem a automação, parcial ou total, de processos de negócio assumem uma relevância crescente. Cada ferramenta de automação, seja fornecida por uma entidade externa ou desenvolvida dentro da organização, adota uma descrição de automação específica. A heterogeneidade de descrições consubstancia um entrave à compatibilidade e interoperabilidade, prejudicando as capacidades de inovação e de cooperação e a competitividade das empresas. A adoção de uma normalização ou, pelo menos, de um conjunto genericamente acordado de melhores práticas, na especificação e descrição da automação de processos de negócio (BPA) será benéfica. É do interesse das organizações orientadas a processos a avaliação da sua situação atual com base num conjunto de melhores práticas. Esta investigação centra-se na procura desse conjunto de melhores práticas e dos elementos necessários para uma avaliação de conformidade.

Palavras-chave: Business Process Automation, BPA, Business Process Management, BPM, Interoperabilidade, Standard, Melhores práticas.

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List of Abbreviations

Abbreviation	Meaning
BCP	Banco Comercial Português S.A.
BPA	Business process automation
BPA/R	Business processes automation and robotization
BPM	Business process management
BPMACC	BPM and Automation Center of Competence of Millennium Operations Center
BPMS	Business process management systems
BPMN	Business process model and notation
BPO	Business process outsourcing
CoE	Center of Excellence
DTO	Digital Transformation Office
E	Interview subject
ETL	Extract, transform and load
FTE	Full time equivalent
IT	Information technology
ITD	IT Department
KPI	Key performance indicators
NPE	Non-performing exposures
NPL	Nom-performing loans
OCR	Optical character recognition
R	Questionnaire respondent
RPA	Robotic process automation
RQ	Research question
SLA	Service-level agreement
SLR	Systematic literature review

1 Introduction

1.1 Overview

To process-oriented organizations, acting in highly competitive and tightly regulated environments, strengthening business processes is a permanent necessity.

Process enhancement can be boosted by adopting technological solutions capable of insuring, in an integrated manner, better operational efficiency and efficacy, service quality, and compliance and reducing risks and costs (Syed *et al.*, 2020). Moreover, they should harness a superior adaptive capacity in face of todays' accelerated evolution of market conditions.

Solutions enabling full or partial business processes' automation (BPA) are becoming increasingly relevant in data quality improvement, processing reliability, benchmarks and customers' satisfaction, as well as risk mitigation and reduction of operational costs (Cewe *et al.*, 2017). Collaboration with other enterprises and mandatory supervisory reporting are activities also pressing towards more significant information sharing; therefore, harshening issues of compatibility and interoperability (Liu *et al.*, 2020).

Each automation tool, either provided by an external supplier or developed inhouse, adopts a specific automation description. This lack of standardization undermines communication, due to ambiguity, lack of clarity and misunderstandings, prejudices quality, because of misinterpretation, errors and suboptimal results, adversely affects performance, due to uncertainty, conflict and impact on productivity (Lewicki *et al.*, 2019). Consequently, description heterogeneity stands as a bottleneck to compatibility and interoperability, harming an enterprise's ability for innovation, cooperation and competitiveness (Liu *et al.*, 2020).

Adopting standard specification and description, or at least a set of commonly agreed best practices, on BPA provides benefits, acting as an enhancer of robustness, flexibility, efficiency and competitiveness. In a networked and regulated environment, sustainable interoperability within and among organizations is a crucial factor for successfully managing collaborations at all levels: abstract (business) and concrete (technology) (Agostinho *et al.*, 2015).

1.2 Research problem, questions and purpose statement

It is in process-oriented organizations' best interest to assess its current situation, as well as to identify improvement measures. To fulfill that purpose, it is necessary to conduct an evaluation based on a set of best practices. This research focuses on the search of such set of best practices and on the necessary elements to perform an alignment assessment. In this context, the following research questions were defined:

RQ1: What are the methods used to describe business process automation?

RQ2: Are those methods aligned with the best practices?

RQ3: Are the methods used sufficient to insure interoperability?

RQ4: What additional methods should be used to ensure interoperability?

1.3 Summarized methodology

This dissertation uses the case study methodology, to assess BPA description's alignment.

Case study research is defined by Yin (1994) as an empirical inquiry that investigates a contemporary phenomenon within its real-life context; when the boundaries between phenomenon and context are not evident; and in which multiple sources of evidence are used (Yin, 1994).

The case study that will be performed in this research follows Yin's perspective and Soy's guidelines (Soy, 1997), which proposes the use of five main steps:

- Research design: determination and definition of research questions; definition of propositions to help focusing the core of the study and selection of cases and determination of data gathering and analysis techniques;
- Preparation for evidence collection: development of a protocol for the case study, to assure reliability. Includes goals, relevant literature and procedures for obtaining the data;
- Evidence collection: collection of data in the field, systematic storage of evidence and classification according to investigation issues;
- Evidence analysis: evaluation and analysis of the data to reinforce the research findings and conclusions;
- Sharing of results: preparation of a complete, accessible and verifiable report.

Figure 2 illustrates the interdependencies of this methodology's phases, considering a preliminary step dedicated to planning.

The selection of case study as research methodology was due to its adequacy to real-life, contemporary, human situations in pursuit of the goal of gaining a deeper understanding of the research problem.

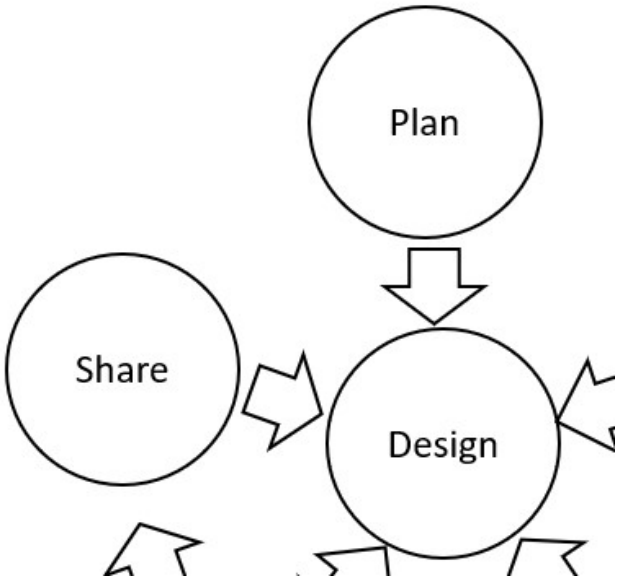


Figure 1. Case study phases' interdependencies.
Adapted from (Baškarada, 2014)

1.4 Document organization

This document is organized in 8 chapters, including this one.

Chapter 2 contains the theoretical background, explaining key definitions for the understanding of this work.

Chapter 3 presents the systematic literature review (SLR), explaining the motivation for this work, enunciating the research questions, describing the review protocol, detailing the execution of the review protocol, and presenting the results from the selected papers' analysis.

Chapter 4 deepens the description of the research problem, motivation for carrying out this work.

Chapter 5 describes the research methodology - case study - used to conduct this study.

Chapter 6 presents the results obtained and their analysis and interpretation.

Chapter 7 contains the main findings and contributions of this work.

In Chapter 8, limitations and future work are discussed.

2 State of the art

2.1 Business process management

A process is a series of actions which are carried out so to achieve a particular result (Merriam-Webster Dictionary, 2022). Business process is a set of functions in a specific sequence that deliver value for an internal or external customer (Kirchmer, 2017). Depending on their execution's dynamism, business processes can be divided into structured (static) processes; structured processes with *ad hoc* exceptions; unstructured processes with pre-defined fragments; and unstructured processes (Szelągowski & Lupeikiene, 2020).

Business process management (BPM) was initially described as a structured approach used to analyse and continually improve fundamental activities, such as manufacturing, marketing, communications, and other major elements of an enterprise's operation (Elzinga *et al.*, 1995). In its early stages was essentially used to increase efficiency and to reduce costs.

Nowadays BPM is considered as both a management discipline and a set of technologies that supports managing by process, and it is used in all areas of organization management and within the interaction between the organization and its environment (Szelągowski & Lupeikiene, 2020).

Consists of designing, implementing, controlling and improving business processes so to increase the ability of an organization to achieve a global high level of performance. Promotes reactivity and operational flexibility in organizations. Involves understanding the relationship between the location of value creation and the value itself, with the aim of improving overall performance and fulfill stakeholders' expectations. Is appreciated for being a valuable approach to confer maturity and agility to organizations applying it (Lamine *et al.*, 2020).

BPM has a lifecycle composed by five stages, as illustrated in Figure 2:

- Design: analysis of the business process by interviewing stakeholders aiming its alignment with the organization goals to generate desired business outcomes and creation of a framework defining workflows, training methodology, and stakeholders involved at each step;

- Model: transference of the idea into a visual format and design of the complete process workflow, representing every event, step, data flow, involved stakeholders and other conditions, using BPM tools;
- Execute: deployment of the process and employees' training;
- Monitor: setting of key performance indicators (KPI) for each job function and tracking their evolution using BPM tools;
- Optimize: regular and periodic reanalysis of business process in pursuit of efficiency and productivity improvements and continuous alignment with the organization strategy.

To address the necessary continuous processes' improvement, dictated by the ongoing adaptation of processes to customer expectations, regulatory demands, business goals and global competition, BPM has evolved extending traditional BPM software systems to enable a more agile, dynamic, contingent, human and intelligent management and adopting an adaptive and advanced case management paradigm. The result is a more intense knowledge-based business process management, better prepared to deal with unpredictability and the need for innovation (Szelągowski & Lupeikiene, 2020).

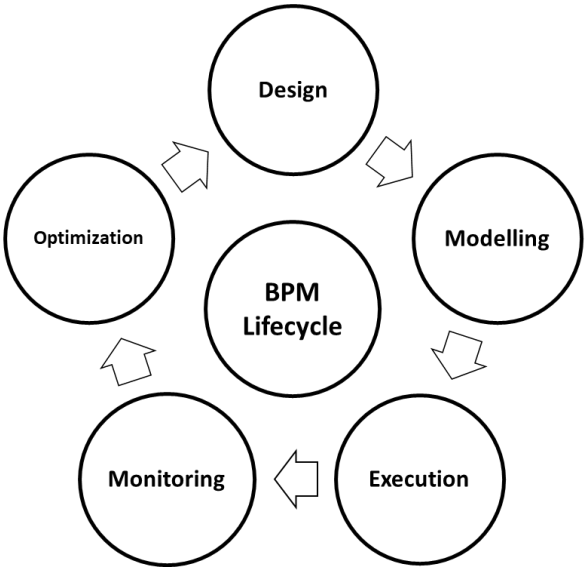


Figure 2. BPM lifecycle.

2.2 Automation

The dictionary defines automation as the technique of making an apparatus, a process, or a system to operate automatically (Merriam-Webster Dictionary, 2022). The International Society of Automation defines it as the creation and application of technology to monitor and control the production and delivery of products and services.

Automation involves a very broad range of technologies including robotics and expert systems, telemetry and communications, electro-optics, cybersecurity, process measurement and control, sensors, wireless applications, systems integration, and test measurement.

A robot is an electromechanically designed machine, programmable by a computer and capable of carrying out a complex series of actions automatically. Therefore, robotic process automation (RPA) means automation of service tasks. For business processes, the term RPA most commonly refers to configuring software to do the work previously done by humans (Madakam *et al*., 2019). The IEEE Corporate Advisory Group (Hofmann *et al*., 2020) defines RPA as the use of a preconfigured software instance that uses business rules and predefined activity choreography to complete the autonomous execution of a combination of processes, activities, transactions, and tasks in one or more unrelated software systems to deliver a result or service with human exception management.

Adopting RPA enhances customers satisfaction since promoting higher processes' efficiency, accuracy, reliability, and regulatory compliance (Keung *et al*., 2021). Additionally increases employees' satisfaction due to lower repetitive workload and human error amendments.

Process automation can also be interpreted as a particular type of an organizational and technological change (an inherent part of which is the specific software's implementation) leading to the appearance of the so-called hybrid work environment. This environment is understood as a coherent set of IT tools (business applications and software robots), processes and procedures, as well as people with certain competences and skills, carrying out specific business processes and processing specific data (Sobczak, 2019). The automation of business flows, using large and heterogeneous data and knowledge and applying more complex decision-making, embodies a wider concept that encompass automation and robotization of business processes (BPA/R) (Mazilescu & Micu, 2019).

Automation benefits relate also to flexibility, scalability, standardization, cost reduction, control and governance. These issues transcend the task level and point to the broader level of the business process (Willcocks *et al*., 2017). The automation can evolve from a single task automation to the automation of several tasks in a process, and even further to the automation of the business process choreography. RPA is limited to highly rule-based, structured, mature, standardized, repetitive and well-documented decision logic for tasks with digitized structured data input (Ng *et al*., 2021). The increasingly degree of complexity demanded by increasingly dynamic business environments requires assistance in decision-making processes with cognitive computing and embedded intelligence, making use of further technological capabilities provided by other methods such as process mining (PM), machine learning and cognitive or artificial intelligence (AI) (Wewerka & Reichert, 2021).

Broadly, process automation technologies are recognized for several advantages, including high accuracy and uniformity of operations, consistency, reliability, increased productivity, costs reduction, efficiency, regulatory compliance, low technical barriers, non-invasive technology, and improvement in employee morale (Madakam *et al*., 2019). Characteristics that make it an attractive solution for a variety of industries.

2.3 Interoperability

Interoperability is defined as the ability of enterprises and entities within those enterprises to communicate and interact effectively (ISO/DIS, 2009), translating in business processes understood and aligned within and across organizational boundaries (Figure 3). As an engineering discipline, enterprise interoperability is not yet well defined. Although, it can be described as the ability of enterprises

or organizations to structure, formalize, and present their knowledge and to exchange or share it (Mu *et al*., 2016).

Interoperability concerns can be classified into four categories: data, service, process, and business. The goal of an enterprise is to run its business. The business is realized through processes. Processes employ services which in turn need data to perform tasks or activities (ISO/DIS, 2009).

In competitive market conditions, enterprises' ability to collaborate can be a critical factor. Enterprises are beginning to consider and assess their collaborative capabilities, which can be set on four levels (Mu *et al*., 2015): (1) communication: the ability to exchange and share information, (2) openness: the ability to share business services and functionalities with others, (3) federation: the ability to work with others by following collaborative processes in pursuit of a common objective, as well as the objective of the enterprise itself and (4) interoperability: the ability to work with others without the need for a special effort; the enterprises involved are seen as a seamless system.

In increasing common collaborative contexts, interoperability has now become a prerequisite. Over the past decade, both the concept and the context of interoperability evolved from a mainly IT-focused to a business focused domain and its evaluation has become a growing concern (Liu *et al*., 2020).

The effectiveness of information-sharing among digital systems and business process depends on the enterprises' ability to surpass interoperability barriers, which are incompatibilities between entities of an enterprise or between enterprises that obstruct the exchange of information, the utilization of services or the common understanding of exchanged items. These barriers may fall into three domains: conceptual, technological and organizational. Breaking down technological barriers is crucial due to the practical and operational role of enterprises information systems (Mu *et al*., 2015).

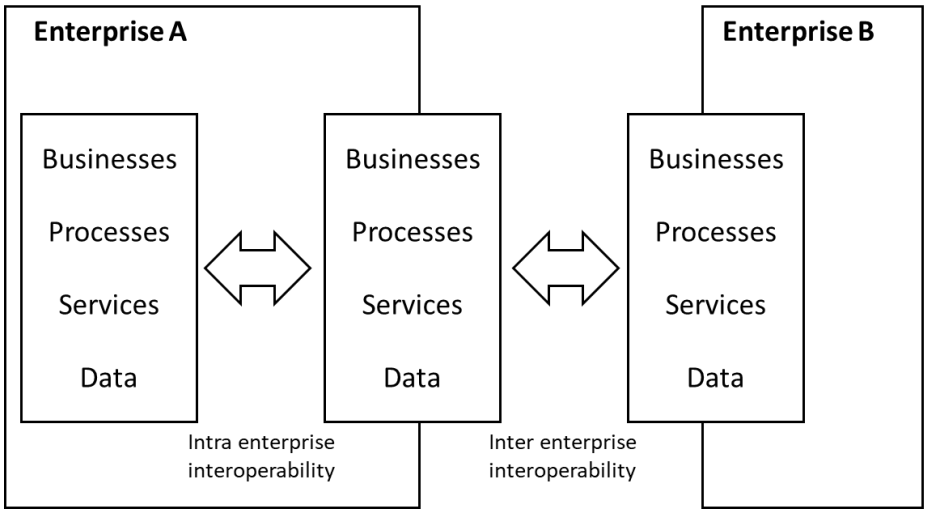


Figure 3. Intra and inter enterprise's interoperability.
Adapted from (Jakimoski, 2016)

Therefore, detecting interoperability problems as quickly and extensively as possible and solving them in a both adequate and efficient manner is in the best interest of enterprises operating in a wide variety of industries, particularly those involved in collaborative business processes, in highly competitive and regulated environments.

2.4 Standards and best practices

Standard is a level of quality or achievement, thought to be acceptable. It also means something (criterion, protocol, measure, guideline, example) used to judge the quality of something else or to guide the creation of a good or a service. Consequently, standardization is the process of developing, promoting and mandating standards-based and compatible technologies and processes within a given industry. Standards for technologies can in force quality and consistency features to ensure compatibility, interoperability and safety.

The standardization process involves several stakeholders, such as users, producers, distributors, merchants, interest groups, governments, and standards organizations. The development of standards and specifications offers each stakeholder exclusive benefits. To enterprises, the benefits are fulfillment of market requirements; competitiveness due to a time and knowledge advantage; productivity and efficiency due to early insights into market developments and regulatory processes; stronger market position due to prompt implementation of new regulation; and cost reduction (DKE German Commission for Electrical, 2022).

Management philosophies Lean and Six Sigma both focus on establishing standards (Pepper & Spedding, 2010). The business process standardization is one of the first steps towards process automation. Organizations engage in standardization and optimization of processes to increase efficiency, compatibility, availability, productivity, auditability, automation, regulatory compliance and customer satisfaction (Kokina & Blanchette, 2019).

Business processes standards aim to provide a common understanding and alignment on the information shared among entities within an enterprise and among enterprises acting as partners, making collaboration a feasible and tending smother process.

According to Google Trends Analysis, RPA only started to become a trendy topic (score: 25/100) in March 2017. Despite the existence of several RPA vendors and products in the market, the guidelines and frameworks offered by suppliers and consultants may provide biased information. Meanwhile, academic research in these topics is still incipient (Syed *et al*., 2020). Therefore, is not surprising the nonexistence of a standard framework for BPA description. In its absence, the use of a set of best practices is the commitment to use all the knowledge and experience disposable to ensure the desired optimal results.

Best practices are procedures that have been shown by research and experience to produce optimal results and that is established or proposed as a standard suitable for widespread adoption (Merriam-Webster Dictionary, 2022). Optimal results are assessed in terms of performance improvement, such as process efficiency, effectiveness and quality, in four dimensions: time, cost, quality and flexibility. Generally, best practices are extracted from literature reviews, interviews, surveys and focus groups. In a quantitative approach, best practices can be obtained from historical data analysis (Pope *et al*., 2021).

3 Literature review

A Systematic Literature Review (SLR) is a means of identifying, evaluating and interpreting all available research relevant to a particular research question, or topic area, or phenomenon of interest. Its aim is to present a fair evaluation of a research topic by using a trustworthy, rigorous, and auditable methodology (Kitchenham, 2004).

The SLR performed in this research followed Kitchenham's Procedures for Performing Systematic Reviews (Kitchenham, 2004), which comprises three main phases:

- Planning: identification of the need for a review that summarizes all existing information about some phenomenon in a thorough and unbiased manner; specification of the research questions, goals, inclusion and exclusion criteria; and development of the review protocol;
- Conducting: selection of primary studies; quality assessment of the selected studies; data extraction using the review protocol developed in the previous phase;
- Reporting: summarization of the extracted information relevant for the study goals and effective communication of the results.

Figure 4 illustrates the adaptation of the methodology to this research.

The election of SLR as research methodology was due to the objective of collecting maximum information concerning the investigation problem and obtaining answers to the research questions.

