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Best practices for business process automation description – a case study

Catarina Silvares[a], Henrique São Mamede[b,c] and João Costa[d]

[a]Department of Computer Science Engineering, Instituto Superior Tecnico, Lisbon, Portugal; [b]INESC TEC–Institute for Systems and Computer Engineering, Technology and Science, Porto, Portugal; [c]Department of Sciences and Technology, Universidade Aberta, Rua da Escola Politécnica, Lisboa, Portugal; [d]Department of Computer Science, ISCTE-UIL–Instituto Universitário de Lisboa, Lisbon, Portugal

ABSTRACT

Organizations in competitive, regulated environments must enhance business processes for efficiency, quality, and compliance while minimizing risks and costs. Process automation solutions play a vital role in achieving these goals, though the variety of tool descriptions creates challenges for compatibility and interoperability. This hinders innovation and competitiveness. The adoption of standard specifications or widely accepted best practices for automation descriptions offers a solution. This research aims to identify a set of best practices to guide process-oriented organizations in evaluating their current automation practices, ensuring alignment and fostering improvements in business process automation.

KEYWORDS

Business Process Automation; BPA; RPA; Business Process Management; BPM; Interoperability; Standard

Introduction

Process-oriented enterprises operating in highly competitive and strictly regulated settings must strengthen their business processes. C. SILVARES

Adopting technological solutions that guarantee improved operational efficacy and efficiency, service quality, and compliance and reduce risks and costs, in an integrated manner, can help to enhance processes (Syed et al. 2020).

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

Each automation tool, provided by an external supplier or developed in-house, adopts a specific description. This lack of standardisation undermines communication, prejudices quality, adversely affects performance, and impacts productivity (Lewicki, Tochowicz, and van Genuchten 2019). Consequently, description

CONTACT Henrique São Mamede jose.mamede@uab.pt INESC TEC—Institute for Systems and Computer

heterogeneity is 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 on BPA, or at least a set of widely accepted best practices, has advantages, and improves competitiveness, robustness, flexibility, and efficiency.

Innovation in the banking and financial sector evolves alongside globalisation and the digital transformation of the economy, requiring enhanced competitive and collaborative capacities. Lowering risks and costs and increasing productivity and margins require appropriate technological tools. BPA is among them (Cooper et al. 2019). No matter how flexible the enterprises' infrastructure is, implementing and managing increasingly complex, intelligent, agile, robust, and responsive BPA requires dynamic interaction of highly compatible solutions. Interoperability becomes a requirement for success and resilience (Issac, Muni, and Desai 2018).

A Portuguese financial institution was used to conduct this study. Its strategic plan for the years 2021–2024 reinforces among its acting priorities leading in efficiency by lowering costs and enhancing productivity through reengineering and automation of business processes. It also anticipates 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, intelligent automation and informed and agile management of business processes and regulatory compliance. As a process-oriented organisation, it is in this Bank's best interest to assess its current situation concerning interoperability at the pragmatic level of BPA description. Without standards applicable to BPA description, the set of best practices collected through the SLR (Table 3) was used to perform an alignment assessment regarding the Bank's adoption of a technological-independent description of its business process automation.

It is in process-oriented organisations' best interest to assess their current situation and identify improvement measures. To fulfil that purpose, it is necessary to conduct an evaluation based on a set of best practices. This research focuses on searching for such a set of best practices and the elements required 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 ensure interoperability?

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

This paper is structured in 8 sections. This section presents the introduction, giving the research context and problem. In section 2, the methodology used is described. Section 3 presents the research background, with the main concepts used. Section 4 describes the systematic literature review. Section 5 details the case study. Section 6 summarises the evidence collection and analysis. Section 7 discusses the results. In section 8, the conclusions of this paper are presented.

Methodology

This research uses the case study methodology to assess the alignment of the BPA description. The case study that will be performed in this research follows Yin's perspective (Yin 1994) and Soy's guidelines (Soy 2022), which propose using five main steps: research design, preparation for evidence collection, evidence collection, evidence analysis and sharing results. The selection of a case study as a research methodology was due to its adequacy to real-life, contemporary human situations to gain a deeper understanding of the research problem. The methodology is illustrated in Figure 1.