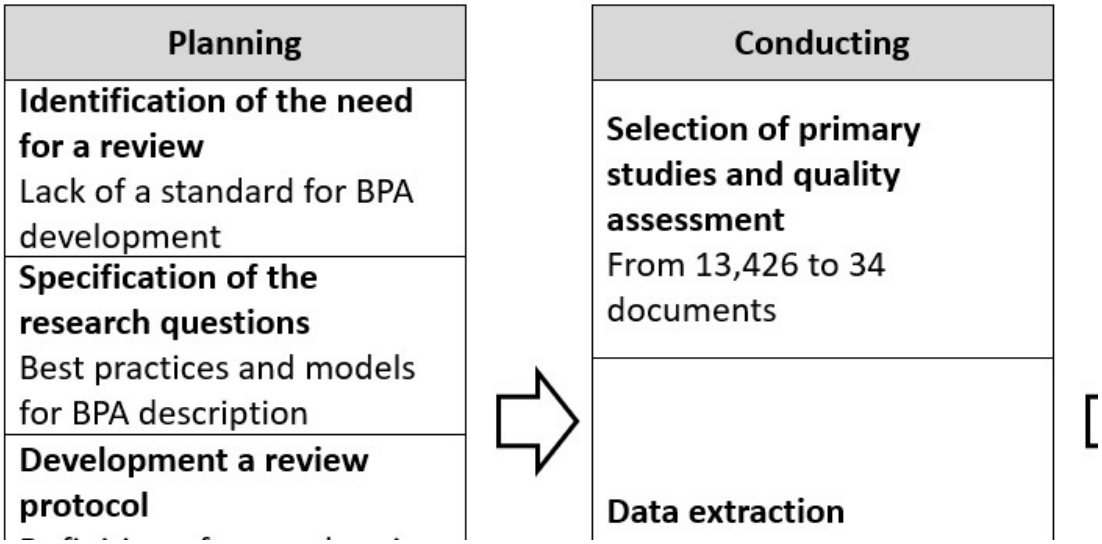


Figure 4. SLR phases.

Adapted from (Kitchenham, 2004)

3.1 Planning

This phase addresses the first phase of the SLR and its stages. Its subsections explain the motivation for this work, enunciate the research questions and describe the review protocol.

3.1.1 Motivation

Enterprises' demand for new technological innovations (Mazilescu & Micu, 2019) and an increasing degree of BPA so to stay competitive in their markets (Wewerka & Reichert, 2021), as well as to explore new markets. And, evermore frequently, competitiveness means collaboration with external partners and transparency toward stakeholders. In this context, the digital lifecycle support of business processes involves multiple participants and software systems.

Although BPA is becoming more common and more organizations are implementing software products to automate at least some of the daily or regular activities (Mazilescu & Micu, 2019), enterprises still have difficulties to fully understand the fundamental concepts of BPA, to accurately estimate the effects of its introduction in the organization (Wewerka & Reichert, 2021) and to assertively decide which model to implement: the creation of Automation Centers of Excellence (CoE) in order to acquire the appropriate level of competence to internally improve the operation of the enterprise or outsourcing and obtaining automation services from external contractors (Marciniak & Stanisławski, 2021).

Whatever model chosen, from among the many possible listed in Table 1, an enterprise should be able to change from one to another or simply select a different vendor, avoiding vendor's lock-in situations. The inexistence of standards applicable to BPA description is a critical obstacle to interoperability, harming an enterprise ability to renegotiate prices and/or to get a better service.

This work intends to collect a set of best practices that organizations will be able to adopt for the technological-independent description of their business processes automation and elements to perform an alignment assessment, so to avoid the adverse and pernicious situations mentioned above.

Table 1. RPA sourcing options description.
Adapted from (Lacity & Willcocks, 2016)

Sourcing options	Description
Insource	Purchase RPA licenses directly from RPA software providers.
Insource and consulting	Purchase RPA licenses directly from RPA software providers and engage consulting firms for services and configurations.
Outsourcing with a traditional business process outsourcing (BPO) provider	Purchase RPA as part of an integrated service delivered by a traditional BPO providers.
Outsourcing to RPA providers	Purchase RPA from the new breed of RPA outsourcing providers.
Cloud-source	Purchase RPA through cloud services.

3.1.2 Objective

SLR is an important activity in scientific research. When trying to summarize all existing information about some phenomenon in a thorough and unbiased manner; provides the synthesis of existing knowledge, which is then used to answer the research questions.

3.1.3 Research questions

The search intended to achieve two main objectives concerning BPA description. Therefore, to attain these objectives two research questions (RQ) were formulated:

RQ1. Which are the best practices for the technological-independent description of their business process automation?

RQ2. Which are the description models available for the technological-independent description of their business process automation?

3.1.4 Protocol

The protocol first step was the definition of a search string. A combination of keywords, expressions and symbols, or truncated versions, and Boolean operators designed to conduct a search in a set of chosen data sources targeting the maximum number of relevant publications on the study subject.

This work made use of the following:

Search string: ((“robotic process automation” OR “business process automation”) AND (“best practice*” OR “good practice*” OR guid* OR standar* OR model* OR framework OR approach* OR theor* OR map*))

and

Data sources: Academic Search Complete (ASC), Business Source Complete (BSC), Complementary Index (CI), Dialnet (D), Directory of Open Access Journals (DOAJ), IEEE Xplore Digital Library (IEEE), ResearchGate (RG), Science Citation Index Expanded (SCIE), ScienceDirect (SD), Scopus (S), Social Sciences Citation Index (SSCI).

The second step involved the definition of inclusion and exclusion criteria and their subsequent application on the set of publications resultant from step one. The criteria used in this work are presented on Table 2.

Table 2. Inclusion and exclusion criteria.

Inclusion criteria	Exclusion criteria
White paper	Different focus
Discipline of Information Technology	Published before Jan2010
Full document availability	Duplication

The third step involved the reading of the abstract and the conclusions of the set of publications resultant from the previous step two. This allowed discarding articles not relevant enough to the subject of this study.

The fourth step was the full reading of the set of publications resulting from step three. This ensured a short list of the most relevant articles.

After careful examination of the articles, a backward and forward search was performed. The newly identified papers were then scrutinized under the same criteria used in the first iteration. This fifth and final step led to the final list of papers.

3.2 Conducting

Describes the second phase of SLR and its stages. Its subsections detail the execution of the review protocol and the analysis of its results.

3.2.1 Selection of publications

The application of the search string to the chosen data sources resulted in a total of 13,426 documents. The use of the criteria presented on Table 2 excluded 13,322. Reading the abstract and the conclusions of the remaining 104 discarded another 58. The full reading of the remaining 46 documents dismissed 25. The short list of relevant publications was then complete with a total of 17 documents. The backward and forward search allowed the identification of another set of 17 documents, leading to a final list of 34 documents. Papers' selection according to the review protocol is summarized in Figure 5.

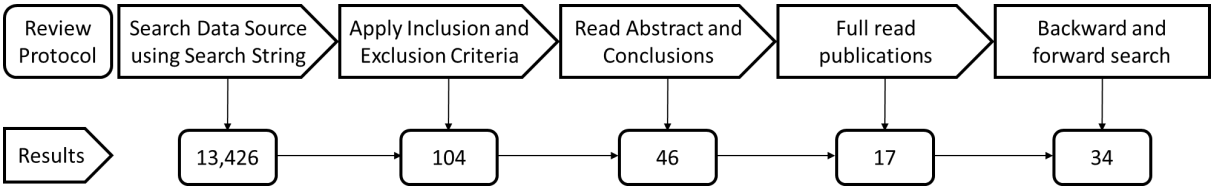


Figure 5. Selection of papers.

Table 3 lists the selected documents, showing author, title and ordered by year of publications.

Table 3. List of selected documents.

Year	Author	Title
2013	Grossmann *et al.*	Design for service compatibility
2014	Fung	Criteria, Use Cases and Effects of Information Technology Process Automation (ITPA)
2014	Heravi *et al.*	Ontology-based standards development: Application of OntoStanD to ebXML business process specification schema
2015	Mallek *et al.*	Enabling model checking for collaborative process analysis: from BPMN to 'Network of Timed Automata'
2015	Mu *et al.*	A methodology proposal for collaborative business process elaboration using a model-driven approach
2016	Lacity & Willcocks	Robotic Process Automation at Telefónica O2
2017	Anagnoste	Robotic Automation Process -The next major revolution in terms of backoffice operations improvement
2017	Dunlap & Lacity	Resolving tussles in service automation deployments: service automation at Blue Cross Blue Shield North Carolina

Year	Author	Title
		(BCBSNC)
2017	Willcocks *et al.*	Robotic process automation: strategic transformation lever for global business services?
2018	Issac *et al.*	Delineated Analysis of Robotic Process Automation Tools
2018	Ratia *et al.*	Robotic Process Automation – Creating Value by Digitalizing Work in the Private Healthcare?
2019	Cooper *et al.*	Robotic Process Automation in Public Accounting
2019	Huang & Vasarhelyi	Applying robotic process automation (RPA) in auditing: A framework
2019	Kokina & Blanchette	Early evidence of digital labor in accounting: Innovation with Robotic Process Automation
2019	Leno *et al.*	Action logger: enabling process mining for robotic process automation
2019	Lewicki *et al.*	Are Robots Taking Our Jobs? A RoboPlatform at a Bank.
2019	Madakam *et al.*	The future digital work force: robotic process automation (RPA)
2019	Mazilescu & Micu	Technologies that through Synergic Development can support the Intelligent Automation of Business Processes
2019	Osman	Robotic Process Automation: Lessons Learned from Case Studies
2019	Phillips & Collins	Automation – It does involve people
2019	Sobczak	Developing a robotic process automation management model.
2019	William & William	Improving Corporate Secretary Productivity using Robotic Process Automation
2020	Enriquez *et al.*	Robotic Process Automation: a Scientific and Industrial Systematic Mapping Study
2020	Hofmann *et al.*	Robotic process automation
2020	Leno *et al.*	Robotic Process Mining: Vision and Challenges.
2020	Liu *et al.*	A framework to evaluate the interoperability of information systems – Measuring the maturity of the business process alignment
2020	Syed *et al.*	Robotic Process Automation: Contemporary themes and challenges
2020	Szelągowski & Lupeikiene	Business Process Management Systems: Evolution and Development Trends
2021	Brdjanin *et al.*	Automatic derivation of conceptual database models from differently serialized
2021	Kedziora & Penttinen	Governance models for robotic process automation: The case of Nordea Bank
2021	Keung *et al.*	Data-driven order correlation pattern and storage location assignment in robotic mobile fulfillment and process automation system

Year	Author	Title
2021	Leno *et al.*	Discovering data transfer routines from user interaction logs
2021	Ng *et al.*	A systematic literature review on intelligent automation: Aligning concepts from theory, practice, and future perspectives
2021	Wewerka & Reichert	Robotic process automation – a systematic mapping study and classification framework

3.2.2 Data extraction analysis

The data extraction analysis presents the appraisal of several parameters of the selected papers, such as year of publication, data base, publication type and publication.

Figure 6 portrays the distribution of the selected documents according to their year of publications evidencing an increasing interest in process automation over time.

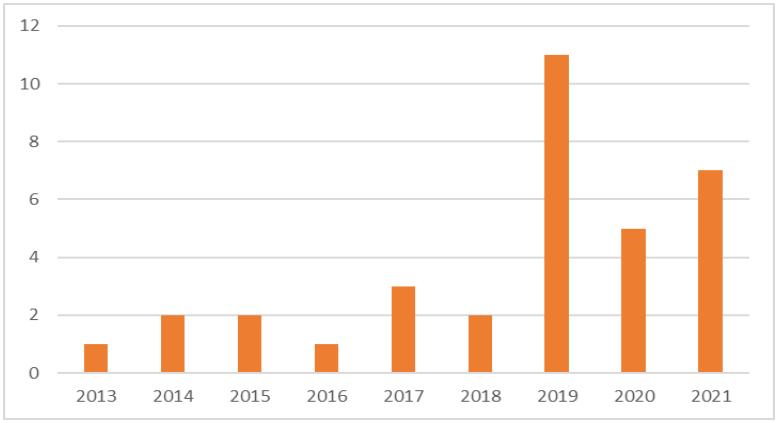


Figure 6. Number of documents per year.

Figure 7 illustrates documents' provenance according to data base. It shows a variety of data bases and the relevance of Scopus and ScienceDirect.

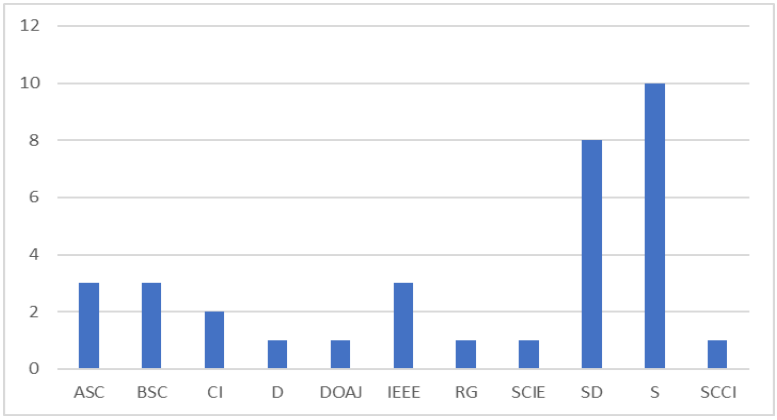


Figure 7. Number of documents per data base.

Figure 8 represents the documents' distribution between publication types, displaying preponderance of journal articles (88.24%) over conference papers (11.76%).

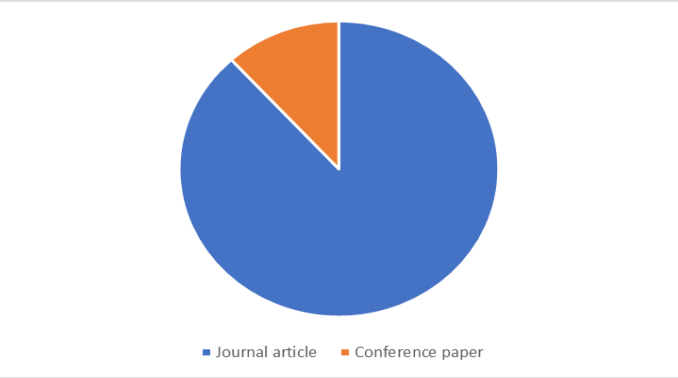


Figure 8. Distribution of documents between publication types.

Tables 4 and 5 displays documents' distribution based on their publication. Reveals a rather broad distribution among different knowledge areas.

Table 4. Number of documents per conference.

Conference	Nr. of papers
International Conference on Business Process Management	1
International Academic Mindtrek Conference	1
International Conference on Advances in Electronics, Computers and Communications	1
International Conference on Technologies and Applications of Artificial Intelligence	1

Table 5. Number of documents per publication.

Publication	Nr. of papers
Accounting Horizons	1
Advanced Engineering Informatics	2
Advances in Robotics & Automation	1
Annals of the University Dunarea de Jos of Galati	1
Business & Information Systems Engineering	1
Business Informatics	1
Business Information Review	1
Computers in Industry	1
Electronic Markets	1
Enterprise Information Systems	3
IEEE Access	1
IEEE Software	1
Informatica	1
Informatica Economica	1
Information Systems	1

Publication	Nr. of papers
International Journal of Accounting Information Systems	3
International Journal of Information Management	1
Journal of Information Systems and Technology Management	1
Journal of Information Technology Teaching Cases	3
MIS Quarterly Executive	1
Proceedings of the International Conference on Business Excellence	1
Software and Systems Modeling	2

3.3 Reporting

This section concerns the third phase of the SLR. Its subsections present the results from the selected papers' analysis with the aim of answering the previously defined research questions.

3.3.1 Best practices for technological-independent description of BPA

Analyzing the selected documents allowed the identification of a set of practices summarized in Table 6 and examine in further detail in this section.

Table 6. Practices of BPA description.

Practice	Source
Modelling the business process	(Cooper *et al*., 2019), (Dunlap & Lacity, 2017), (Enriquez *et al*., 2020), (Fung, 2014), (Grossmann *et al*., 2013), (Heravi *et al*., 2014), (Hofmann *et al*., 2020), (Huang & Vasarhelyi, 2019), (Issac *et al*., 2018), (Kedziora & Penttinen, 2021), (Keung *et al*., 2021), (Kokina & Blanchette, 2019), (Lacity & Willcocks, 2016), (Lewicki *et al*., 2019), (Liu *et al*., 2020), (Madakam *et al*., 2019), (Mallek *et al*., 2015), (Mazilescu & Micu, 2019), (Mu *et al*., 2015), (Ng *et al*., 2021), (Phillips & Collins, 2019), (Ratia *et al*., 2018), (Sobczak, 2019), (Syed *et al*., 2020), (Szelągowski & Lupeikiene, 2020), (Wewerka & Reichert, 2021), (Willcocks *et al*., 2017), (William & William, 2019)
Specification of key performance indicators	(Anagnoste, 2017), (Cooper *et al*., 2019), (Fung, 2014), (Hofmann *et al*., 2020), (Huang & Vasarhelyi, 2019), (Kedziora & Penttinen, 2021), (Keung *et al*., 2021), (Kokina & Blanchette, 2019), (Lacity & Willcocks, 2016), (Madakam *et al*., 2019), (Mazilescu & Micu, 2019), (Ng *et al*., 2021), (Phillips & Collins, 2019), (Ratia *et al*., 2018), (Sobczak, 2019), (Syed *et al*., 2020), (Wewerka & Reichert, 2021), (Willcocks *et al*., 2017), (William & William, 2019)
Modelling of As-Is/To-Be scenarios	(Enriquez *et al*., 2020), (Hofmann *et al*., 2020), (Huang & Vasarhelyi, 2019), (Kedziora & Penttinen, 2021), (Keung *et al*., 2021), (Kokina & Blanchette, 2019), (Lacity & Willcocks, 2016), (Madakam *et al*., 2019), (Mazilescu & Micu, 2019), (Ng *et al*., 2021), (Osman, 2019), (Phillips & Collins, 2019), (Ratia *et al*., 2018), (Sobczak, 2019), (Syed *et al*., 2020),

Practice	Source
	(Willcocks *et al*., 2017), (William & William, 2019)
Modelling of user interface objects	(Anagnoste, 2017), (Cooper *et al*., 2019), (Enriquez *et al*., 2020), (Heravi *et al*., 2014), (Hofmann *et al*., 2020), (Huang & Vasarhelyi, 2019), (Lacity & Willcocks, 2016), (Leno *et al*., 2020), (Leno *et al*., 2021), (Madakam *et al*., 2019), (Osman, 2019), (Ratia *et al*., 2018), (Sobczak, 2019), (Syed *et al*., 2020), (William & William, 2019)
Modelling rules and decisions	(Anagnoste, 2017), (Cooper *et al*., 2019), (Dunlap & Lacity, 2017), (Enriquez *et al*., 2020), (Fung, 2014), (Hofmann *et al*., 2020), (Kedziora & Penttinen, 2021), (Keung *et al*., 2021), (Kokina & Blanchette, 2019), (Leno *et al*., 2020), (Madakam *et al*., 2019), (Ng *et al*., 2021), (Syed *et al*., 2020), (Wewerka & Reichert, 2021), (Willcocks *et al*., 2017),
Engagement of all stakeholders	(Anagnoste, 2017), (Cooper *et al*., 2019), (Enriquez *et al*., 2020), (Fung, 2014), (Hofmann *et al*., 2020), (Kedziora & Penttinen, 2021), (Keung *et al*., 2021), (Kokina & Blanchette, 2019), (Lacity & Willcocks, 2016), (Leno *et al*., 2020), (Madakam *et al*., 2019), (Ratia *et al*., 2018), (Sobczak, 2019), (Syed *et al*., 2020)
Modelling logs and exceptions	(Anagnoste, 2017), (Enriquez *et al*., 2020), (Huang & Vasarhelyi, 2019), (Kedziora & Penttinen, 2021), (Kokina & Blanchette, 2019), (Lacity & Willcocks, 2016), (Leno *et al*., 2020), (Lewicki *et al*., 2019), (Madakam *et al*., 2019), (Ng *et al*., 2021), (Ratia *et al*., 2018), (Sobczak, 2019), (Syed *et al*., 2020), (Wewerka & Reichert, 2021)
Modelling data extraction and transformation	(Brdjanin *et. al*, 2021), (Heravi *et al*., 2014), (Hofmann *et al*., 2020), (Huang & Vasarhelyi, 2019), (Leno *et al*., 2020), (Leno *et al*., 2021), (Madakam *et al*., 2019), (Mazilescu & Micu, 2019), (Syed *et al*., 2020)
Modelling choreography	(Anagnoste, 2017), (Grossmann *et al*., 2013), (Heravi *et al*., 2014), (Hofmann *et al*., 2020), (Lewicki *et al*., 2019), (Mallek *et al*., 2015), (Mu *et al*., 2015), (Sobczak, 2019), (William & William, 2019)
Modelling related systems	(Cooper *et al*., 2019), (Fung, 2014), (Hofmann *et al*., 2020), (Leno *et al*., 2020), (Lewicki *et al*., 2019), (Mazilescu & Micu, 2019), (Ng *et al*., 2021), (Syed *et al*., 2020)
Specification of compliance checking	(Cooper *et al*., 2019), (Huang & Vasarhelyi, 2019), (Lacity & Willcocks, 2016), (Syed *et al*., 2020)
Adoption of modular system	(Hofmann *et al*., 2020), (Kedziora & Penttinen, 2021), (Syed *et al*., 2020)

Many enterprises engage in an early practice of modelling their business processes, so to better understand its complexity as well as to document it at a granular level of detail (Kokina & Blanchette, 2019). Most commonly this also involves a process discovery, in which undergo the analysis of AS-IS process and its transformation into an automated TO-BE process (Osman, 2019). This reengineering leads to optimized business processes (Syed *et al*., 2020), through its better understanding, simplifica-

tion, standardization and stabilization (Lacity & Willcocks, 2016), increasing its automation viability. Automation is recognized as an opportunity to simplify processes and eliminate redundant or non-value adding tasks (Osman, 2019).