Following the methodology steps (Figure 1), the actions to be realised are as described:

- Step 1 – Theoretical research background, including systematic literature review to confirm the research question.
- Step 2 – Selection of the proper case to be analysed.
- Step 3 – Development of questionnaires and interviews for data gathering.
- Step 4 – Data gathering using the developed questionnaires and interviews.
- Step 5 – Analysis of obtained data collection, evaluation, and discussion of the results.
- Step 6 – Communication of the results through this paper.

Research background

This section corresponds to step 1 of the methodology. It only partially fulfils the step of the methodology since, in the next section, the systematic literature review will be described.

Business process management

A process is a series of actions that are carried out to achieve a particular result (Merriam-Webster Dictionary 2022). A business process is a set of functions in a specific sequence that deliver value for an internal or external customer (Kirchmer 2017).

Business Process Management (BPM) was initially described as a structured approach used to analyse and continually improve fundamental activities of an enterprise's operation (Elzinga et al. 1995). It was used to increase efficiency and reduce costs. Nowadays, BPM is considered a management discipline and a set of technologies supporting management by process (Szelągowski and Lupeikiene 2020). It consists of designing,

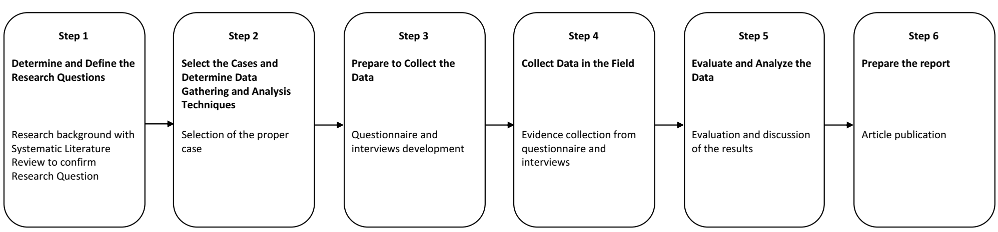

Figure 1. Case study methodology.

implementing, controlling, and improving business processes to increase the ability of an organisation to achieve a high level of global performance.

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. It developed traditional BPM software systems to enable 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 and Lupeikiene 2020).

Automation

A robot is an electromechanically designed machine, programmable by a computer and capable of automatically carrying out a complex series of actions. Therefore, robotic process automation (RPA) means automation of service tasks, which are by default implemented as a service to connect a service endpoint. For business processes, the term RPA most commonly refers to configuring software to do the work previously done by humans (Madokam, Holmukke, and Jaiswal 2019). The IEEE Corporate Advisory Group (Hofmann, Samp, and Urbach 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.

Process automation can also be interpreted as a particular type of organisational 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 a coherent set of IT tools (business applications and software robots), processes and procedures, and people with certain competencies and skills carrying out specific business processes and processing particular data (Sobczak 2019). Automating business flows, using large and heterogeneous data and knowledge, and applying more complex decision-making embodies a broader concept encompassing automation and robotisation of business processes (BPA/R) (Mazilescu and Micu 2019).

Adopting RPA enhances customer satisfaction by promoting higher processes' efficiency, accuracy, reliability, and regulatory compliance (Keung et al. 2021). Additionally, it increases employees' satisfaction due to lower repetitive workload and human error amendments. Automation benefits include flexibility, scalability, standardisation, cost reduction, control, and governance. These issues transcend the task level and point to the broader level of the business process (Willcocks, Lacity, and Craig 2017). Automation can evolve from a single task automation to the automation of several tasks in a process, and even further, it can be used to automate the business process choreography. The increasing complexity demanded by dynamic business environments requires assistance in decision-making processes with cognitive computing and embedded intelligence. It now uses additional technological capabilities provided by other methods such as process mining, machine learning and cognitive or artificial intelligence (Wewerka and Reichert 2021).

Process automation technologies are broadly recognised for several advantages, including high accuracy and uniformity of operations, consistency, reliability, increased productivity, cost reduction, efficiency, regulatory compliance, low technical barriers, non-invasive technology, and improvement in employee morale (Madokam, Holmukke, and Jaiswal 2019). These characteristics make it an attractive solution for a variety of industries.