Also mentioned in a great number of cases is the practice of identifying the main performance metrics, as for instance the labour intensity, the error reduction rate, the straight-through processing rate, the number of systems involved, the number of process task exceptions, the rate of human intervention in case of automation failure, the number of task steps, current costs, or process task maturity (Wewerka & Reichert, 2021) (Kokina & Blanchette, 2019). Automation is recognized for helping improve process key performance indicators (Hofmann *et al*., 2020), some with the additional purpose of justifying the investment in automation tools.

Rules-based is one of the key ingredients to process automation as mentioned throughout the literature and embedded in its own definition (Leno *et al*., 2020). Decision logic needs to be expressed in terms of business rules (Syed *et al*., 2020), since automation requires a prescribed rule for every eventuality: a deterministic outcome, which needs to be unambiguous. Alongside comes exception handling, particularly relevant during scripting phase of automation software development. A broader script including multiple exceptional behaviours can act as a mitigator of several sorts of risks (e.g., ethical, security, regulatory). The set of business rules can be augmented to higher levels of sophistication to answer progressively complex demands with increasingly robustness and compliancy (Dunlap & Lacity, 2017).

Software robots work with systems in the presentation layer in the sense that the execution of the software robot in an information system ecosystem does not impact on the underlying infrastructure of the business logic or on the data access layers (Hofmann *et al*., 2020). Thus, the implementation of automation techniques requires detailed description of users' behaviours that automation is to replicate (Enriquez *et al*., 2020), such as data transfer routines (e.g., copying, cutting, pasting, and editing operations), user interface navigation steps to transfer and/or edit data available in one set of fields (or cells) of the user interface of a software application to another set of fields of the same or another application (Leno *et al*., 2021). These connections between software applications and the fact that frequent access to multiple systems is identified as a characteristic of a good candidate to automation recommend mapping of systems and applications interconnections (Fung, 2014) (Lewicki *et al*., 2019). Relevant not only to anticipate the need of robot's script adaptation to respond to related system / application's changes and graphical interfaces' evolutions but also to allow evolution to knowledge-based software robots, capable of search for information across systems (Hofmann *et al*., 2020).

BPA development and maintenance involves several participants, from business users to regulatory entities (Syed *et al*., 2020). Automation, in some cases, is built by one or several business units (Kedziora & Penttinen, 2021) (Syed *et al*., 2020); sometimes involves process owners; in other cases, internal and/or external IT professionals, consultants and automation specialists take part (Lacity & Willcocks, 2016); and, in some industries' context, the participation of internal and/or external controllers and auditors is indispensable (Kedziora & Penttinen, 2021) (Madakam *et al*., 2019). Comprehensive engagement of participants and governance model's elements are considered relevant in mitigation of both potential problems (Kedziora & Penttinen, 2021) and compliance risks (Syed *et al*., 2020).

Conformity is a broad theme, from event log control (Wewerka & Reichert, 2021), through exception handling, up to security and regulatory requirements (Kedziora & Penttinen, 2021). Therefore, the design phase of a BPA should include functionalities to validate the design of the process before deployment, as well as an escape flow in the event of faults in the usual flow (Grossmann *et al*., 2013).

Another recognized functional requirement is data-awareness (Leno *et al*., 2019), since data are crucial in rule-based decision making as well as determinant to performance quality related to data transformation. More relevant than the fact that automation typically involves large volumes of data, is the fact that many are semi-structured or unstructured and must be extracted, processed and transferred to different locations (databases or applications) (Mazilescu & Micu, 2019). Consequently, to apply automation techniques, it is necessary to have detailed information on all applications used (Enriquez *et al*., 2020). Particularly relevant when foreseen an evolution to more sophisticated automation, by addition of artificial intelligence (machine learning and cognitive computing) (Cooper *et al*., 2019).

Broader scale BPA employment in an organization requires close interaction of several stakeholders: the units responsible for developing and maintaining the robots (an internal automation CoE or an external contractor); the business departments that are beneficiaries of the implemented automation and sometimes act as automation developers; the IT department responsible for developing and maintaining the applications used in automated processes; and the departments responsible for security and compliance (Sobczak, 2019). Due to BPA scalability, error propagation is a very serious matter, assuming special relevancy in highly regulated industries (Ratia *et al*., 2018). Stakeholders' involvement and collaboration grants a desirable multi-disciplinarity that should be fostered by management strategy (Enriquez *et al*., 2020).

Auditability and conformance checking are issues also to address. Although automation may be used in detecting anomalous actions against compliance rules, automation description must allow auditability to embedded rules and its execution (Syed *et al*., 2020), both from the organization internal point of view (e.g., conformance with IT governance rules (Lacity & Willcocks, 2016)) as from the organization external point of view (e.g., conformance with regulatory rules (Huang & Vasarhelyi, 2019)).

End-to-end process automation may not be the most advisable strategy. Automation of subprocesses of the given process or even process building blocks could be a better approach. The challenge seems to be the discovery of partially deterministic routines so to store re-usable and scalable modules, replicating activities and execution logic in different processes and contexts, highlighting synergies in automation across business departments (Hofmann *et al*., 2020).

3.3.2 Description models for technological-independent description of BPA

Different description models were mentioned in the collection of papers, as listed in Table 7 and subsequently detailed.

Table 7. Description models in BPA.

Description model	Source
BPMN and extensions	(Grossmann *et al*., 2013), (Heravi *et al*., 2014), (Keung *et al*., 2021), (Leno *et al*., 2019), (Leno *et al*., 2020), (Mallek *et al*., 2015), (Mu *et al*., 2015), (Sobczak, 2019), (Syed *et al*., 2020), (Wewerka & Reichert, 2021)
Petri net	(Grossmann *et al*., 2013), (Heravi *et al*., 2014), (Mu *et al*., 2015)
BPEL	(Heravi *et al*., 2014), (Mu *et al*., 2015)
Proprietary model	(Enriquez *et al*., 2020), (Liu *et al*., 2020)
BPMN-R	(Syed *et al*., 2020)
ebXML Business Process Specification Schema	(Heravi *et al*., 2014)
Process map	(Phillips & Collins, 2019)
Network of Timed Automata (NTA)	(Mallek *et al*., 2015)

From the cases reported in the literature, many enterprises document the automated process flow using Business Process Model and Notation (BPMN), or some extension of it. This graphical notation allows both business processes specification directly by the stakeholders who design, manage and realize business processes and its diagrams' translation into software process components.

However, other description models appear related with special features such as using Petri net notation to modelling service processes in behavioural compatibility checking and diagnosis (Grossmann *et al*., 2013); ebXML Business Process Specification Schema (ebBP) in a business-to-business context with the aim of improving standards-based interoperability between trading partners (Heravi *et al*., 2014); Process map to illustrate a process flow (Phillips & Collins, 2019); or Network of Timed Automata (NTA) in a collaborative context with the purpose of solving interoperability problems (Mallek *et al*., 2015).

3.4 Discussion

The SLR reveled the inexistence of a standard for technological-independent automation description. Although, provided relevant information to enlighten the research problem.

It is acknowledged that well documented processes, providing process descriptions that accurately detail processes, are essential for automation development and that higher levels of process knowledge determine shorten automation's programming and testing time. Concurrently, it is recognized that the various guidelines and frameworks offered by vendors and consultants for the selection and implementation of BPA solutions may not always provide unbiased information and that most market available solutions do not adequately cover the analysis and design phases of the BPA lifecycle.

The SLR allowed confirmation that changing from an internally developed automation solution to an external commercial product involved completely rebuilt the automation solution. Constraining in any

circumstance, in same industries, with higher standards for security and regulatory compliance (e.g., power supply, pharmaceutical, accounting, banking), the change may be proven unviable.

Many of the practices identified were extensively apparent throughout the selected papers, establishing themselves as good candidates to best practice for technological-independent automation description.

The attempt to learn best practices from best performing cases described in literature, through contextual, behavioral and performance differences and similarities analysis, is perceived as successful since it enabled the identification of a set of proven practices pointing to detailed description of the characteristics of each process to be automated, including information such as objectives, scope, metrics, deliverables, stakeholders, customers, input data, output data, business rules, transformation rules, requirements, systems' interactions.

Although less expressive, the SLR also provided an insight about adequate modelling languages. Perhaps not surprising the prevalence of BPMN usage, given its goal to support Business Process Modeling by providing a standard notation that is comprehensible to business users yet represents complex process semantics for technical users.

4 Research problem

As stated by Pentti Hakkarainen, member of the Supervisory Board of the European Central Bank, on January 13th, 2022, at the Institute for Financial Integrity and Sustainability, "New technological developments are exerting competitive pressure on banks. Banks will need to react to the changes in their customers behavior, demanding more efficient and convenient online services. There are also new risks that come with technological developments. Using technology more widely and involving third parties more heavily, for example through outsourcing and cloud computing, will make banks more dependent on the availability of IT services and more vulnerable to cyber risk." (Hakkarainen, 2022).

Banking sector has an increasingly complex and demanding regulatory context (Basel Committee on Banking Supervision, 2017). In the aftermath of the 2008's world financial crisis, the COVID-19 pandemic and the recent geopolitical events have highlighted the unpredictable nature of external shocks that can impact the sector. These unexpected external events increase the risk of inadequate responses to new market conditions and underline both needs to reinforce internal processes and controls on the application systems and to minimize technological vulnerabilities.

Innovation on banking sector evolves alongside with globalization and digital transformation of the economy. This broader arena implicates the need for an enhanced competitiveness capacity but also the opportunity to further collaboration. Lowering risks and costs and increasing productivity and margins requires appropriate technological tools. Automation of business processes is among them (Hofmann *et al*., 2020). According to Information Services Group (ISG, 2018), 54% of European companies were planning to automate at least 10 processes via RPA by 2020. ISG's 2018 EMEA RPA Study, involving 549 European business leaders, revealed a mix picture, showing that one-third of the enterprises had chosen to handle some, or all, of their RPA transformation inhouse, half were engaged with external consultants and service providers, and that was almost twice more probable to

use a previously existing provider relationship when considering RPA implementation and management (Information Services Group, 2018).

This scenario, combined with an increasing number of RPA commercial solutions, represents a challenge to the enterprises' ability to share information and business services and functionalities. No matter how flexible the enterprises' infrastructure, implementing and managing increasingly complex, intelligent, agile, robust and responsive BPA requires the dynamic interaction of highly compatible solutions. Interoperability becomes a requirement to success and resilience (Liu *et al*., 2020).

In conducting this study, a Portuguese financial institution was used (detailed in section 5.1.1). This enterprise - Banco Comercial Português, S.A. - shares with its European pears a highly competitive and tightly regulated environment, stressed by recent geopolitical events. On top of this, struggles with an historical low growth economy as the Portuguese and constraints on profitability imposed by law, regarding mandatory contributions to the National Resolution Fund, and restrictions on the application of market conditions to bank charges and commissions. Nevertheless, the bank's 2021-2024 strategic plan reinforces among its acting priorities leading in efficiency by lowering costs and enhancing productivity through reengineering and automation of business processes and deepening the advantage of data and technology by focusing on the implementation of a leading-edge data platform and a comprehensive application of advanced analytical models enabling differentiation through distinctive competencies of large-scale personalization, intelligent automation and informed and agile management of business processes and regulatory compliance (Banco Comercial Português, S.A., 2022a).

As a process-oriented organization, is in Banco Comercial Português, S.A.'s best interest to assess its current situation concerning interoperability at the pragmatic level, on the matter of BPA description. In the absence of standards applicable to BPA description, the set of best practices collected through the SLR was used to perform an alignment assessment regarding the bank's adoption of a technological-independent description of its business processes automation.

5 Research methodology

The aim of this study is the search for a set of best practices for the technological-independent BPA description and on the necessary elements to perform an alignment assessment. Due to the shortage of relevant literature relating the research topic, the investigation methodology chosen was the case study.

Following the steps described in subsection 1.3, this study is expected to provide initial insights on the research problem, casting a "first stone" to further studies that may contribute to the development of well-grounded and generalizable propositions (Eisenhardt & Graebner, 2007). This study follows a single case design and uses a descriptive – given that tries to completely describe different characteristics of a phenomenon in its context – and exploratory – since dealing with a not well-known situation - qualitative and quantitative methodology (Yin, 1994).

Critics of the case study method, more oriented towards quantitative methods, question the reliability and/or generalizability of the results obtained with a small number of cases, the bias of the conclu-

sions due to overexposure of the investigator and its usefulness in addition to being an exploratory tool (Soy, 1997). Its robustness thus depends on the validity of the construct, on internal and external validation and on reliability, based on the rigorous application of the phases of the process: careful definition of research questions, meticulous design (selection of cases and collection and analysis techniques), preparation of the collection, data collection, analysis and presentation of results (Baškarada, 2014).

The two first steps of case study methodology are described in the next two subsections. The two subsequent steps are addressed in the next section.

5.1 Research design and case selection

The definition of the research problem was given in subsection 1.2. It was followed by a comprehensive SLR, from which emerged the RQ also listed in subsection 1.2 and the study objectives stated there.

The case selection was based on convenience and special interest (Baškarada, 2014). On one hand, the unit of analysis ensured accessibility, affordability, and feasibility for data collection purposes, on the other hand, the research problem represents a practical and current dilemma for the unit of analysis.

5.1.1 The case: Banco Comercial Português, S.A.

The case study took place at Banco Comercial Português, S.A. (BCP), commercially known as Millennium bcp, a Portuguese commercial bank that is part of BCP Group. The Group provides banking services and financial activities in Portugal and in foreign markets as Poland, Mozambique, Angola (through its associate Banco Millennium Angola, S.A.) and China (Figure 9).

Millennium bcp is Portugal's largest private sector banking institution and is focused on the retail and enterprises' markets, providing a variety of financial products and services, through a modern branch network with wide domestic coverage, several foreign offices and remote banking channels (banking service by telephone and online). At the end of March 2022, the bank had 421 branches in Portugal (including one branch in Macao), serving over 2.5 million customers, with particular emphasis on the expansion of the mobile customer base: a 20% increase year-on-year, to 1.2 million customers (Banco Comercial Português, S.A., 2022b).

Figure 9. BCP Group geographical location.

Adapted from (Banco Comercial Português, S.A., 2022b)

BCP was incorporated on June 25th, 1985, as a limited liability company ("sociedade anónima") organized under the laws of Portugal following the deregulation of the Portuguese banking industry. BCP was founded by a group of over 200 shareholders and a team of experienced banking professionals who sought to capitalize on the opportunity to form an independent financial institution that would serve the then underdeveloped Portuguese financial market more effectively than state-owned banks (Banco Comercial Português, S.A., 2022b).

Initially, Bank's development was characterized by organic growth, a series of strategic acquisitions helped solidify its position in the Portuguese market and increase its offering of financial products and services. In March 1995, BCP acquired control of Banco Português do Atlântico, S.A. (BPA), which was then the largest private bank in Portugal. This was followed by a joint takeover bid for the whole share capital of BPA. In June 2000, BPA was merged into BCP. In 2000, BCP also acquired Império insurance company, along with Banco Mello and Banco Pinto & Sotto Mayor (Banco Comercial Português, S.A., 2022b).

In 2004, with a view to strengthening its focus on the core business of distribution of financial products and optimizing capital consumption, BCP sold insurers Império Bonança, Seguro Directo, Impergesto and Servicomercial to the Caixa Geral de Depósitos group. BCP reached an agreement with Fortis (currently Ageas) for the sale of a controlling stake and management control of insurers Ocidental - Companhia Portuguesa de Seguros, S.A., Ocidental - Companhia Portuguesa de Seguros de Vida, S.A. and Médis - Companhia Portuguesa de Seguros de Saúde, S.A., as well as the pension

fund manager PensõesGere - Sociedade Gestora de Fundos de Pensões, S.A. (Banco Comercial Português, S.A., 2022b).

After the consolidation of its position in the Portuguese banking market, the Bank focused on the development of its retail business in new regions, with the goal of attaining significant positions in emerging markets in Europe and in Africa. The Bank concentrated on businesses with strong growth prospects in foreign markets with a close historical connection to Portugal or that have large communities of Portuguese origin (such as Angola, Mozambique, the United States, Canada, France, Luxembourg and Macao), as well as in markets where the Bank's successful Portuguese business model can be effectively exported and tailored to suit such local markets, such as Poland, Greece and Romania (Banco Comercial Português, S.A., 2022b).

In October 2003, BCP began the process of replacing these brands in Portugal with a single brand name Millennium bcp. The rebranding in other markets was completed in 2006. All operations of the Bank are now carried out under the "Millennium" brand. In Portugal, the Bank also operates under the "ActivoBank" brand (Banco Comercial Português, S.A., 2022b).

In 2004, the Bank sold its non-life insurance businesses and divested a portion of its life insurance business by entering into a joint venture with Ageas (formerly Fortis), named Millenniumbcp Ageas, of which 51% is held by Ageas and 49% by the bank (Banco Comercial Português, S.A., 2022b).

In recent years, the Bank has refocused on operations that it considers core to its business. As part of this refocus, the Bank divested several of its international operations (in France, Luxembourg, United States, Canada, Greece, Turkey and Romania), while retaining commercial protocols to facilitate remittances from Portuguese emigrants in some markets. In 2010, the Bank transformed its Macao off-shore branch into an on-shore branch (Banco Comercial Português, S.A., 2022b).

Figure 10 summarizes Banco Comercial Português, S.A.'s history highlights.

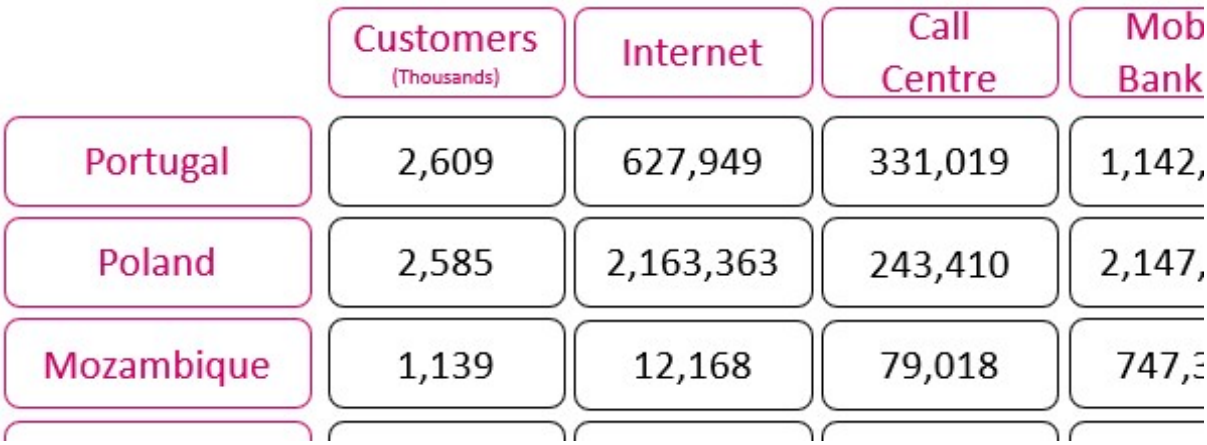
Figure 10. BCP history summary.
Adapted from (Banco Comercial Português, S.A., 2022b)

In July 2013, BCP agreed with the European Commission a restructuring plan, aiming to achieve the operational recovery of its core market and entailing an improvement of the profitability of the BCP in Portugal, through continued cost reduction and reinforcement the bank's financial and capital position (Banco Comercial Português, S.A., 2022b).

The program was successfully implemented, reflecting in 2018 a reduction in operating costs of more than 40% in Portugal, which began in 2011, and a reduction in the volume of non-performing exposures (NPE) of 11 billion euros since 2013. Three competencies were assumed as essential to this recovery: a customer-centric business model, a market leadership in terms of efficiency and a set of competitive and profitable international operations (Banco Comercial Português, S.A., 2022b).

In 2018, BCP Group started a new growth cycle, aiming to ensure profitability and a sustainable position, in a market in which change and the ability to adapt are crucial skills. The strategic plan designed for 2018-2021 included five central priorities for the future: talent mobilization, mobile-centric digitization, growth and leadership in Portugal, growth and international presence, and business model sustainability (Banco Comercial Português, S.A., 2022b).

Successfully execution of 2018-2021 strategic plan was crucial for setting the bank on a solid normalization path by significantly reducing its legacy exposures. It also laid important foundations for the future by a substantial acceleration in the Bank's level of digitization. This trajectory was particularly influenced by developments in Portugal (a 40% reduction of NPEs compared to 2018 and mobile customers up by 48% in 2020 – Figure 11) where the bank managed to recover its volume growth trend (≈5% per year growth in lending and deposits over 2018-20) and increase its share of revenues (+0.6% in 2018-20) in an environment of margin compression and continued low interest rates (Banco Comercial Português, S.A., 2022a).



	Customers (Thousands)	Internet	Call Centre	Mob Bank
Portugal	2,609	627,949	331,019	1,142,
Poland	2,585	2,163,363	243,410	2,147,
Mozambique	1,139	12,168	79,018	747,3

Figure 11. Customers distribution through remote, mobile and automated channels.
Updated on August 31st, 2022. Adapted from (Banco Comercial Português, S.A., 2022b)

This progress was impacted by the COVID-19 pandemic and other exogenous factors, such as the aggravation of risk associated with mortgage portfolio in Poland after 2019 European Union Court of Justice ruling and the subsequent sharp increase in litigation. The new context made it necessary to update the strategic plan and for the moment focus more on Portugal. The 2021-2024 strategic plan

stipulates seven priorities: serving the financial and protection needs of customers with personalized solutions which combine targeted human touch with a leading mobile platform, consolidating its trusted partner role for corporate recovery and transformation, improving capital and risk resilience, maintaining top efficiency, attain data and technology edge, enhancing capability building and talent renewal, and increase sustainability drive (Banco Comercial Português, S.A., 2022a).

During the previous strategic plan, BCP implemented several transformational changes in its operating model that generated productivity gains which can be expected to generate further cost improvements during this cycle, such as: the migration of transactions to mobile and automated channels, branch network reconfiguration, process reengineering / automation, and centralization of selected middle and back-office tasks. During last cycle, the bank also developed new cutting-edge capabilities to start digitally monitoring productivity and tracking the benefits of these changes, facilitating data-driven decisions about resource assignation and capacity management. This transformational agenda was complemented by a thorough review of procurement spending examining both demand management and supplier terms (Banco Comercial Português, S.A., 2022a).

BCP is committed to maintaining its competitive distance in efficiency versus its peers, driven by factors affecting the entire financial industry: constrained profitability, uncertainty about revenues net of risk cost, opportunities emerging from customer's behavior change, and still untapped potential for scaling the deployment of automation and artificial intelligence technologies. The bank will reinforce its efforts to further reduce operational costs, acting on four fronts: simplification and automation (first reengineering, then automating processes); structure optimization (simplifying the organization and further centralizing activities); distribution redesign (optimizing network configuration, formats and rightsizing the branch network); and internalized model scope (considering outsourcing for commoditized support functions). In the simplification and automation front, BCP sees a clear opportunity for expanding and enhancing its approach to deploying next-generation processes across a new wave of domains in order to embed high levels of automation principally across operations and credit collection processes. This will be accomplished by adopting an end-to-end process redesign logic, implemented in a way that its combines leading capabilities in digital interfaces, both with customers and other users (Figure 12), with intelligent automation technologies (Banco Comercial Português, S.A., 2022a).

BCP aims to use data as a competitive edge. The vast technology transformation program initiated in the previous cycle will continue in this cycle. Digitally-enabled growth, improved efficiency and new tech-enabled agility will be achieve through a set of technological capabilities: digital platforms capable of enabling a superior customer experience at speed; ecosystems and open integration; new data governance and data quality management framework covering priority regulatory reposting data domains to ensure adequate data quality levels while delivering on regulatory commitments and framing a path for continuous improvement; real-time analytical data platform combining a data lake, a high performance database and streaming cloud-based open source technologies to deliver sub-second analytical data services at scale; collaborative advanced analytics and artificial intelligence platform, offering a library of reusable assets and automating both data engineering and the model lifecycle; intelligent automation capabilities orchestrating the combination RPA, OCR, NPL and deep learning models to form a new breed of re-engineered processes and setting a new standard in operational

excellence; a cloud enterprise level landing zone to run a first set of critical workloads where automated deployments, containerization and the latest observability technology is bringing clear gains in agility, scalability and resilience; and shifting towards an active defense model that protects beyond the traditional perimeter (Banco Comercial Português, S.A., 2022a).

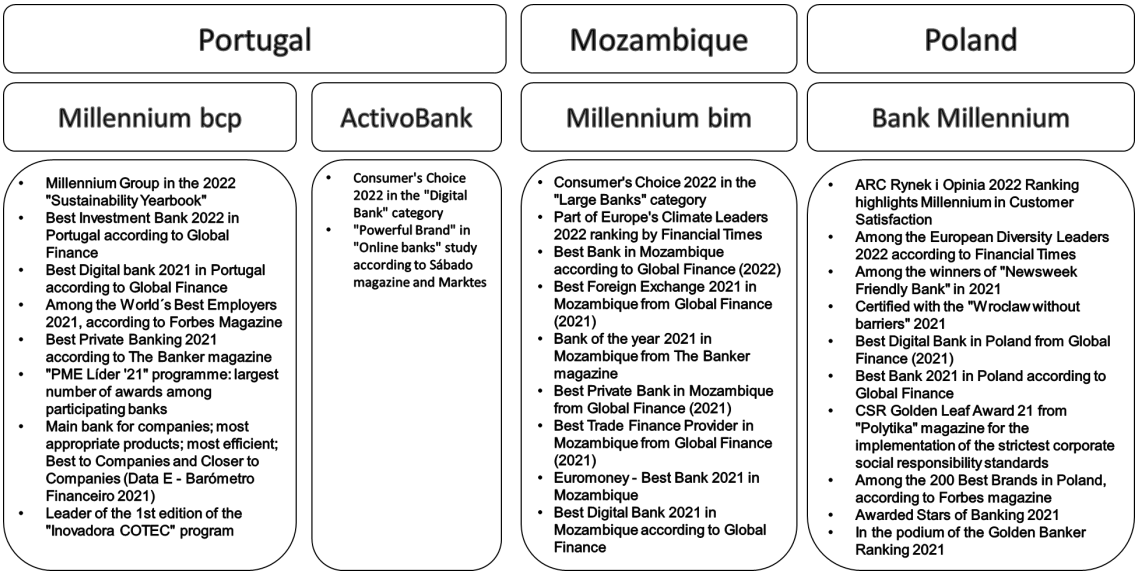


Figure 12. Recent main awards received by BCP Group's banks.
Adapted from (Banco Comercial Português, S.A., 2022b)

In its current organization model, BCP counts with a distributed model of automation capabilities. Under the same Executive Committee Member, automation capabilities are allocated to three different departments: IT Department (ITD); Digital Transformation Office (DTO); and BPM and Automation Center of Competence of Millennium Operations Center (BPMACC).

ITD's mission is to contribute to the continuous improvement of the bank's level of service and efficiency through the rational use of technology, maximizing three areas of action: customer satisfaction, delivery quality and employee performance. In fulfilling this mission, ITD is responsible for: alignment of IT objectives with the bank's strategic plan; definition of effective processes for project management and for the management of IT resources; definition of technological infrastructures and information systems that support the defined strategy; monitoring IT risk management, ensuring the necessary protection of the bank's assets and operations; compliance with internal and external regulations and requirements; maximizing the level of customer satisfaction with IT services; and management of the relationship with third parties / IT suppliers.

DTO is co-responsible for defining and executing the bank's digital transformation in close coordination with the different departments that are an integral part of these processes, prioritizing the highest value initiatives, ensuring the deepening of the bank's relationship with the customer in a more relevant and convenient, through an innovative and differentiating offer of products and services, improving the customer's experience in their use and, at the same time, ensuring more and better efficiency and effectiveness of the associated processes and the bank's operating model.

BPMACC is responsible for: implementing process-oriented solutions (Business Process Management Systems - BPMS), including the definition of standards and procedures to be observed, prioritization of implementations and coordination with all areas involved in the development and implementation process; implementing, coordinating and supporting of process automation and artificial intelligence; implementing and ensuring maintenance and development of solutions and databases for operational support, in coordination with the ITD; and managing demand and the legacy application park, identifying ways to improve and reduce the risk of the existing application architecture.

5.2 Preparation for evidence collection

The data collection protocol included survey tools. A survey is a process of trying to discover something in a systematic way (Carmo & Ferreira, 2008). A survey has three phases: design (objectives' setting, sampling, and questions definition), execution (logistics and distribution), and results' analysis and report. Survey research aims to collect information from a sample of individuals by answering questions (Check & Schutt, 2012).

A combination of quantitative methods – questionnaire – and qualitative methods – interviews – was used, benefiting from the pros and bridging the cons of each method (summarized in Table 8), so that multiple sources and techniques could strengthen the case study method (Soy, 1997). Data collection was performed with questionnaires and interviews to internal organization automation experts as well as to external organization automation experts.

Table 8. Pros and cons questionnaires and interviews.
Adapted from (Carmo & Ferreira, 2008)

Method	Pros	Cons
Questionnaire	Systematization Greater simplicity of analysis Faster data collection and analysis Less expensive	Conception difficulties Not applicable to the entire population High non-response rate
Interview	Flexibility in terms of duration, adaptation to new situations and different types of interviewees Depth (allows you to observe the interviewee and gather intimate or confidential information)	Requires greater expertise from the investigator More expensive Takes longer

5.2.1 Questionnaire

Quantitative methodology, questionnaires included, is orientated towards the quantification and justification of phenomena and makes use of controlled methods. Seeks to eliminate subjectivity concerns and to ensure objectivity through data distance, orientation towards results, verification, replicability and generalization. Assumes an hypothetico-deductive nature (Serapioni, 2000).

The questionnaire was designed to be answered online, with no interaction between the investigator and the respondents. To ensure directivity and to minimize the need for clarification from respondents,

the questionnaire was carefully thought out to present a logical, organized and coherent structure (Carmo & Ferreira, 2008).

As recommended (Carmo & Ferreira, 2008), the number of questions was as few as possible to adequately address the problem and most questions required a closed answer. To increase respondents' understanding and reduce ambiguity, many questions contained an example or explanation. The questionnaire covered all the points to be inquired, containing only the pertinent questions and avoiding unnecessary and/or indiscreet ones. The relevant aspect of the questionnaire presentation included the investigator presentation as well as the research problem, alongside with precise, clear and short filling instructions.

The questionnaire aims to validate the respondents' experience in relation to the research problem; to evaluate and validate the relevance of the topic, and to compile structured information to allow an objective assessment of best practices' alignment.

Sample definition considered three aspects: identification, selection and dimension. As a prerequisite, the target population was selected as narrowly as possible (Glasow, 2005). Sample size was specially impacted by the investigator´s ability to gain access to the study subjects. So, Banco Comercial Português, S.A., as the first relevant unit of analysis contributed with 7 subjects. A second unit of analyses, an informal group of professionals in the field of automation, contributed with 9 subjects. The total of 16 respondents represents a theoretical sample and ensures an adequate precision degree (Glasow, 2005). Subjects' competences and qualification, from either unit analyses, confer a high degree of confidence. To ensure confidentiality, respondents will be called R1, R2, etc.

The questionnaire was distributed using electronic mail. The invitation, that can be found in Appendix I, explained the research purpose and contained clear instructions to maximize the number of responses and to minimize dropouts. The invitation also contained the link to the questionnaire, built in Google Forms and fully reproduced in Appendix II. Due to the relatively extensive list of topics and to the need to include verification questions and to minimize ambiguity (Carmo & Ferreira, 2008), most questions required a closed answer. A pretest was performed to estimate the filling time, and that information was included in the invitation. To improve the quantitative data collection, closed answer questions made use of three sets of 5-point Likert scales, dedicated to inquiring frequency, importance and agreement. The questions were presented in an organized and sequenced way, thus the objectives set could be reached. Table 9 summarizes the questionnaire layout, exposing its sections, objectives and variables.

Table 9. Questionnaire layout, sections, objectives and variables.

Question	Objective	Variable
Section 1 – Authorization collection		
1. I authorize the use of my data for the purpose of this study. Yes No	Authorization collection	Authorization
Section 2 – Identification and characterization of the respondent		
2. What is your age?	Contextualization of age group	Age group

Question	Objective	Variable
[20,30[[30,40[[40,50[[50,60[> 60		
3. What is your gender? Male Female Prefer not to answer	Contextualization of gender	Gender
Section 3 – Experience and materiality		
This section aims to contextualize the respondent professional and RPA/BPA experience.		
4. What is your field of activity? Insurance Finance Telecommunications Retail Other (Please specify)	Contextualization of activity	Activity field
5. Do you work at Banco Comercial Português, S.A.? Yes No	Contextualization of activity	Employer
6. Have you worked in finance industry in the past? Yes No	Contextualization of activity	Experience in finance industry
7. What is your professional experience? Nacional International Both	Contextualization of professional experience	Professional experience
8. What is your actual occupation? Developer Business Analyst Team Manager Project Manager Other (Please specify)	Contextualization of business role	Business role
9. What other role(s) did you play in RPA/BPA team / project? (Tick all applicable) Developer Business Analyst Team Manager Project Manager No other Other (Please specify)	Contextualization of professional experience	RPA/BPA experience
10. How many employees does the company where RPA was implemented have? < 10 [10,50[[50,250[[250,500[[500, 1000[> = 1000	Contextualization of activity	Company dimension
11. How many robots did the largest project you worked on have? < 5 [5, 10[[10,50[	Contextualization of professional experience	Automation maturity level

Question	Objective	Variable
[50, 100[> = 100		
Section 4 – Usage and perceived value		
This section aims to evaluate how the respondent makes use of the identified practices and rates its relevance.		
12. Your team uses formal description of RPA/BPA [description of the steps that RPA/BPA takes in each interface (graphical or not) with which it interacts]? Very frequently Frequently Occasionally Rarely Never	Analyses of identified practices use	Formal description usage
13. Your team stakeholders' use formal description of RPA/BPA? Very frequently Frequently Occasionally Rarely Never	Analyses of identified practices use	Formal description coverage
14. Formal description of RPA/BPA is: Extremely important Very important Moderately important Slightly important Not important at all	Analyses of the identified practices perceived relevance	Formal description relevance
15. Your description of RPA/BPA specifies key performance indicators? Very frequently Frequently Occasionally Rarely Never	Analyses of identified practices use	Key performance indicators usage
16. RPA/BPA related key performance indicators description is: Extremely important Very important Moderately important Slightly important Not important at all	Analyses of the identified practices perceived relevance	Key performance indicators relevance
17. Your description of RPA/BPA includes AS IS-TO BE scenarios modelling? Very frequently Frequently Occasionally Rarely Never	Analyses of identified practices use	AS IS-TO BE scenarios modelling usage
18. AS IS-TO BE scenarios modelling is: Extremely important Very important Moderately important Slightly important Not important at all	Analyses of the identified practices perceived relevance	AS IS-TO BE scenarios modelling relevance
19. Your description of RPA/BPA includes user interface objects modelling (e. g. screenshot and identification of	Analyses of identified practices	User interface objects model-

Question	Objective	Variable
which objects the robot should act and in what way)? Very frequently Frequently Occasionally Rarely Never	use	ling usage
20. You model your user interface objects using: (Tick all applicable) Text description Mockups Screenshot of applications Videos Other (Please specify)	Analyses of identified practices use	User interface objects modelling usage
21. User interface objects modelling is: Extremely important Very important Moderately important Slightly important Not important at all	Analyses of the identified practices perceived relevance	User interface objects modelling relevance
22. Your description of RPA/BPA includes rules and decisions modelling (i. e. description of decision logic, business rules and exception handling)? Very frequently Frequently Occasionally Rarely Never	Analyses of identified practices use	Rules and decisions modelling usage
23. You model rules and decisions using: Structured and systematic approach (e. g. DMN table) Description script Other (Please specify)	Analyses of identified practices use	Rules and decisions modelling usage
24. Rules and decisions modelling is: Extremely important Very important Moderately important Slightly important Not important at all	Analyses of the identified practices perceived relevance	Rules and decisions modelling relevance
25. Your description of RPA/BPA engages all stakeholders? Very frequently Frequently Occasionally Rarely Never	Analyses of identified practices use	Stakeholders' engagement
26. Stakeholders' engagement is: Extremely important Very important Moderately important Slightly important Not important at all	Analyses of the identified practices perceived relevance	Stakeholders' engagement relevance
27. Your description of RPA/BPA includes logs and exceptions modelling? Very frequently Frequently Occasionally Rarely	Analyses of identified practices use	Logs and exceptions modelling usage

Question	Objective	Variable
Never		
28. Logs and exceptions modelling is: Extremely important Very important Moderately important Slightly important Not important at all	Analyses of the identified practices perceived relevance	Logs and exceptions modelling relevance
29. Your description of RPA/BPA includes data extraction, transformation and load (ETL) modelling? Very frequently Frequently Occasionally Rarely Never	Analyses of identified practices use	Data ETL modelling usage
30. You model ETL using: Information flow Other (Please specify)	Analyses of identified practices use	Data ETL modelling usage
31. Data extraction, transformation and load modelling is: Extremely important Very important Moderately important Slightly important Not important at all	Analyses of the identified practices perceived relevance	Data ETL modelling relevance
32. Your description of RPA/BPA includes choreography modelling (i. e. detailed description of users' behavior that automation is to replicate)? Very frequently Frequently Occasionally Rarely Never	Analyses of identified practices use	Choreography modelling usage
33. Choreography modelling is: Extremely important Very important Moderately important Slightly important Not important at all	Analyses of the identified practices perceived relevance	Choreography modelling relevance
34. Your description of RPA/BPA includes related systems modelling (i. e. mapping of systems and applications interconnections)? Very frequently Frequently Occasionally Rarely Never	Analyses of identified practices use	Related systems modelling usage
35. You model related systems: (Tick all applicable) Data location Point of access Access credentials Relationship Other (Please specify)	Analyses of identified practices use	Related systems modelling usage
36. Related systems modelling is: Extremely important Very important	Analyses of the identified practices perceived	Related systems modelling relevance

Question	Objective	Variable
Moderately important Slightly important Not important at all	relevance	
37. Your description of RPA/BPA includes compliance checking specification (e. g. functionalities to validate the design and escape flow in the event of faults)? Very frequently Frequently Occasionally Rarely Never	Analyses of identified practices use	Compliance checking specification usage
38. Compliance checking specification is: Extremely important Very important Moderately important Slightly important Not important at all	Analyses of the identified practices perceived relevance	Compliance checking specification relevance
39. Your description of RPA/BPA adopts a modular system (i. e. automation of sub-processes of the given process or even process building blocks)? Very frequently Frequently Occasionally Rarely Never	Analyses of identified practices use	Modular system usage
40. Modular system adoption is: Extremely important Very important Moderately important Slightly important Not important at all	Analyses of the identified practices perceived relevance	Modular system adoption relevance
Section 5 – Description models		
This section aims to evaluate the description models used by the respondent.		
41. Your team always uses the same description notation? Yes No Not applicable	Analyses of the description model	Formal description notation
42. Your team stakeholders' use the same description notation used by your team? Very frequently Frequently Occasionally Rarely Never	Analyses of the description model	Formal description notation coverage
43. The description notation used by your team is: Petri net - Petri net - Wikipedia BPMN Business Process Model and Notation - Wikipedia BPEL - Business Process Execution Language - Wikipedia ebXML - ebXML - Wikipedia Other (Please specify)	Analyses of the description model	Formal description notation
44. The criteria for the description notation choice was: According to a best practice	Analyses of the description mod-	Formal description nota-

Question	Objective	Variable
Internally developed / adopted Comprehensible outside the team / company Other (Please specify)	el	tion criteria choice
Section 6 – Interoperability concerns		
This section aims to evaluate how respondent grades the interoperability adequacy.		
45. Interoperability is relevant for RPA/BPA. Strongly agree Agree Neutral Disagree Strongly disagree	Analyses of interoperability adequacy	Interoperability relevance
46. Justify your answer to question 45.	Analyses of interoperability adequacy	Interoperability relevance
47. Your RPA/BPA description model is suitable to ensure interoperability. Strongly agree Agree Neutral Disagree Strongly disagree	Analyses of interoperability adequacy	Interoperability adequacy
48. Describe additional methods used / necessary to ensure interoperability.	Analyses of interoperability adequacy	Interoperability adequacy

5.2.2 Interviews

Qualitative research is a broad term which includes a variety of approaches based on inductive reasoning, used to collect data in natural settings, so to achieve in-depth understanding of participants' point of view and to obtain a richer description of the studied phenomenon, in which the researcher assumes the role of primary data collection instrument, from nonrandom and purposeful samples, through an emergent and flexible design and the use of multiple forms of data and perspectives (Young & Babchuk, 2019).