Interoperability

Interoperability is defined as the ability of enterprises and entities within those enterprises to communicate and interact effectively (2009), translating into business processes understood and aligned within and across organisational boundaries (Figure 2). 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 realised through processes. Processes employ services which, in turn, need data to perform tasks or activities (2009).

Scientific researchers are addressing the different issues related to enterprise interoperability across varying levels of granularity, from data, processes, and rules interoperability at the lower granularity level to ecosystem interoperability at the highest granularity level (Torkhani et al. 2018).

Enterprises are beginning to consider and assess their collaborative capabilities, which can be set on four levels (Mu, Bénabena, and Pingaud 2015): (i) communication, the ability to exchange and share information; (ii) openness, the ability to share business services and functionalities with others, (iii) 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 (iv) interoperability: the ability to work with others without the need for a special effort; the enterprises involved are seen as a seamless system.

In increasingly common collaborative contexts, interoperability has become a prerequisite, enabling the integration of business and operational rules while assisting in data preparation for user tasks. 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).

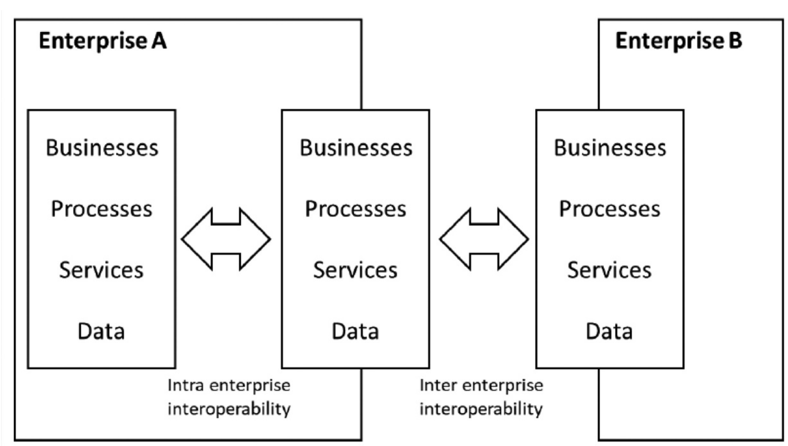

Figure 2. Intra and inter-enterprise interoperability (adapted from (Jakimoski 2016)).

The effectiveness of information-sharing among digital systems and business processes 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 utilisation of services or the common understanding of exchanged items. Breaking down technological barriers is crucial due to enterprise information systems' practical and operational role (Mu, Bénabena, and Pingaud 2015).

Therefore, detecting interoperability problems as quickly and extensively as possible and solving them adequately and efficiently is in the best interest of enterprises operating in various industries, particularly those involved in collaborative business processes in highly competitive and regulated environments.

Standards and best practices

A standard is an acceptable level of quality or achievement. Standards for technologies can result in force quality and consistency features to ensure compatibility, interoperability, and safety. Consequently, standardisation is developing, promoting and mandating standards-based and compatible technologies and processes within a given industry.

Management philosophies, such as Lean and Six Sigma, focus on establishing standards (Pepper and Spedding 2010). Business process standardisation is one of the first steps towards process automation. Organisations use the standardisation and optimisation of processes to increase efficiency, compatibility, availability, productivity, auditability, automation, regulatory compliance, and customer satisfaction (Kokina and Blanchette 2019).

Business process 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 feasible and tending to smoother processes.

Despite several RPA vendors and products in the market, the guidelines and frameworks offered by suppliers and consultants may provide biased information. Meanwhile, academic research on these topics is still developing (Syed et al. 2020). Therefore, it is common knowledge that no standard framework for describing BPA exists. In its absence, using a set of best practices is the commitment to using all the knowledge and experience to ensure optimal results.

Best practices are procedures shown by research and experience to produce optimal results that are established or proposed as a standard suitable for widespread adoption (Merriam-Webster Dictionary 2022). 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 (Poppe et al. 2021).

Literature review

This section corresponds to step 1 of the methodology. Together with the previous section, it fulfils step 1 of the methodology.