Interviews are a qualitative methodology in which direct interaction is the key factor (Carmo & Ferreira, 2008) and were used in this study with the objective of gathering additional in-depth information about the methods used by automation experts, along with a more detailed insight on their opinions and past experiences, and additional discussion about questionnaire results worthy of further exploration. The interviews preparation considered the recommended standards of action listed in Table 10.

Table 10. Interview procedures.

Adapted from (Carmo & Ferreira, 2008)

Before	Define the objective Build the interview guide Choose the interviewees Prepare the potential interviewees Set date, time and place Prepare the interviewees (technical formation)
During	Introduce the interviewer and present the objective Obtain and maintain trust Listen Allow “warm up” time Retain control with diplomacy Use warm up and focus questions Properly frame sensitive questions Avoid leading questions
After	Record observations about the interviewee's behavior Record observations about the environment in which the interview took place

Considering the interviews objective, sampling took a single stage stratified approach, as presented in Table 11. Thus, sample selection fell on a set of qualified informants (Carmo & Ferreira, 2008) from both units of analysis: one external automation expert and three internal automation experts – two belonging to BPMACC and another from DTO, resulting in a convenience sample, covering the entire spectrum of research. To ensure confidentiality, subjects will be called E1, E2, E3 and E4.

Table 11. Characterization of interview sample.

Interviewed subject	Stratum	Business role
E1	Internal automation expert from BPMACC – BCP	Team Manager
E2	Internal automation expert from BPMACC – BCP	Senior Developer
E3	Internal automation expert from DTO – BCP	Team Manager
E4	External automation expert – non BCP	Team Manager

Subjects were contacted in advanced, by phone and electronic mail (Appendix III), to check their availability, to explain the reason for their selection, the value of their response to the research, to inform the expected duration of the interview, and to arrange the date, time and place for it to be held.

The interviews followed a structured model, consisting of pre-defined open and closed questions (Baškarada, 2014), design to meet the objective. Table 12 summarizes the interview script, exposing

its sections, objectives and variables. As recommended (Carmo & Ferreira, 2008), a pretest was performed allowing to determinate thirty minutes as estimated duration. The interview script is reproduced in Appendix IV.

Table 12. Interview script, sections, objectives and variables.

Question	Objective	Variable
1. Is your day going well?	Introduction. Put the interviewee more at ease	Mood
Section 1 – Experience and materiality		
This section aims to contextualize the respondent professional and RPA/BPA experience and its RPA/BPA context.		
2. How long have you been working in RPA/BPA?	Contextualization of professional experience	RPA/BPA experience
3. What is your actual occupation? Developer Business Analyst Team Manager Project Manager Other (Please specify)	Contextualization of business role	Business role
4. Your RPA/BPA solution is: Inhouse developed Inhouse developed with consultant's help Purchased solution from a provider	Contextualization of sourcing situation	RPA/BPA sourcing
5. Your RPA/BPA solution is used: Only in internal processes Only in processes of collaboration with other enterprises Both	Contextualization of cooperation	Cooperation level
Section 2 – Usage and perceived value		
This section aims to evaluate how the respondent makes use of the identified practices and rates its relevance.		
6. Your team uses formal description of RPA/BPA [description of the steps that RPA/BPA takes in each interface (graphical or not) with which it interacts]? Very frequently Frequently Occasionally Rarely Never	Analyses of identified practices use	Formal description usage
7. Formal description of RPA/BPA is: Extremely important Very important Moderately important Slightly important Not important at all	Analyses of the identified practices perceived relevance	Formal description relevance
8. Why do you classify the relevance of the formal description in this way?	Analyses of the identified practices perceived relevance	Individual opinion

Question	Objective	Variable
Section 3 – Usage limitations		
This section aims to identify limiting factors to the use of the formal description of RPA/BPA.		
9. What do you consider to be limiting factors in the use of formal description of RPA/BPA? Your team does not have the necessary time Enterprise's size does not justify Interaction with other systems RPA/BPA low level of complexity Vendors opposition Other (Please specify)	Identification of limiting factors	Individual opinion
10. Typically, in an automation project, which activities suffer resource cuts?	Identification of stress factors	Individual opinion
11. What KPI's do you use?	Identification of KPI's	Individual opinion
Section 4 – Satisfaction and change opportunity		
This section aims to evaluate respondents' satisfaction levels and assess change opportunity.		
12. How satisfied are you with your current technology? Extremely satisfied Very satisfied Neutral Slightly satisfied Not satisfied at all	Identification of satisfaction level	Individual opinion
13. Has your company ever considered changing the RPA/BPA technology it currently uses? (If Yes) And the change took place? (If Yes) Why? (If No) Why not?	Identification of opportunity for change	Individual opinion
14. If it were up to you, you would change your RPA/BPA technology? Why?	Identification of empowerment to change	Individual opinion

6 Evidence collection and analysis

Upon conclusion of data collection, the following step is their evaluation and analysis with the aim of finding linkages between the research object and the outcomes.

6.1 Questionnaire

The invitation (Appendix I) to complete the questionnaire (Appendix II) was sent by electronic mail on October 7th, 2022, to a specific list of contacts. The questionnaire was available on Google Forms for completion between October 7th and 20th, 2022. Sixteen valid responses were collected, compiled in Appendix V.

The first section, composed exclusively of the first question, aimed to collect the express authorization of the respondents for the use of their answers in this study.

The Section 2 aimed at a brief demographic characterization of the sample. The answers to question 2, illustrated in Figure 13, refer to the age group in which each respondent falls in. The sample does not contain subjects over 50 years old, highlighting the age group of [30,40[, to which 11 of the respondents belong. The answers to question 3 (Figure 14), concern the gender of the subjects. There is an underrepresentation of the female gender (18.8% corresponding to 3 subjects).

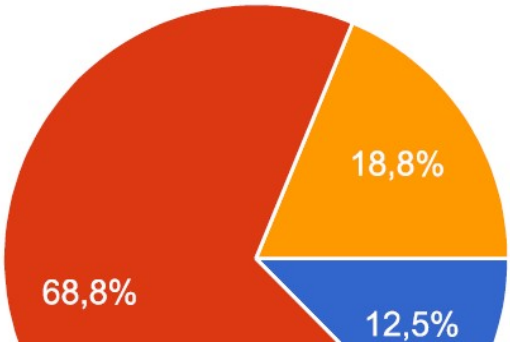


Figure 13. Sample characterization by age group.

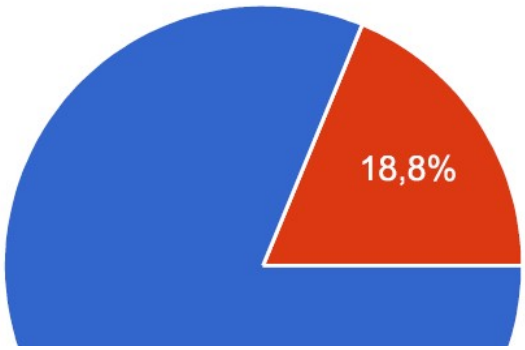


Figure 14. Sample characterization by gender.

The third section aimed to characterize the sample in terms of professional activity and RPA/BPA experience. The sample proved to be diverse in terms of activity field, as shown in Figure 15, which illustrates the responses obtained to question 4. The financial area is predominant, with 50% of responses, followed by telecommunications with 12.5% of responses (2). Seven of the subjects (43.8%) reported working at Banco Comercial Português, S.A. (responses to question 5) and an additional of 8 respondents revealed that they had worked in the financial area in the past, despite currently working in a different area (responses to question 6). Half (8) of the respondents classified their professional experience as exclusively national, but 37.5% of the sample (6) also revealed to have international experience, as shown in Figure 16, which illustrates the answers to question 7.

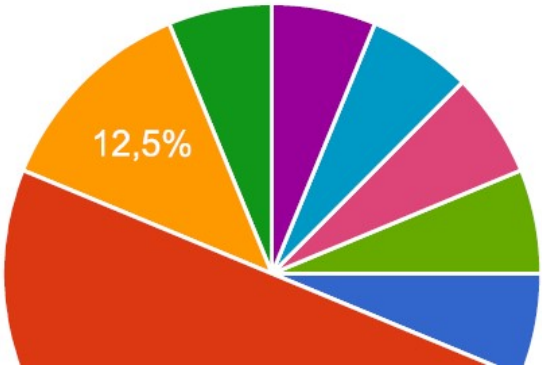


Figure 15. Sample characterization by activity field.

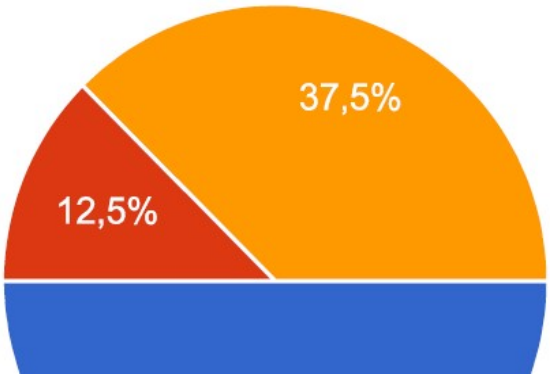


Figure 16. Sample professional experience characterization.

The answers to question 8 (Figure 17) revealed a diverse sample regarding the current business role of the subjects, with a slight preponderance of developers (37.5%), followed by project managers (25%). However, Figure 18 (answers to question 9) shows that the majority (87.5%) have already played other roles in RPA/BPA teams or projects, and five of them have already assumed more than 2 different roles.

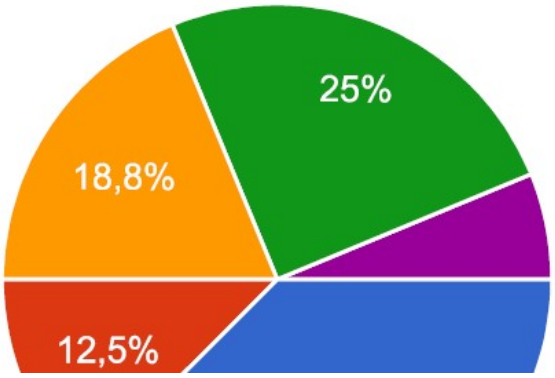


Figure 17. Sample characterization by current business role.

Figure 18. Sample characterization by current business role.

Most respondents (62.5%) revealed that the RPA/BPA they worked on were implemented in large companies, as shown in Figure 19, which refers to the answers obtained to question 10. Almost the same percentage (68.8%) worked on projects that involved fifty or more robots (Figure 20 - answers to question 11).

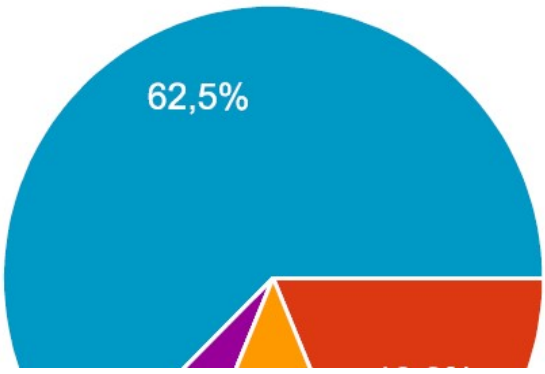


Figure 19. Number of employees of the company where RPA/BPA was implemented.

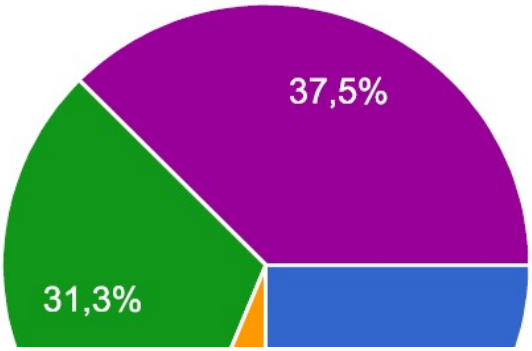


Figure 20. Number of robots of the largest project.

Section 4 aimed to assess the adherence to the practices identified in the SLR and the way in which respondents perceive their value and rate their relevance. The majority (93.8%) of the respondents revealed that they regularly or very regularly perform the formal description of the RPA/BPA, as shown in Figure 21, which illustrates the answers to question 12. The same analysis in relation to the team's stakeholders reveals a slightly lower (81.3%) adherence to the practice (Figure 22 - answers to question 13). In assessing its relevance, 81.3% recognize the practice as very important or extremely important (Figure 23 - responses to question 14).

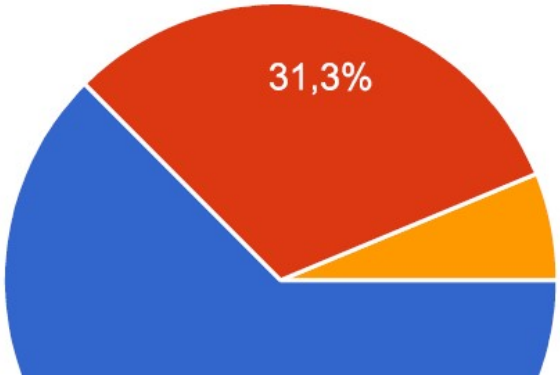


Figure 21. Usage of RPA/BPA formal description.

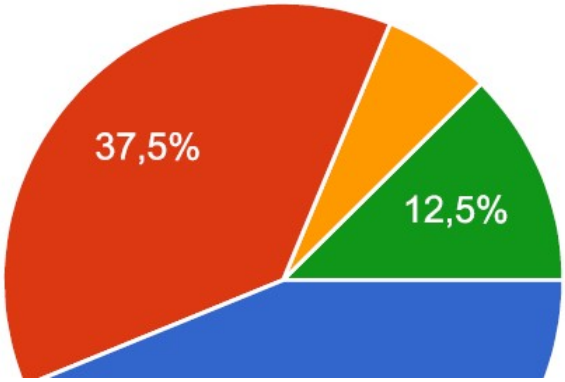


Figure 22. Usage of RPA/BPA formal description by team stakeholders.

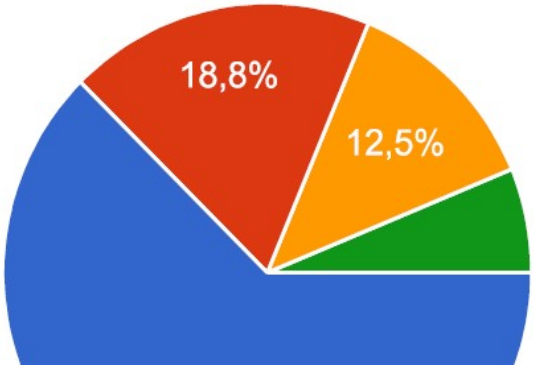


Figure 23. Relevance of RPA/BPA formal description.

The answers obtained in the questions related to the usage of the twelve practices identified in the SLR (questions 12, 15, 17, 19, 22, 25, 27, 29, 32, 34, 37, 39) are summarized in Table 13, which contains the percentage and absolute values obtained in each of the options of the 5-point Likert scale dedicated to inquiring frequency (Very frequently – VF, Frequently – FQ, Occasionally – OC, Rarely – RR, and Never – NR). In general, the identified practices show a good adherence by the respondents. With a use classified as very frequent, stands out the modelling of rules and decisions (13), closely followed by modelling the business process (10) and modelling of AS-IS and TO-BE scenarios (10). Classified as frequently used, the highlight was the engagement of all stakeholders (10), seconded by specification of key performance indicators (8) and modelling ETL (8). As the least used, was classified modelling ETL (7), seconded by modelling logs and exceptions (6), modelling choreography (6), and modelling related systems (6).

Table 13. Results on identified practices usage.

Practice	VF	FQ	OC	RR	NV
Modelling the business process	62.50% (10)	31.25% (5)	6.25% (1)	-	-
Specification of key performance indicators	37.50% (6)	50.00% (8)	6.25% (1)	6.25% (1)	-
Modelling of As Is–To Be scenarios	62.50% (10)	25.00% (4)	12.50% (2)	-	-
Modelling of user interface objects	56.25% (9)	31.25% (5)	-	12.50% (2)	-
Modelling rules and decisions	81.25% (13)	-	18.75% (3)	-	-
Engagement of all stakeholders	12.50% (2)	62.50% (10)	18.75% (3)	6.25% (1)	-
Modelling logs and exceptions	50.00% (8)	12.50% (2)	31.25% (5)	6.25% (1)	-
Modelling data extraction and transformation	6.25% (1)	50.00% (8)	31.25% (5)	12.50% (2)	-
Modelling choreography	31.25% (5)	31.25% (5)	25.00% (4)	12.50% (2)	-
Modelling related systems	18.75% (3)	43.75% (7)	31.25% (5)	-	6.25% (1)
Specification of compliance checking	50.00% (8)	25.00% (4)	18.75% (3)	6.25% (1)	-
Adoption of modular system	43.75% (7)	37.50% (6)	12.50% (2)	6.25% (1)	-

Question 20 was intended to obtain additional information on how respondents model user interface objects. Figure 24 shows that the majority resorts to applications' screenshot (93.8%) and to text description (87,5%). Results also revealed that 15 of the respondents use more than one option.

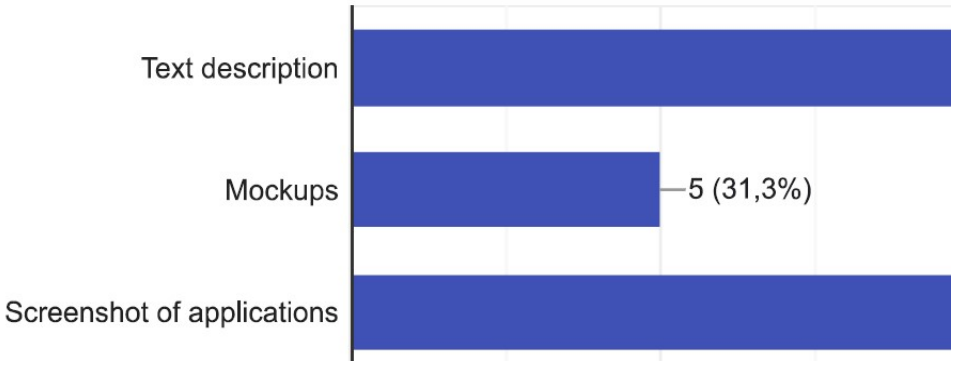


Figure 24. User interface objects' modelling options.

The answers to question 23 (Figure 25) allowed to obtain more information about modeling rules and decisions. The majority of respondents (9) revealed the use a description script and six others a structured and systematic approach.

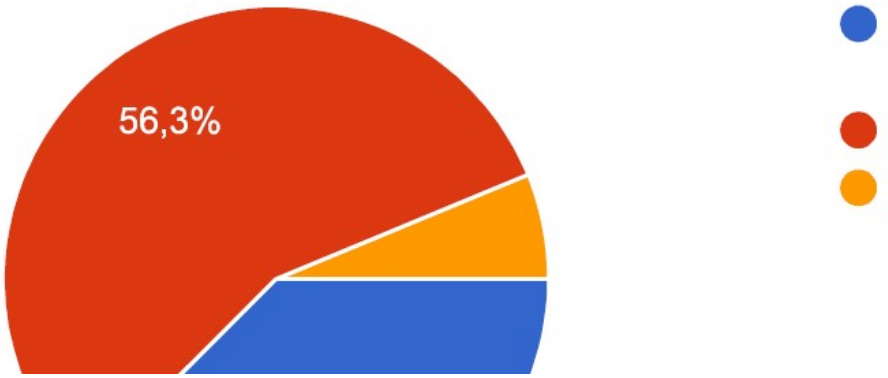


Figure 25. Rules and decisions modelling options.

Question 30 sought information on data extraction, transformation and load (ETL) modelling. The majority (87.5%) identified the use of information flow, but it was also possible to identify two additional ones: Microsoft SQL Server Integration Services (SSIS) and text description (Figure 26).

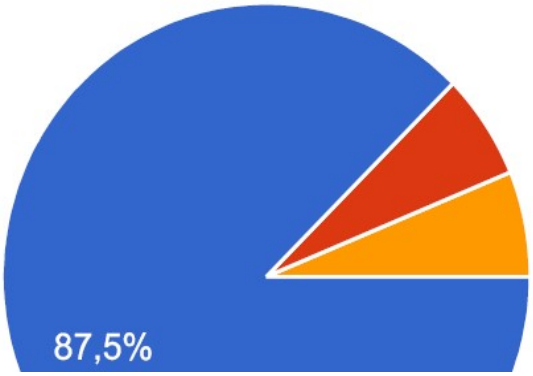


Figure 26. ETL modelling options.

Answers to question 35 provided information about modelling of related systems. Most respondents (13) revealed modeling data location and access credentials (Figure 27), but only 2 respondents said to model this two alone. However, there were 4 respondents who reported using of all four options.

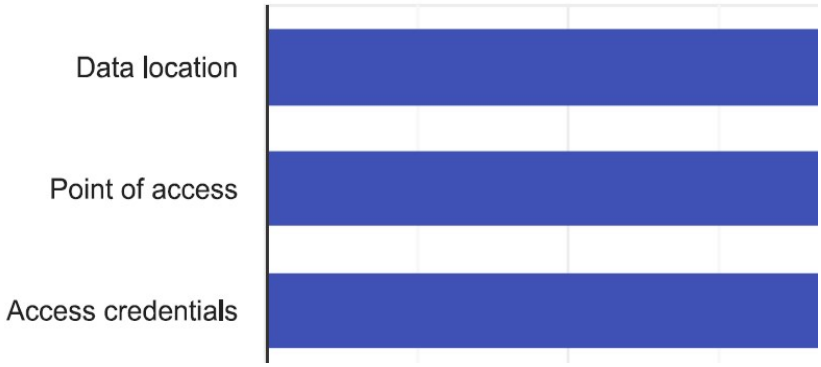


Figure 27. Related systems modelling options.

The answers obtained in the questions related to the perceived value of the twelve practices identified in the SLR (questions 14, 16, 18, 21, 24, 26, 28, 31, 33, 36, 38, 40) are summarized in Table 14, which contains the percentage and absolute values obtained in each of the options of the 5-point Likert scale dedicated to inquiring importance (Extremely important – EI, Very important – VI, Moderately important – MI, Slightly important – SI and Not important at all - NI). In general, the identified practices are perceived as valuable. Classified as extremely important, stands out modelling rules and decisions (11), closely followed by modelling the business process (10), modelling AS-IS and TO-BE scenarios (10) and the engagement of all stakeholders (10). Classified as very important, the highlight was modelling related systems (9), seconded by modelling logs and exceptions (8) and modelling ETL (8). As the least important, was classified modelling choreography (8), seconded by modelling ETL (7).

Table 14. Results on identified practices value.

Practice	EI	VI	MI	SI	NI
Modelling the business process	62.50% (10)	18.75% (3)	12.50% (2)	6.25% (1)	-
Specification of key performance indicators	43.75% (7)	37.50% (6)	12.50% (2)	6.25% (1)	
Modelling of As Is–To Be scenarios	62.50% (10)	25.00% (4)	12.50% (2)	-	-
Modelling of user interface objects	56.25% (9)	25.00% (4)	18.75% (3)	-	-
Modelling rules and decisions	68.75% (11)	31.25% (5)	-	-	-
Engagement of all stakeholders	62.50% (10)	25.00% (4)	6.25% (1)	6.25% (1)	-
Modelling logs and exceptions	43.75% (7)	50.00% (8)	6.25% (1)	-	-
Modelling data extraction and transformation	6.25% (1)	50.00% (8)	31.25% (5)	12.50% (2)	-
Modelling choreography	18.75% (3)	31.25% (5)	31.25% (5)	18.75% (3)	-
Modelling related systems	12.50% (2)	56.25% (9)	31.25% (5)	-	-
Specification of compliance checking	43.75% (7)	43.75% (7)	6.25% (1)	6.25% (1)	-
Adoption of modular system	31.25% (5)	43.75% (7)	12.50% (2)	12.50% (2)	-

The fifth section aimed to evaluate the description models used by the respondents. Answers to question 41 reveal that 87.5% of respondents always use the same notation in RPA/BPA description. But the same cannot be said about its stakeholders, as shown in Figure 28, since only 37.5% of the stakeholders use the same notation.

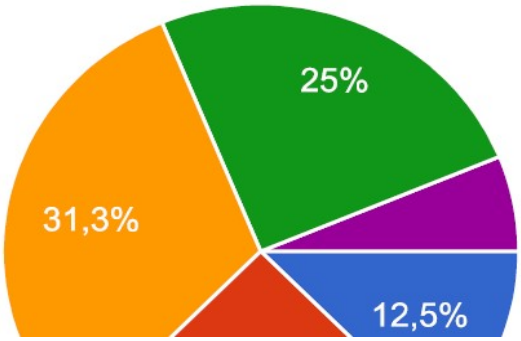


Figure 28. Stakeholders using the same description notation.

Respondents refer BPMN has the most used (81.3%) description notation (answers to question 43) and the main criteria invoked for that choice was doing so according to a best practice (43.8%) and because it was internally developed / adopted (37.5%), as shown in Figure 29, which illustrates the answers to question 44.

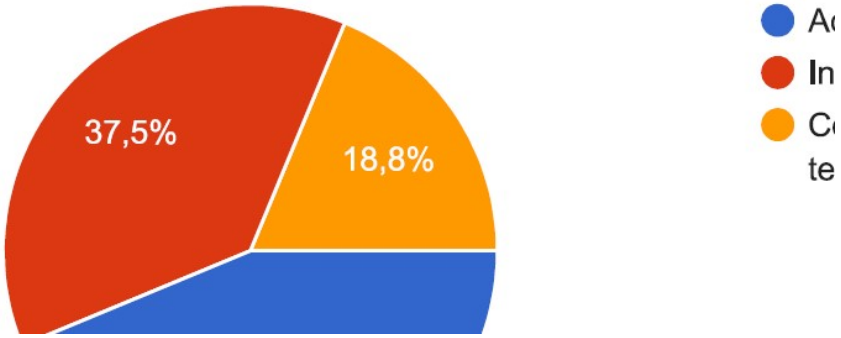


Figure 29. Criteria for description notation choice.

Section 6 aimed to evaluate how respondents grade the interoperability adequacy. Two of the questions designed to seek for respondents concerns about interoperability (questions 45 and 47) used a 5-point Likert scale dedicated to inquiring agreement. As shown in Figure 30, the majority of respondents (93.8%) agreed that interoperability is relevant for RPA/BPA. One respondent said to disagree.

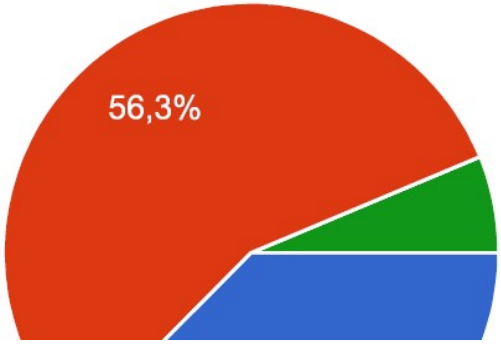


Figure 30. Interoperability relevance for RPA/BPA.

Question 46 sought to obtain a deeper insight for the relevance attributed by respondents to interoperability. The results are gathered in Table 15.

Table 15. Justifications for interoperability relevance.

Justification
To guaranty easy methodology explanation and handling from one team to another
Interoperability is relevant in every projects / system
A business process normally includes a lot of different systems that don't communicate with each other
Increased productivity. With the time required to process data reduced, organizational efficiencies increase. Reduced costs. Since fewer resources or additional maintenance is required. Reduced errors.
RPA software vendors are mostly recent in software industry. Mergers and acquisitions will occur, and some vendors might close. It's very relevant to be able to migrate easily. RPA assets are growing in number at a very fast pace.
Organizational efficiency
All processes should be closed and enough to run by themselves only
Interoperability refers to the basic ability of computerized systems to connect and communicate with one another readily, even if they were developed by widely different manufacturers in different industries
Generally, it is necessary to have bots automating part or parts of a process, so other systems may be needed to complete the process end to end
The automation can be used in multiple scenarios where multiple platforms are involved. It will help in in lessening human workload and without errors.
It is important that the automated process can scale horizontally. The code or process that runs on one machine must be able to run on another, instantly or almost, for that scalability to be sustainable (speaking only as interoperability in software).
RPA processes benefit from using modular, reusable components.
Automation teams should be technology agnostic and for that reason we should pursue a path where we have a technology ecosystem composed by several tools (RPA, Process Mining, Chatbot, OCR, etc.)

As to whether their RPA/BPA description model is suitable to ensure interoperability respondents' opinions are more divided and only 62.6% express agreement, as illustrated in Figure 31 (answers to question 47).

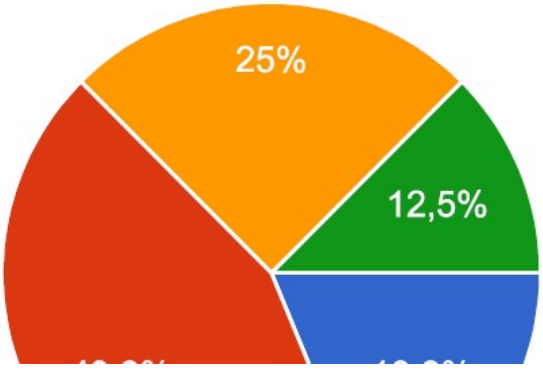


Figure 31. RPA/BPA description model suitability to ensure interoperability.

Question 48 was intended to obtain detailed information about additional methods used by respondents in an attempt to ensure interoperability. The results are gathered in Table 16.

Table 16. Additional methods to ensure interoperability.

Additional methods
Common language, templates
Process standardization, application interfaces
APIs. Web Services
1. XML forward and reverse engineering 2. PoC for software migration 3. Don't use too low-level automation functionalities of specific software vendors (avoid specific software development) 4. Keep automation solution simple 5. Develop automation patterns (like in software engineering)
Meetings with the app owners
According to the Healthcare Information and Management Systems Society (HIMSS), "Interoperability describes the extent to which systems and devices can exchange data and interpret that shared data. For two systems to be interoperable, they must be able to exchange data and subsequently present that data such that it can be understood by a user."
Usage of report tools
Saving data in documents as a way to record the end result of that process.
Standardized environment between our resources (i. e. every machine is equal with the same software and updates installed to ensure that everyone process runs the same in all our resources).

6.2 Interviews

Interviewees' preparation (technical formation) was ensured by e-mailing in advance a summary of the study, the interview questions and an explanation of its organization (sections) and objectives. The interviews were conducted in person and online, using Microsoft Teams, as explained in Table 17. Both means of conduction made it possible to achieve the proposed objectives, due to the observance of the recommended standards of action listed in Table 10 (Carmo & Ferreira, 2008). The interviewees were relaxed and in a good mood and maintained a collaborative attitude throughout the interviews. The complete transcript of the interviews can be found in Appendix VI.

Table 17. Interviews schedule.

Interviewee	Stratum	Business role	Date	Time	Place
E1	BPMACC	Team Manager	Oct/17/2022	16;00	In person - TagusPark
E2	BPMACC	Senior Developer	Oct/19/2022	10:30	In person - TagusPark
E3	DTO	Team Manager	Oct/20/2022	09:15	Online
E4	Non BCP	Team Manager	Oct/20/2022	12:00	Online

The content of the interviews was analyzed and summarized in Appendix VII, in order to facilitate the interpretation of the results.

Questions in section 1 aimed to contextualize the interviewees professional and RPA/BPA experience and its RPA/BPA context. Answers to questions 2 and 3 reveal that the four interviewees are experienced professionals who have played either multiple roles or management roles in RPA context, so they can be considered reliable sources of information. Answers to question 4 show that, in terms of sourcing options, BCP chose to purchase RPA licenses directly from RPA software providers and engage consulting firms for help in its customization and then pursued with inhouse development. The external automation expert E4 identified the use of a purchased solution from a provider. Answers to question 5 reveal an exclusive application of RPA solutions to internal processes in BCP, whereas the external automation expert E4 mentioned RPA/BPA solution use in both internal and inter-enterprises collaboration processes.

Section 2 objective was to evaluate the usage of the practices identified through the SLR and its perceived value. It was found that the use RPA/BPA formal description is very frequent (answers to question 6), and that internal automation experts and external automation experts share a unanimous opinion regarding the high relevance of the formal description (answers to question 7). Answers to question 8 list several reasons for that perception, according to each interviewee context: being essential for RPA functioning and development; allowing better communication among stakeholders; facilitating future maintenance, reference and improvement; enabling the automation viability assessment; and constituting a contingency knowledge backup.

Questions in section 3 focused on the identification of limiting factors to the usage of RPA/BPA formal description. Interviewees point out (answers to question 9) several reasons that, in their opinion, may result in less usage of RPA/BPA formal description: shortage of time and resources; need to avoid lag time in project context, and lack of awareness for its importance. Interviewees recognized that, in contexts with limited resources, the formal description can suffer negative impacts (answers to question 10), especially with regard to the detailed specification of requirements; the description, with the appropriate level of detail, of the AS-IS and TO-BE scenarios; the pre-assessment of the expected impact with the implementation of automation; the description of the test plan; and, in a context of urgency, the necessary contestation of the automation claim. Answering to question 11, the interviewees listed a vast set of KPIs, defined to measure not only the performance of automation, but also of the business process itself. In terms of automatism performance, they pointed out the average processing time, the volume of operations processed, the volume of exceptions, and the RPA occupancy rate. In terms of the business process, they listed some operational-oriented KPIs, such as risk mitigation gains, SLA gains, and SLA of RPA corrective actions, and some management-oriented KPIs, such as compliance gains, quickness to get to market, financial return, FTE reduction and human labor savings.

Section 4 was dedicated to measuring the degree of satisfaction with the RPA/BPA solution and assessing change opportunity. Answers to question 12 reveal interviewees are mostly satisfied with their RPA/BPA solution, although they recognize aspects that can be improved. Still, nothing so relevant that it leads them to ponder changing technology (answers to questions 13 and 14), especially as they

do not perceive any substantial benefit from the change, although they clearly identify that it would involve high costs.

7 Results discussion

The questionnaire aimed to validate the respondents' experience in relation to the research problem; to evaluate and validate the relevance of the topic, and to compile structured information to allow an objective assessment of best practices' alignment.

Sample characterization, in terms of professional activity and RPA/BPA experience (section 3 of the questionnaire), revealed diversity in terms of activity field, but predominance of financial area. Although only seven of the subjects reported working at Banco Comercial Português, S.A., an additional of eight respondents revealed that they had worked in the financial area in the past. Six subjects also revealed to have international experience. The results also revealed diversity regarding the current business role of the subjects and that the majority (87.5%) have already played other roles in RPA/BPA teams or projects, considering that five of them have already assumed more than two different roles. Subjects worked in RPA/BPA projects implemented in large companies, involving fifty or more robots. These results portray subjects' adequacy in terms of competence and qualification, thus conferring a high degree of confidence. Furthermore, making the results more interesting for the context of enterprises in the financial area.

Concerning the assessment of the adherence to the practices identified in the SLR and how their value and relevance is perceived (section 4 of the questionnaire), the answers obtained in the questions related to the usage of the twelve practices identified in the SLR, summarized in Table 13, indicate a good generally adherence and the answers obtained in the questions related to their perceived value, summarized in Table 14, shown they are perceived as valuable.

In relation to description notation (section 5 of the questionnaire), the most mentioned was BPMN and the main criteria of choice was being according to a best practice.

Regarding interoperability adequacy (section 6 of the questionnaire), interoperability was considered relevant for RPA/BPA and a deeper insight for its relevance is gathered in Table 15. RPA/BPA description model was considered suitable to ensure interoperability but eventually not enough, considering the additional methods listed in Table 16.

Interviews were used to better assess Banco Comercial Português, S.A.'s situation, through the gathering of additional in-depth information about the methods used by its automation experts, along with a more detailed insight on their opinions and past experiences, and additional discussion about questionnaire results worthy of further exploration. A fourth interview was conducted with an external automation expert to discover points of contact and divergence.

The interviews (section 1of the interview) reveal that the four interviewees were experienced professionals who have played either multiple roles or management roles in RPA context, so they can be considered reliable sources of information.

The use of RPA/BPA formal description (section 2 of the interview) is very frequent and both internal and external automation experts share a unanimous opinion regarding the high relevance of the

formal description pointing it out as being essential for RPA functioning and development; allowing better communication among stakeholders; facilitating future maintenance, reference and improvement; enabling the automation viability assessment; and constituting a contingency knowledge back-up.

Concerning usage limitations (section 3 of the interview), situations were identified that may result in less usage of RPA/BPA formal description, such as shortage of time and resources; need to avoid lag time in project context, and lack of awareness for its importance; specially in contexts with limited resources. A vast set of KPIs was listed, defined to measure not only the performance of automation, but also of the business process itself.

Regarding the degree of satisfaction with the RPA/BPA solution and the assessment of change opportunity (section 4 of the interview), satisfaction levels are high, although improvement opportunities have been identified. Still, nothing so relevant that it leads to pondering changing technology.

Resuming to the focus of this research and to the four research questions, from the results obtained in the questionnaires and in the interviews it is concluded that:

RQ1: What are the methods used to describe business process automation?

A variety of methods and tools are used to describe the business process automation.

RQ2: Are those methods aligned with the best practices?

The set of practices identified with the SLR has enough adherence to be considered a starting point for the definition of a set of good practices.

RQ3: Are the methods used sufficient to ensure interoperability?

The set of practices identified with the SLR is used, not only, but also for reasons of interoperability.

RQ4: What additional methods should be used to ensure interoperability?

There are additional methods used to ensure interoperability, as listed in Table 16.

As a final note, it should be noted that technological-independent description of BPA is considered important or even very important. Nonetheless, its execution is not always proportional to the importance attributed to it, as shown by interviews results. In terms of project management, when facing resource constraints (humans and/or temporal), teams tend to dispense, abbreviate, or simplify the detail in which they execute the modelling activities. Despite the recognized use of a diversified number of KPI's, it was not possible to identify any related to the percentage of coverage of the process description. The interviews allowed detection of quite standardized forms of description, which seem to stem from a particular application context, which is enhanced in a context that only involves internal processes. The situation may need to be reviewed if, and when, automation includes collaboration with external entities. The high degree of satisfaction with the current RPA/BPA solution does not give room for change. In this context of stability, the challenges of technologically independent description are not acutely felt, relegating the subject of description to a discretionary terrain.

8 Conclusions

This section contains the conclusion of the work realized as well as the obtained results, the limitations of the study carried out and the recommendations and proposals for future work.

This study initial purpose was to assemble an encompassing set of best practices suitable for enterprise's use in the technological-independent description of their business process automation. The SLR methodology used aimed the identification of available research relevant to the research problem.

The SLR execution confirmed the absence of a standardized framework for technological-independent BPA description. However, made possible the collation of a set of best practices and models suitable for business processes automation's description.

The subsequent case study provided an opportunity to assess a contemporary real-life situation. Through a carefully planned, designed and executed study, it is possible to render an alignment assessment and determine the value the practices identified through the SLR.

Resuming to the focus of this research and to the four research questions, from the results obtained in the questionnaires and in the interviews it is concluded that:

RQ1: What are the methods used to describe business process automation?

Questionnaire responses (sections 4 and 5), corroborated by interviews results (section 2) confirm the use of a variety of methods and tools in business process automation description.

RQ2: Are those methods aligned with the best practices?

Results from both questionnaire (Table 13 and Figure 29) and interviews (section 2) show that the practices identified through the SLR have enough adherence to be considered a starting point for the definition of a set of good practices.

RQ3: Are the methods used sufficient to ensure interoperability?

Responses to questionnaire question 46 (Table 15) and to interview question 8 confirm that RPA/BPA formal description is used, not only, but also for reasons of interoperability.

RQ4: What additional methods should be used to ensure interoperability?

Answers to questionnaire question 48 confirm that additional methods are used to ensure interoperability, as listed in Table 16.

This study is a starting point for defining an expanded set of best practices for technological-independent BPA description, designed to help enterprises avoiding lock-in situations and ensuring interoperability, as factors of agility, compatibility, collaboration and competitiveness.

8.1 Limitations

This research limitations can be grouped into three categories.

The first one refers to the literature background. The relatively novelty of BPA theme means a scarcity of academic research and subsequently shortage of reliable scientific publications on its issues. The construction of the search string was quite challenging, and several attempts had to be made so to obtain a sufficient number of white papers with adequate adhesion to the research problem. The

SLR execution, as expected, confirmed the absence of a standardized framework for technological-independent BPA description. Therefore, to make possible the collation of a set of best practices and models suitable for business processes automation's description, it required an exhaustive analysis and an interpretive approach to the reality described and studied in each article.