The Systematic Literature Review (SLR) performed in this research followed Kitchenham's Procedures for Performing Systematic Reviews (Kitchenham 2004), which comprises three main phases: planning, conducting, and reporting. The objective is to collect the maximum information concerning the investigation problem and obtain answers to the research questions.

This review intends to achieve two main objectives concerning BPA description expressed through the following research questions (RQ):

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

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

This work made use of the following search string:

('robotic process automation' OR 'business process automation') AND ('best practice*' OR 'good practice*' OR guide* OR standar* OR model* OR framework OR approach* OR theor* OR map*)

The data sources used are Academic Search Complete, Business Source Complete, Complementary Index, Dialnet, Directory of Open Access Journals, IEEE Xplore Digital Library, ResearchGate, Science Citation Index Expanded, ScienceDirect, Scopus, Social Sciences Citation Index.

Inclusion and exclusion criteria presented in Table 1 were used.

Applying the search string to the chosen data sources resulted in 13,426 documents. The use of the criteria presented in Table 1 excluded 13,322. Reading the abstract and the conclusions of the remaining 104, another 58 were discarded. The whole reading of the remaining 46 documents dismissed 29. The shortlist of relevant publications was then completed with 17 papers. The backward and forward search (snowballing) allowed the identification of another set of 17 documents, leading to a final list of 37 documents. The selection of papers according to the review protocol is summarised in Figure 3.

Table 2 lists the selected documents, showing author, title and ordered by year of publication.

Discussion

Resuming the focus of this research and the two research questions, from the results obtained in the SLR, it is concluded that:

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

The SLR revealed the inexistence of a standard for technological-independent automation description but provided 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

Table 1. Inclusion and exclusion criteria.

Inclusion criteria	Exclusion criteria
Scientific paper peer-reviewed	Different focus
Discipline of Information Technology	Published before Jan/2010
Full document availability	Duplication

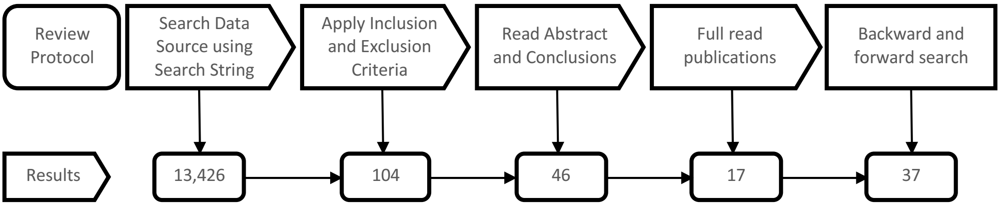

Figure 3. Selection of papers.

higher levels of process knowledge determine shorten automation's programming and testing time. Concurrently, it is recognised that the various guidelines and frameworks offered by vendors and consultants for selecting and implementing BPA solutions may only sometimes provide unbiased information. Most market-available solutions need to 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 rebuilding the automation solution. Constraining in any circumstance, in the 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 for best practices for technological-independent automation description.

The attempt to learn best practices from best-performing cases described in literature through contextual, behavioural and performance differences and similarities analysis is perceived as successful since it enabled the identification of a set of proven practices (Table 3), pointing to a 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.

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

Although less expressively, the SLR provided insight into adequate modelling languages (Table 4). The prevalence of BPMN usage is not surprising, given its goal to support Business Process Modelling by delivering a standard notation that is understandable to business users yet represents complex process semantics for technical users.

The SLR methodology allowed the identification of available research relevant to the research problem. Its execution confirmed the absence of a standardised framework for technological-independent BPA description. However, it made possible the collation of a set of best practices and models suitable for business process automation's description, answering the RQ posed in the beginning.

The subsequent case study will provide an opportunity to assess a contemporary real-life situation. Through a carefully planned, designed, and executed study, it is expected to render an alignment assessment and an expanded set of best practices. Limitations deriving from the lack of specific studies dedicated to the research problem are expected

Table 2. List of selected documents.