Limitations deriving from the lack of specific studies focused enough on the research problem were expected to be mitigated by the complementary contribution from automation experts both from an organization with a high mature level of business automation and vendors or consultants specialized in process automation. In this regard, the sample size for both questionnaire and interview can be considered small, undermining the extent to which the results can be generalized.

Identical limitation arises from the methodology used. In spite of RPA maturity of the multinational enterprise used in this investigation, a single case study, focused on one particular industry, may not render a complete picture of the research problem.

8.2 Recommendations and future work

This study made clear the relevance of carrying out more extensive research on the broader issue of interoperability in BPA context as well as on the specific issue of the development of technological-independent BPA description international standard.

More single case studies and multi-case studies, within early BPA adopters' industries and across industries, as well as studies on multi-enterprises collaborative value chains may provide evidence enough to the construction of a robust theoretical body of knowledge. Equally beneficial will be research work using different methodologies, e. g. Design Science Research (DSR). Performing a DSR in an enterprise undergoing technological transition (from one RPA solution to another) or in an enterprise using different technologies can provide insightful contributions. It will also be useful further research focused on developing evaluation techniques designed to uncover interoperability problems and metrics for alignment assessment.

BCP would benefit from promoting further investigation on these issues, considering the bank objectives and strategic plan (Banco Comercial Português, S.A., 2022a); the increasing uncertainty of global markets; the specially challenging geopolitical context; and that maintaining competitiveness is close linked to the implementation of new technological innovations and process automation (Mazilescu & Micu, 2019).

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Appendices

Appendix I – Questionnaire invitation

My name is Catarina Silvares, and I am a student of the Master of Science Degree in Information and Enterprise Systems at Instituto Superior Técnico (IST) of the University of Lisbon, and under the guidance of Prof. Dr. Henrique São Mamede, I am carrying out a research entitled "Best practices for business process automation description", which will serve as the basis for my master's thesis.

On the research topic:
Each automation tool, either provided by an external supplier or developed inhouse, adopts a specific automation description. Description heterogeneity stands as a bottleneck to compatibility and interoperability, harming an enterprise's ability for innovation, cooperation and competitiveness. Adopting standard specification and description, or at least a set of commonly agreed best practices, on business process automation provides benefits. It is in process-oriented organizations' best interest to assess its current situation based on a set of best practices. This research focuses on the search of such set of best practices and on the necessary elements to perform an alignment assessment.

I invite you to fill in the questionnaire, which you can access through the link below. I estimate that it will take approximately 15 minutes to complete.

Your participation is voluntary, and you can stop or withdraw at any time.

Your response will be kept confidential and used only for the purpose of this investigation.

Thank you in advance for your participation,
Catarina Silvares

Instructions: Most questions are single answer, so tick only one of the boxes, the one correspondent to your answer. Questions 9, 20 and 35 are multiple answer, so tick all the options applicable. Questions 46 and 48 require a free style answer. Several other questions require additional information.

Link: https://docs.google.com/forms/d/e/1FAIpQLSeuZTJei9VDaToxm0eEHQ46fFr1RHEWDNhR6_-elPnP4ZOINA/viewform?usp=sf_link

Glossary:
RPA = Robotic process automation
BPA = Business process automation

Appendix II – Questionnaire (Google Forms)

Practices for business proce automation description

This questionnaire is part of a research study entitled "E process automation description" which will serve as the Science Degree in Information and Entreprise Systems a Técnico.

On the research topic:

Each automation tool, either provided by an external sup inhouse, adopts a specific automation description. Desc stands as a bottleneck to compatibility and interoperabi enterprise's ability for innovation, cooperation and comp standard specification and description, or at least a set practices, on business process automation provides ber oriented organizations's best interest to assess its curre set of best practices. This research focuses on the sear

*Obrigatório

1. I authorize the use of my data for the purpose

- ◯ Yes

2. What is your age? *

- ◯ [20, 30[
- ◯ [30,40[
- ◯ [40,50[

3. What is your gender? *

- ◯ Male
- ◯ Female

4. What is your field of activity? *

- ◯ Insurance
- ◯ Finance
- ◯ Telecommunications

5. Do you work at Banco Comercial Português, S.

- ◯ Yes

6. Have you worked in finance industry in the pas

- ◯ Yes

7. What is your professional experience? *

- ◯ National
- ◯ International

8. What is your actual occupation? *

- ◯ Developer
- ◯ Business analyst
- ◯ Team manager

9. What other role(s) did you play in RPA/BPA tea

- [ ] Developer
- [ ] Business analyst
- [ ] Team manager
- [ ] Project manager

10. How many employees does the company wh implemented have?

- ◯ < 10
- ◯ [10,50[
- ◯ [50,250[

11. How many robots did the largest project you

- ◯ <5
- ◯ [5,10[
- ◯ [10,50[

12. Your team uses formal description of RPA/BI steps that RPA/BPA takes in each interface (grap which it interacts]?

- ◯ Very frequently
- ◯ Frequently

13. Your team stakeholders' use formal descripti

- ◯ Very frequently
- ◯ Frequently
- ◯ Occasionally

14. Formal description of RPA/BPA is? *

- ◯ Extremely important
- ◯ Very important
- ◯ Moderately important

15. Your description of RPA/BPA specifies key p
indicators?

- ◯ Very frequently
- ◯ Frequently
- ◯ Occasionally

16. RPA/BPA related key performance indicators

- ◯ Extremely importante
- ◯ Very important
- ◯ Moderately important

17. Your description of RPA/BPA includes AS IS-
modelling?

- ◯ Very frequently
- ◯ Frequently
- ◯ Occasionally

18. AS IS-TO BE scenarios modelling is: *

- ◯ Extremely important
- ◯ Very important
- ◯ Moderately important

19. Your description of RPA/BPA includes user i
modelling (e. g. screenshot and identification of
robot should act and in what way)?

- ◯ Very frequently
- ◯ Frequently

20. You model your user interface objects using:

- ☐ Text description
- ☐ Mockups
- ☐ Screenshot of applications

21. Your description of RPA/BPA includes rules a
modelling (i. e. description of decision logic, bus
exception handling)?

- ◯ Very frequently
- ◯ Frequently
- ◯ [illegible]

22. Use interface objects modelling is: *

- ◯ Extremely important
- ◯ Very important
- ◯ Moderately important

23. You model rules and decisions using: *

- ◯ Structured and systematic approach (e. g. DMN tabl
- ◯ Description script

24. Rules and decisions modelling is: *

- ◯ Extremely important
- ◯ Very important
- ◯ Moderately important

25. Your description of RPA/BPA engages all stal

- ◯ Very frequently
- ◯ Frequently
- ◯ Occasionally

26. Stakeholders engagement is: *

- ◯ Extremely important
- ◯ Very important
- ◯ Moderately important

27. Your description of RPA/BPA includes logs ai
modelling?

- ◯ Very frequently
- ◯ Frequently
- ◯ Occasionally

28. Logs and exceptions modelling is: *

- ◯ Extremely important
- ◯ Very important
- ◯ Moderately important

29. Your description of RPA/BPA includes data e
transformation and load (ETL) modelling?

- ◯ Very frequently
- ◯ Frequently
- ◯ Occasionally

30. You model ETL using: *

- ◯ Information flow

31. ETL modelling is: *

- ◯ Extremely important
- ◯ Very important
- ◯ Moderately important

32. Your description of RPA/BPA includes chorec
e. detailed description of users' behavior that aut
replicate)?

- ◯ Very frequently
- ◯ Frequently

33. Choreography modelling is: *

- ◯ Extremely important
- ◯ Very important
- ◯ Moderately important

34. Your description of RPA/BPA includes relatec
(i. e. mapping of systems and applications interc

- ◯ Very frequently
- ◯ Frequently
- ◯ Occasionally

35. You model related systems: *

- [ ] Data location
- [ ] Point of access
- [ ] Access credentials

36. Related systems modelling is: *

- ◯ Extremely important
- ◯ Very important
- ◯ Moderately important

37. Your description of RPA/BPA includes compl
specification (i. e. functionalities to validate the c
flow in the event of faults)?

- ◯ Very frequently
- ◯ Frequently

38. Compliance checking specification is: *

- ◯ Extremely important
- ◯ Very important
- ◯ Moderately important

39. Your description of RPA/BPA adopts a modul automation of sub-processes of the given proces building blocks)?

- ◯ Very frequently
- ◯ Frequently
- ◯ Occasionally

40. Modular system adoption is: *

- ◯ Extremely important
- ◯ Very important
- ◯ Moderately important

41. Your team always uses the same description

- ◯ Yes
- ◯ No

42. Your team stakeholders' use the same descri by your team?

- ◯ Very frequently
- ◯ Frequently
- ◯ Occasionally

43. The description notation used by your team i

- ◯ Petri net (https://en.wikipedia.org/wiki/Petri_net)
- ◯ BPMN (https://en.wikipedia.org/wiki/Business_Process_M
- ◯ BPEL (https://en.wikipedia.org/wiki/Business_Proce

44. The criteria for the description notation choic

- ◯ According to a best practice
- ◯ Internally developed / adopted

45. Interoperability is relevant for RPA/BPA. *

- ◯ Strongly agree
- ◯ Agreee
- ◯ Neutral

46. Justify your answer to question number 45. *

A sua resposta

47. Your RPA/BPA description model is suitable t interoperability.

- ◯ Strongly agree
- ◯ Agreee
- ◯ Neutral

48. Describe additional methods used/necessary interoperability.

Appendix III – Interview invitation

My name is Catarina Silvares, and I am a student of the Master of Science Degree in Information and Enterprise Systems at Instituto Superior Técnico (IST) of the University of Lisbon, and under the guidance of Prof. Dr. Henrique São Mamede, I am carrying out a research entitled "Best practices for business process automation description", which will serve as the basis for my master's thesis.

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I invite you to a an in-person / online interview, lasting approximately 30 minutes, to be held on a date to be agreed.

Questions will be sent to you in advance for better preparation of answers.

Your collaboration for the scientific development of this research topic would be very important.

Please, contact me if you have any questions.

Best regards,
Catarina Silvares

Appendix IV – Interview script

Thank you for your willingness to collaborate with the research. The objective of this interview is to gather additional in-depth information about the methods used by automation experts in business process automation description, along with a more detailed insight on your opinion and past experiences, and additional discussion about results obtained in a questionnaire recently carried among automation experts on this subject.

The interview will be recorded for later transcription, it will not be shared or disseminated, and it will be deleted as soon as all the necessary data are collected.

Your response will be kept confidential and used only for the purpose of this investigation.

Your participation is voluntary, and you can stop or take a break.

1. Is your day going well?

_____

2. How long have you been working in RPA/BPA?

_____

3. What is your actual occupation?

a) Developer

b) Business Analyst

c) Team Manager

d) Project Manager

e) Other (Please specify)_____

4. Your RPA/BPA solution is:

a) Inhouse developed

b) Inhouse developed with consultant's help

c) Purchased solution from a provider

5. Your RPA/BPA solution is used:

a) Only in internal processes

b) Only in processes of collaboration with other enterprises

c) Both

6. Your team uses formal description of RPA/BPA [description of the steps that RPA/BPA takes in each interface (graphical or not) with which it interacts]?

a) Very frequently

b) Frequently

c) Occasionally

d) Rarely

e) Never

7. Formal description of RPA/BPA is:

a) Extremely important

b) Very important
c) Moderately important
d) Slightly important
e) Not important at all

8. Why do you classify the relevance of the formal description in this way?

_____

_____

9. What do you consider to be limiting factors in the use of formal description of RPA/BPA?
a) Your team does not have the necessary time
b) Enterprise's size does not justify
c) Interaction with other systems
d) RPA/BPA low level of complexity
e) Vendors opposition
f) Other (Please specify)_____

10. Typically, in an automation project, which activities suffer resource cuts?

_____

_____

11. What KPI's do you use?

_____

_____

12. How satisfied are you with your current technology?
a) Extremely satisfied
b) Very satisfied
c) Neutral
d) Slightly satisfied
e) Not satisfied at all

13. Has your company ever considered changing the RPA/BPA technology it currently uses?
(If Yes) And the change took place? (If Yes) Why?
(If No) Why not?

_____

_____

14. If it were up to you, you would change your RPA/BPA technology? Why?

_____

The interview has come to an end, once again, thank you for participating in this research.

Appendix V – Answers to the questionnaire

Subject	Date/hour	S1	Section 2		Section 3					
		Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9
R1	Oct/07/2022 18:24	Y	[30,40[	M	TC	N	Y	INT	PM	DV;TM;PM
R2	Oct/072022 18:35	Y	[30,40[	F	FI	Y	Y	BOT	DV	BA
R3	Oct/07/2022 18:51	Y	[20, 30[	M	IT	N	Y	NAT	DV	DV;BA
R4	Oct/07/2022 19:24	Y	[30,40[	M	FI	N	Y	NAT	DV	DV;BA
R5	Oct/08/2022 08:02	Y	[30,40[	M	FI	Y	Y	BOT	PM	PM
R6	Oct/10/2022 10:27	Y	[40,50[	M	FI	Y	Y	NAT	DV	BA
R7	Oct/10/2022 10:50	Y	[40,50[	M	FI	Y	N	NAT	TM	DV;BA;PM
R8	Oct/13/2022 09:00	Y	[30,40[	F	Utilities	N	Y	BOT	BA	DV;BA
R9	Oct/17/2022 09:13	Y	[30,40[	M	RT	N	Y	BOT	PM	DV;BA;PM
R10	Oct/17/2022 10:22	Y	[30,40[	F	TC	N	Y	NAT	PM	DV;BA;TM;PM
R11	Oct/17/2022 11:57	Y	[30,40[	M	IN	N	Y	BOT	DV	BA;TM
R12	Oct/17/2022 13:13	Y	[30,40[	M	RPA devel-opment	N	N	NAT	DV	DV;BA
R13	Oct/17/2022 17:19	Y	[30,40[	M	FI	Y	N	BOT	CT	DV;TM
R14	Oct/18/2022 09:31	Y	[40,50[	M	FI	Y	Y	NAT	TM	NO
R15	Oct/18/2022 14:16	Y	[20, 30[	M	BPO	N	Y	INT	BA	NO
R16	Oct/18/2022 15:33	Y	[30,40[	M	FI	Y	Y	NAT	TM	DV;BA;TM;PM

Legend:

S = Section; R = Respondent; Q = Question

Y = Yes; N = No

F = Female; M = Male

IN = Insurance; FI = Finance; TC = Telecommunications; RT = Retail

INT = International; NAT = National; BOT = Both

BA = Business Analyst; CT = Controller; DV = Developer; PM = Project Manager; TM = Team Manager; NO = No other

Subject	Section 3		Section 4									
	Q10	Q11	Q12	Q13	Q14	Q15	Q16	Q17	Q18	Q19	Q20	Q21
R1	>=1000	<5	VF	VF	EI	FQ	EI	VF	EI	VF	TD;MU;SS	VI
R2	>=1000	[50,100[	VF	RR	EI	FQ	VI	FQ	EI	VF	TD;SS	EI
R3	>=1000	[50,100[	VF	VF	EI	FQ	MI	VF	EI	VF	TD;SS;VD	EI
R4	[50,250[	>=100	FQ	VF	MI	FQ	MI	FQ	MI	RR	TD;UM	MI
R5	[10,50[	>=100	OC	FQ	VI	FQ	VI	VF	EI	FQ	TD;SS	VI
R6	>=1000	<5	VF	FQ	EI	FQ	VI	FQ	VI	FQ	TD;SS	VI
R7	>=1000	[50,100[	FQ	FQ	EI	RR	VI	FQ	VI	VF	TD;SS	VI
R8	>=1000	>=100	FQ	FQ	VI	VF	EI	OC	VI	RR	SS	MI
R9	>=1000	>=100	VF	FQ	MI	VF	EI	VF	EI	FQ	TD;SS;VD	EI
R10	[10,50[	[50,100[	VF	FQ	EI	VF	EI	VF	EI	VF	TD;MU;SS;VD	EI
R11	[500,1000[	[10,50[	VF	FQ	EI	VF	EI	VF	VI	VF	TD;SS	EI
R12	>=1000	<5	VF	FQ	EI	FQ	VI	VF	EI	VF	TD;SS;VD	EI
R13	[10,50[	>=100	FQ	OC	SI	OC	SI	OC	MI	FQ	TD;SS;VD	MI
R14	>=1000	>=100	VF	VF	EI	VF	EI	VF	EI	VF	TD;SS;VD	EI
R15	[50,250[	<5	FQ	RR	EI	FQ	VI	VF	EI	FQ	MU;SS	EI
R16	>=1000	[50,100[	VF	FQ	VI	VF	EI	VF	EI	VF	TD;MU;SS;VD	EI

Legend:

R = Respondent; Q = Question

VF = Very frequently; FQ = Frequently; OC = Occasionally; RR = Rarely; NV = Never

EI = Extremely important; VI = Very important; MI = Moderately important; SI = Slightly important; NI = Not important at all

TD = Text description; MU = Mockups; SS = Screenshot of applications; VD = Videos

Subject	Section 4												
	Q22	Q23	Q24	Q25	Q26	Q27	Q28	Q29	Q30	Q31	Q32	Q33	Q34
R1	VF	DS	EI	FQ	VI	FQ	EI	FQ	IF	MI	RR	SI	FQ
R2	VF	DS	EI	FQ	EI	VF	EI	FQ	IF	VI	VF	EI	VF
R3	VF	DS	VI	OC	EI	VF	VI	OC	IF	VI	VF	MI	OC
R4	VF	SSA	EI	FQ	EI	OC	MI	RR	IF	SI	VF	VI	OC
R5	OC	DS	VI	FQ	MI	OC	VI	FQ	IF	VI	OC	MI	OC
R6	OC	Excel	VI	FQ	EI	OC	VI	FQ	SSIS	VI	OC	VI	FQ
R7	VF	DS	VI	FQ	EI	VF	VI	OC	IF	VI	FQ	MI	FQ
R8	OC	DS	EI	FQ	EI	RR	VI	OC	IF	MI	FQ	VI	NV
R9	VF	SSA	EI	OC	VI	OC	VI	OC	IF	MI	FQ	MI	FQ
R10	VF	SSA	EI	VF	EI	VF	EI	VF	IF	EI	VF	EI	VF
R11	VF	DS	EI	FQ	VI	VF	EI	FQ	IF	VI	OC	MI	OC
R12	VF	SSA	EI	FQ	VI	VF	EI	FQ	IF	VI	FQ	VI	FQ
R13	VF	SSA	EI	RR	SI	VF	EI	RR	IF	SI	OC	SI	FQ
R14	VF	DS	EI	VF	EI	FQ	VI	FQ	Text de-scription	VI	VF	EI	VF
R15	VF	SSA	EI	OC	EI	OC	VI	OC	IF	MI	RR	SI	OC
R16	VF	DS	VI	FQ	EI	VF	EI	FQ	IF	MI	FQ	VI	FQ

Legend:

R = Respondent; Q = Question

VF = Very frequently; FQ = Frequently; OC = Occasionally; RR = Rarely; NV = Never

EI = Extremely important; VI = Very important; MI = Moderately important; SI = Slightly important; NI = Not important at all

SSA = Structured and systematic approach; DS = Description script

IF = Information flow

Subject	Section 4						Section 5			
	Q35	Q36	Q37	Q38	Q39	Q40	Q41	Q42	Q43	Q44
R1	DL;PA;AC;RL	VI	VF	EI	FQ	VI	Y	RR	BPMN	COT
R2	DL;AC	VI	VF	EI	FQ	VI	Y	RR	BPMN	IDA
R3	DL;PA;AC;RL	VI	VF	EI	OC	MI	Y	OC	BPEL	IDA
R4	DL;PA	MI	RR	MI	RR	SI	Y	VF	BPMN	IDA
R5	AC	VI	FQ	VI	FQ	VI	Y	FQ	N	ABP
R6	DL;PA	VI	OC	VI	FQ	VI	Y	OC	BPMN	ABP
R7	DL;PA	VI	FQ	VI	FQ	MI	Y	FQ	BPMN	ABP
R8	AC	MI	OC	SI	OC	SI	N	OC	BPMN	COT
R9	DL;PA;AC	MI	VF	EI	VF	VI	Y	RR	BPMN	IDA
R10	DL;PA;AC;RL	EI	VF	EI	VF	VI	N	FQ	BPMN	ABP
R11	DL;PA;AC	VI	VF	EI	VF	EI	Y	VF	BPMN	IDA
R12	DL;AC	VI	VF	EI	VF	EI	Y	FQ	BPMN	ABP
R13	DL;AC;RL	MI	VF	VI	VF	EI	Y	RR	BPMN	IDA
R14	DL;PA;AC;RL	EI	FQ	VI	VF	EI	Y	NV	We do not follow a worldwide standard-ized notation	COT
R15	AC	MI	FQ	VI	FQ	VI	Y	OC	BPMN	ABP
R16	DL;PA;AC	VI	OC	VI	VF	EI	Y	OC	BPMN	ABP

Legend:

R = Respondent; Q = Question

DL = Data location; PA = Point of access; AC = Access credentials; RL = Relationship

VF = Very frequently; FQ = Frequently; OC = Occasionally; RR = Rarely; NV = Never

EI = Extremely important; VI = Very important; MI = Moderately important; SI = Slightly important; NI = Not important at all

BPMN = Business Process Model and Notation; BPEL = Business Process Execution Language

ABP = According to a best practice; IDA = Internally developed / adopted; COT = Comprehensible outside the team / company

Subject	Section 6	
	Q45	**Q46**
R1	SA	To guaranty easy methodology explanation and handling from one team to another
R2	AA	interoperability is relevant in every projects / system
R3	SA	A business process normally includes a lot of different systems that don't communicate with each other
R4	AA	NR
R5	AA	NR
R6	AA	Increased productivity. With the time required to process data reduced, organizational efficiencies increase. Reduced costs. Since fewer resources or additional maintenance is required. Reduced errors.
R7	SA	RPA software vendors are mostly recent in software industry. Mergers and acquisitions will occur, and some vendors might close. It's very relevant to be able to migrate easily. RPA assets are growing in number at a very fast pace.
R8	AA	organizational efficiency
R9	DA	All processes should be closed and enough to run by themselves only
R10	AA	Interoperability refers to the basic ability of computerized systems to connect and communicate with one another readily, even if they were developed by widely different manufacturers in different industries
R11	SA	Generally, it is necessary to have bots automating part or parts of a process, so other systems may be needed to complete the process end to end
R12	AA	The automation can be used in multiple scenarios where multiple platforms are involved. It will help in in lessening human workload and without errors.
R13	SA	It is important that the automated process can scale horizontally. The code or process that runs on one machine must be able to run on another, instantly or almost, for that scalability to be sustainable (speaking only as interoperability in software).
R14	SA	RPA processes benefit from using modular, reusable components.
R15	AA	NR
R16	AA	Automation teams should be technology agnostic and for that reason we should pursue a path where we have a technology ecosystem composed by several tools (RPA, Process Mining, Chatbot, OCR, etc.)