Year	Author	Title
2013	(Grossmann, Schrefl, and Stumptner 2013)	Design for service compatibility
2014	(Fung 2014)	Criteria, Use Cases and Effects of Information Technology Process Automation (ITPA)
2014	(Heravi, Lycett, and de Cesare 2014)	Ontology-based standards development: Application of On- toStanD to ebXML business process specification schema
2015	(Mallek et al. 2015)	Enabling model checking for collaborative process analysis: from BPMN to 'Network of Timed Automata'
2015	(Mu, Bénabena, and Pingaud 2015)	A methodology proposal for collaborative business process elaboration using a model-driven approach
2016	(Lacity and Willcocks 2016)	Robotic Process Automation at Telefónica O2
2017	(Anagnostou 2017)	Robotic Automation Process -The next major revolution in terms of backoffice operations improvement
2017	(Dunlap and Lacity 2017)	Resolving tussles in service automation deployments: service automation at Blue Cross Blue Shield North Carolina (BCBSNC)
2017	(Willcocks, Lacity, and Craig 2017)	Robotic process automation: strategic transformation lever for global business services?
2018	(Issac, Muni, and Desai 2018)	Delineated Analysis of Robotic Process Automation Tools
2018	(Ratia, Myllärniemi, and Helander 2018)	Robotic Process Automation – Creating Value by Digitalizing Work in the Private Healthcare?
2019	(Cooper et al. 2019)	Robotic Process Automation in Public Accounting
2019	(Huang and Vasarhelyi 2019)	Applying robotic process automation (RPA) in auditing: A framework
2019	(Kokina and Blanchette 2019)	Early evidence of digital labour in accounting: Innovation with Robotic Process Automation
2019	(Leno et al. 2019)	Action logger: enabling process mining for robotic process automation
2019	(Lewicki, Tochowicz, and van Genuchten 2019)	Are Robots Taking Our Jobs? A RoboPlatform at a Bank.
2019	(Madokam, Holmukke, and Jaiswal 2019)	The future digital work force: robotic process automation (RPA)
2019	(Mazilescu and Micu 2019)	Technologies that, through Synergic Development, can support the Intelligent Automation of Business Processes
2019	(Osman 2019)	Robotic Process Automation: Lessons Learned from Case Studies
2019	(Phillips and Collins 2019)	Automation – It does involve people
2019	(Sobczak 2019)	Developing a robotic process automation management model.
2019	(William and William 2019)	Improving Corporate Secretary Productivity using Robotic Process Automation
2020	(Enriquez et al. 2020)	Robotic Process Automation: a Scientific and Industrial Systematic Mapping Study
2020	(Hofmann, Samp, and Urbach 2020)	Robotic process automation
2020	(Leno et al. 2020)	Robotic Process Mining: Vision and Challenges.
2020	(Liu et al. 2020)	A framework to evaluate the interoperability of information systems – Measuring the maturity of the business process alignment
2020	(Syed et al. 2020)	Robotic Process Automation: Contemporary themes and challenges
2020	(Szelągowski and Lupeikiene 2020)	Business Process Management Systems: Evolution and Development Trends
2021	(Brdjanin et al. 2021)	Automatic derivation of conceptual database models from differently serialized
2021	(Kedziora and Penttinen 2021)	Governance models for robotic process automation: The case of Nordea Bank
2021	(Keung et al. 2021)	Data-driven order correlation pattern and storage location assignment in robotic mobile fulfilment and process automation system
2021	(Leno et al. 2021)	Discovering data transfer routines from user interaction logs
2021	(Ng et al. 2021)	A systematic literature review on intelligent automation: Aligning concepts from theory, practice, and future perspectives
2021	(Wewerka and Reichert 2021)	Robotic process automation – a systematic mapping study and classification framework
2022	(Svistunov and Lobachev 2022)	Promising Trends of Business Processes Automation in Domestic Companies
2022	(Gomes et al. 2022)	Artificial Intelligence-Based Methods for Business Processes: A Systematic Literature Review
2023	(Blahušiaková 2023)	Business process automation–new challenges to increasing the efficiency and competitiveness of companies

Table 3. Practices of BPA description.