Legend:

R = Respondent; Q = Question

SA = Strongly agree; AA = Agree; NT = Neutral; DA = Disagree; SD = Strongly disagree

NR = Not responded

Subject	Section 6	
	Q47	**Q48**
R1	SA	NR
R2	AA	common language, templates
R3	AA	Process standardization, application interfaces
R4	NT	NR
R5	AA	NR
R6	AA	APIs Web Services
R7	NT	1. XML forward and reverse engineering 2. PoC for software migration 3. Don't use too low-level automation functionalities of specific software vendors (avoid specific software development) 4. Keep automation solution simple 5. Develop automation patterns (like in software engineering)
R8	DA	Meetings with the app owners
R9	DA	NR
R10	NT	According to the Healthcare Information and Management Systems Society (HIMSS), “Interoperability describes the extent to which systems and devices can exchange data and interpret that shared data. For two systems to be interoperable, they must be able to exchange data and subsequently present that data such that it can be understood by a user.”
R11	SA	Usage of report tools
R12	AA	Saving data in documents as a way to record the end result of that process.
R13	NT	Standardized environment between our resources (i. e. every machine is equal with the same software and updates installed to ensure that everyone process runs the same in all our resources).
R14	SA	No other. The description of the processes is enough.
R15	AA	NR
R16	AA	NR

Legend:

R = Respondent; Q = Question

SA = Strongly agree; AA = Agree; NT = Neutral; DA = Disagree; SD = Strongly disagree

NR = Not responded

Appendix VI – Interviews transcript

E1 Interview transcription

P1. Is your day going well?

R1: Very well, thank you.

P2. How long have you been working in RPA/BPA?

R2: I have been teaching BPMN for more than ten years (since version 2.0) and I have been developing BPMS for more than 8 years. RPA, in the context of the current software approach, was first explored by our team in 2017 (five years ago). If we consider automation based on user interaction, our team has been working on it for more than twenty years (mainframe emulation automation).

P3. What is your actual occupation?

a) Developer; b) Business Analyst; c) Team Manager; d) Project Manager; e) Other (Please specify)

R3: Officially I'm head of BPMACC. I'm also architect (BPMS/RPA) and developer (BPMS).

P4. Your RPA/BPA solution is:

a) Inhouse developed; b) Inhouse developed with consultant's help; c) Purchased solution from a provider

R4: We have purchased an RPA solution from a vendor. Actually, DTO bought the solution and made the corresponding selection process and we have been using the solution according to infrastructure separation and alignment agreement. For that day on, we developed our own approach, considering that creating a no code BPMS integrated approach would lead us to a better resource, for both technical and human reasons.

P5. Your RPA/BPA solution is used:

a) Only in internal processes; b) Only in processes of collaboration with other enterprises; c) Both

R5: Currently, we use it only in our processes.

P6. Your team uses formal description of RPA/BPA [description of the steps that RPA/BPA takes in each interface (graphical or not) with which it interacts]?

a) Very frequently; b) Frequently; c) Occasionally; d) Rarely; e) Never

R6: Well, a). For the no code solution, we use a very lean approach. Because the interface that is automated is always the same, we developed a simple description for it. Every single automation is described using that "language" because it's the description that is used as a recipe for the automation engine to execute. It's a really beneficial approach. In case of low code (the native tools approach), we developed a template for specification and use it every time we have a development.

P7. Formal description of RPA/BPA is:

a) Extremely important; b) Very important; c) Moderately important; d) Slightly important; e) Not important at all

R7: B. In no code, it's not only extremely important but critical, because the no code approach needs the description to function.

P8. Why do you classify the relevance of the formal description in this way?

R8: As I said before, the software only works with the specified description.

P9. What do you consider to be limiting factors in the use of formal description of RPA/BPA?

a) Your team does not have the necessary time; b) Enterprise's size does not justify; c) Interaction with other systems; d) RPA/BPA low level of complexity; e) Vendors opposition; f) Other (Please specify)

R9: I'll focus my answer in low code approach, since in no code is mandatory. In high application volume enterprises, RPA is the key for low-cost integrations. This has busted demand for these solutions and considering the relatively low availability of resources, the need to cut project time is key. Unfortunately, the most common activity when we cut time (or even the entire activity) is requirements description. Also, if the integration is done mainly to one interface only, the team might skip some details and only mention the function that will be automated.

P10. Typically, in an automation project, which activities suffer resource cuts?

R10: If a project change request cannot be meet using more resources (time, money or people), the activity that is normally crushed or eliminated is requirements detailed specification, which include RPA description.

P11. What KPI's do you use?

R11: More often we use people effort reductions, and we measured it in FTE; and compliance and risk mitigation gains, using a Likert scale or another related scale. Also, it is quite common to measure the quickness to get to market and for that we use the cost of opportunity and the avoided fines. And we also include the overall financial return, including development and maintenance costs and people effort reductions, since this is the most common benefit.

P12. How satisfied are you with your current technology?

a) Extremely satisfied; b) Very satisfied; c) Neutral; d) Slightly satisfied; e) Not satisfied at all

R12: Highly satisfied but one aspect is still undergoing some analysis. The fact that the robots are not personal assistants is a major downturn to our strategy.

P13. Has your company ever considered changing the RPA/BPA technology it currently uses? (If Yes) And the change took place? (If Yes) Why? (If No) Why not?

R13: No.

P14. If it were up to you, you would change your RPA/BPA technology? Why?
R14: No, we are satisfied.

E2 Interview transcription

P1. Is your day going well?
R1: Yes, quite well.

P2. How long have you been working in RPA/BPA?
R2: I've been working in RPA since 2017.

P3. What is your actual occupation?
a) Developer; b) Business Analyst; c) Team Manager; d) Project Manager; e) Other (Please specify)
R3: At the moment, I work as senior developer and solution architect. And I also do business analysis.

P4. Your RPA/BPA solution is:
a) Inhouse developed; b) Inhouse developed with consultant's help; c) Purchased solution from a provider
R4: Here, there are two RPA solutions: one inhouse developed with consultant's help and another solely inhouse developed. I'm actually working in this second (inhouse developed).

P5. Your RPA/BPA solution is used:
a) Only in internal processes; b) Only in processes of collaboration with other enterprises; c) Both
R5: In my current project, there are only internal processes.

P6. Your team uses formal description of RPA/BPA [description of the steps that RPA/BPA takes in each interface (graphical or not) with which it interacts]?
a) Very frequently; b) Frequently; c) Occasionally; d) Rarely; e) Never
R6: We have an internal template for RPA description and that's what we use.

P7. Formal description of RPA/BPA is:
a) Extremely important; b) Very important; c) Moderately important; d) Slightly important; e) Not important at all
R7: I find it extremely important.

P8. Why do you classify the relevance of the formal description in this way?
R8: I can point out two main reasons: good understanding between analyst and process owner about process description or approach and for future purposes, such as maintenance and reference.

P9. What do you consider to be limiting factors in the use of formal description of RPA/BPA?
a) Your team does not have the necessary time; b) Enterprise's size does not justify; c) Interaction with other systems; d) RPA/BPA low level of complexity; e) Vendors opposition; f) Other (Please specify)
R9: Mostly, is the lack of time to specify the process' description from all parts involved point of view: business analyst, process owner, specialist matter expert, etc.

P10. Typically, in an automation project, which activities suffer resource cuts?
R10: Well, the first victim is documentation, which includes AS-IS and TO-BE process definition. Another activity that is rarely delivered is documentation concerning tests plans.

P11. What KPI's do you use?
R11: We are no different from others, we use FTE, the most common KPI used. But we also use risk mitigation and SLA gains.

P12. How satisfied are you with your current technology?
a) Extremely satisfied; b) Very satisfied; c) Neutral; d) Slightly satisfied; e) Not satisfied at all
R12: I'll say very satisfied, but there are opportunities for improvement.

P13. Has your company ever considered changing the RPA/BPA technology it currently uses? (If Yes) And the change took place? (If Yes) Why? (If No) Why not?
R13: No.

P14. If it were up to you, you would change your RPA/BPA technology? Why?
R14: No. Our current RPA technology is suitable for our needs and highly recommended for our industry.

E3 Interview transcription

P1. Is your day going well?
R1: Very well, thank you.

P2. How long have you been working in RPA/BPA?
R2: Little more than a year.

P3. What is your actual occupation?

a) Developer; b) Business Analyst; c) Team Manager; d) Project Manager; e) Other (Please specify)

R3: Currently, I'm a Team Manager.

P4. Your RPA/BPA solution is:

a) Inhouse developed; b) Inhouse developed with consultant's help; c) Purchased solution from a provider

R4: Our solution was purchased and then further developed with the help of a consultant.

P5. Your RPA/BPA solution is used:

a) Only in internal processes; b) Only in processes of collaboration with other enterprises; c) Both

R5: Our solution is used only in internal processes.

P6. Your team uses formal description of RPA/BPA [description of the steps that RPA/BPA takes in each interface (graphical or not) with which it interacts]?

a) Very frequently; b) Frequently; c) Occasionally; d) Rarely; e) Never

R6: We use it all the time.

P7. Formal description of RPA/BPA is:

a) Extremely important; b) Very important; c) Moderately important; d) Slightly important; e) Not important at all

R7: In my personal opinion, is very important.

P8. Why do you classify the relevance of the formal description in this way?

R8: Before automating, the description is essential to understand the business need. We can conclude that automation is not the way. Later, it is fundamental in contingency situations. If the robot doesn't do it, it can be done by humans, because our robots work on front-ends that can also be used by people. Once documented, knowledge is not lost. It is also used in process reviews with the business areas responsible for the process. Blue Prism allows us to do the description, but we do it in Power Point to be easier to understand when we interact with people in the business areas.

P9. What do you consider to be limiting factors in the use of formal description of RPA/BPA?

a) Your team does not have the necessary time; b) Enterprise's size does not justify; c) Interaction with other systems; d) RPA/BPA low level of complexity; e) Vendors opposition; f) Other (Please specify)

R9: The main limiting factor is the lack of time, even though it is very important. The documentation takes a back seat when automation is urgent. We give priority to the completion of the automation. The description can be left for later. But we always end up doing it, because of future maintenance. It's

not so much for configuration, but it's essential for reviewing processes. Sometimes it can be left behind because of a lesser awareness of its importance. And when we have great limitations of people.

P10. Typically, in an automation project, which activities suffer resource cuts?
R10: The description is one of them, especially the AS-IS scenarios and also the quantification of the benefits. Another thing that takes time is defying necessity because it might not make sense to automate. The urgent nature of the request may prevent us from making the appropriate challenging. But that's not all that often.

P11. What KPI's do you use?
R11: From the AS-IS scenario, we use the average processing time of humans. In the TO-BE scenario, we use the average processing time of each robot, the total volume of operations processed, the average of operations processed by each robot, the impact in terms of FTE in the covered areas, the percentage of automated tasks within each business process. We also measure the volume of exceptions, both business (recommended in the process design and with treatment defined by the business area) and system (unforeseen, such as due to system unavailability, changes in the interface, etc.). As system exceptions imply corrective actions on the automatism, the SLA of these actions is measured and compared with the standard SLAs defined according to the criticism of the process. We follow these indicators in real time through monitors that we have installed here in our working room.

P12. How satisfied are you with your current technology?
a) Extremely satisfied; b) Very satisfied; c) Neutral; d) Slightly satisfied; e) Not satisfied at all
R12: I must say I'm very satisfied. But, for someone like me, there is always room for continuous improvement. We have questions regarding the access of the robots that we wanted to be resolved differently but, in this matter, security issues are paramount. I am also concerned about the best way to capitalize the robots, basically, being able to manage a net workforce to allocate according to the needs of the moment.

P13. Has your company ever considered changing the RPA/BPA technology it currently uses? (If Yes) And the change took place? (If Yes) Why? (If No) Why not?
R13: No.

P14. If it were up to you, you would change your RPA/BPA technology? Why?
R14: Based on the information I have, no, I wouldn't. A technological change has to be evaluated by comparing the additional benefits versus the costs of transition. Currently, I don't see an alternative: the costs are prohibitive, and I don't see significant benefits.

E4 Interview transcription

P1. Is your day going well?

R1: Yes, thank you.

P2. How long have you been working in RPA/BPA?

R2: Since 2016.

P3. What is your actual occupation?

a) Developer; b) Business Analyst; c) Team Manager; d) Project Manager; e) Other (Please specify)

R3: I've taken on almost all the roles. Since 2018, I have been a team manager. But, of course, I started as a developer.

P4. Your RPA/BPA solution is:

a) Inhouse developed; b) Inhouse developed with consultant's help; c) Purchased solution from a provider

R4: It's a purchased solution from a provider. The maintenance team itself are outsourcers, undergoing implantation in our facilities.

P5. Your RPA/BPA solution is used:

a) Only in internal processes; b) Only in processes of collaboration with other enterprises; c) Both

R5: Both.

P6. Your team uses formal description of RPA/BPA [description of the steps that RPA/BPA takes in each interface (graphical or not) with which it interacts]?

a) Very frequently; b) Frequently; c) Occasionally; d) Rarely; e) Never

R6: Always. We use a PDD (process definition document) with the AS-IS and TO-BE scenarios.

P7. Formal description of RPA/BPA is:

a) Extremely important; b) Very important; c) Moderately important; d) Slightly important; e) Not important at all

R7: Extremely important.

P8. Why do you classify the relevance of the formal description in this way?

R8: The description is essential to an accurate identification of the need. Without this identification, we will not have a solution of excellence. But it also serves to assess whether we can implement what is intended. The proper documentation of the AS-IS and TO-BE scenarios, the inclusion of screenshots of the interfaces, the handling of business and system exceptions are essential elements for the developer's work. Comparing the AS-IS and TO-BE scenarios has to show noticeable differences, that's

where the delivery value resides. The modular approach and the way variations and exceptions are handled are essential aspects for improving the solution.

P9. What do you consider to be limiting factors in the use of formal description of RPA/BPA? a) Your team does not have the necessary time; b) Enterprise's size does not justify; c) Interaction with other systems; d) RPA/BPA low level of complexity; e) Vendors opposition; f) Other (Please specify)

R9: Description is an insurmountable step. Without the approved PDD, no progress can be made. But there are always difficulties. Availability of teams is a theme. The people initially involved do not always know the entirety of the process, and it becomes necessary to involve even more people.

P10. Typically, in an automation project, which activities suffer resource cuts?

R10: Yes, indeed cuts can happen. In my view, RPA is a band-aid; to give the central IT team time to create an integrated API solution. RPA implementation is therefore an agile process, to be done in weeks. It cannot involve excessive documentation. It may happen that we just go ahead with a simplified description of AS-IS and TO-BE. It implies that we have to strengthen controls, carry out more exhaustive tests and ensure a contingency plan.

P11. What KPI's do you use?

R11: We follow the average processing time of robots and volume of processed operations. In the processed operations, we count how many were processed successfully, how many were processed as exceptions, separating the business ones from the system ones. Thus, we detect opportunities for improvement. We calculate the occupancy rate of each robot and the number of hours released to the team (this is very important, because it is a real benefit for the business teams). We also calculate the revenue generated by the digital workforce.

P12. How satisfied are you with your current technology?

a) Extremely satisfied; b) Very satisfied; c) Neutral; d) Slightly satisfied; e) Not satisfied at all

R12: Extremely satisfied. I am convinced that it is the best solution on the market and any problem that occurs is always resolved quickly.

P13. Has your company ever considered changing the RPA/BPA technology it currently uses? (If Yes) And the change took place? (If Yes) Why? (If No) Why not?

R13: No. As I said, I think we have the best solution on the market, the simplest and most intuitive. And we already have too many processes in this technology.

P14. If it were up to you, you would change your RPA/BPA technology? Why?

R14: No, no. The course is this: decentralize and bet on people's reskilling. Although I don't think we should be held hostage to a single technology.

Appendix VII – Interviews treatment

Variable / Subject	E1	E2	E3	E4
Section 1 – Experience and materiality				
2. RPA/BPA experience	> 10	5	1	> 7
3. Business role	BPMACC Team Manage Architect (BPMS/RPA) Developer (BPMS)	Senior developer Architect Business analyst	Team Manager	Team Manager
4. RPA/BPA sourcing	Purchased solution from a provider, then customized to a no code BPMS integrated approach Inhouse developed	Purchased solution from a provider, then customized Inhouse developed	Purchased solution from a provider, then customized	Purchased solution from a provider
5. Cooperation level	Only in internal processes	Only in internal processes	Only in internal processes	Internal and collaborative processes
Section 2 – Usage and perceived value				
6. Formal description usage	Very frequently No code solution – Description using “execution language” Low code – Specific template	Very frequently Specific template	Very frequently	Very frequently
7. Formal description relevance	Extremely important No code solution - Critical	Extremely important	Very important	Extremely important
8. Individual opinion on formal description relevance	Essential for RPA functioning	Better communication Future mainte-	Viability assessment Contingency	Viability assessment Essential for

Variable / Subject	E1	E2	E3	E4
		nance and reference	knowledge backup Better communication	development Future improvement
Section 3 – Usage limitations				
9. Individual opinion on limiting factors	Few resources Shortage of time Avoid lag time	Shortage of time	Shortage of time Lack of importance awareness Few resources	Few resources
10. Individual opinion on activities impacted by resource cuts	Requirements detailed specification	Documentation: AS-IS and TO-BE process definition Test plan	AS-IS and TO-BE scenarios description Impact assessment Challenging	Detail level of AS-IS and TO-BE scenarios description
11. Individual opinion on KPI's usage	FTE reduction Compliance gains Risk mitigation gains Quickness to get to market Financial return	FTE reduction Risk mitigation gains SLA gains	Average processing time Volume of operations processed FTE reduction Volume of exceptions SLA of RPA corrective actions	Average processing time Volume of processed operations Volume of exceptions RPA occupancy rate Human labor saving
Section 4 – Satisfaction and change opportunity				
12. Individual opinion on satisfaction level	Extremely satisfied but lacks an important feature	Very satisfied	Very satisfied	Extremely satisfied
13. Individual opinion on opportunity for change	No need felt	No	No	No
14. Individual opinion on opportunity for change	Not applicable	No need felt	No significant benefits High costs	No need felt