Practice	Source
Modelling the business process	(Cooper et al. 2019; Dunlap and Lacity 2017; Enriquez et al. 2020; Fung 2014; Grossmann, Schrefl, and Stumptner 2013; Heravi, Lycett, and de Cesare 2014; Hofmann, Samp, and Urbach 2020; Huang and Vasarhelyi 2019; Issac, Muni, and Desai 2018; Kedziora and Penttinen 2021; Keung et al. 2021; Kokina and Blanchette 2019; Lacity and Willcocks 2016; Lewicki, Tochowicz, and van Genuchten 2019; Liu et al. 2020; Madokam, Holmukke, and Jaiswal 2019; Mallek et al. 2015; Mazilescu and Micu 2019; Mu, Bénabena, and Pingaud 2015; Ng et al. 2021; Phillips and Collins 2019; Ratia, Myllärniemi, and Helander 2018; Sobczak 2019; Svistunov and Lobachev 2022; Syed et al. 2020; Szelągowski and Lupeikiene 2020; Wewerka and Reichert 2021; Willcocks, Lacity, and Craig 2017; William and William 2019)
Specification of key performance indicators	(Anagnostou 2017; Cooper et al. 2019; Fung 2014; Hofmann, Samp, and Urbach 2020; Huang and Vasarhelyi 2019; Kedziora and Penttinen 2021; Keung et al. 2021; Kokina and Blanchette 2019; Lacity and Willcocks 2016; Madokam, Holmukke, and Jaiswal 2019; Mazilescu and Micu 2019; Ng et al. 2021; Phillips and Collins 2019; Ratia, Myllärniemi, and Helander 2018; Sobczak 2019; Syed et al. 2020; Wewerka and Reichert 2021; Willcocks, Lacity, and Craig 2017; William and William 2019)
Modelling of As-Is/To-Be Scenarios	(Blahušiaková 2023; Enriquez et al. 2020; Hofmann, Samp, and Urbach 2020; Huang and Vasarhelyi 2019; Kedziora and Penttinen 2021; Keung et al. 2021; Kokina and Blanchette 2019; Lacity and Willcocks 2016; Madokam, Holmukke, and Jaiswal 2019; Mazilescu and Micu 2019; Ng et al. 2021; Osman 2019; Phillips and Collins 2019; Ratia, Myllärniemi, and Helander 2018; Sobczak 2019; Syed et al. 2020; Willcocks, Lacity, and Craig 2017; William and William 2019)
Modelling of user interface objects	(Anagnostou 2017; Cooper et al. 2019; Enriquez et al. 2020; Heravi, Lycett, and de Cesare 2014; Hofmann, Samp, and Urbach 2020; Huang and Vasarhelyi 2019; Lacity and Willcocks 2016; Leno et al. 2020, 2021; Madokam, Holmukke, and Jaiswal 2019; Osman 2019; Ratia, Myllärniemi, and Helander 2018; Sobczak 2019; Syed et al. 2020; William and William 2019)
Modelling rules and decisions	(Anagnostou 2017; Cooper et al. 2019; Dunlap and Lacity 2017; Enriquez et al. 2020; Fung 2014; Gomes et al. 2022; Hofmann, Samp, and Urbach 2020; Kedziora and Penttinen 2021; Keung et al. 2021; Kokina and Blanchette 2019; Leno et al. 2020; Madokam, Holmukke, and Jaiswal 2019; Ng et al. 2021; Syed et al. 2020; Wewerka and Reichert 2021; Willcocks, Lacity, and Craig 2017)
Engagement of all stakeholders	(Anagnostou 2017; Cooper et al. 2019; Enriquez et al., 2020; Fung 2014; Hofmann, Samp, and Urbach 2020; Kedziora and Penttinen, 2021; Keung et al., 2021; Kokina and Blanchette 2019; Lacity and Willcocks 2016; Leno et al., 2020; Madokam, Holmukke, and Jaiswal 2019; Ratia, Myllärniemi, and Helander 2018; Sobczak 2019; Syed et al. 2020)
Modelling logs and exceptions	(Anagnostou 2017; Blahušiaková 2023; Enriquez et al. 2020; Huang and Vasarhelyi 2019; Kedziora and Penttinen 2021; Kokina and Blanchette 2019; Lacity and Willcocks 2016; Leno et al. 2020; Lewicki, Tochowicz, and van Genuchten 2019; Madokam, Holmukke, and Jaiswal 2019; Ng et al. 2021; Ratia, Myllärniemi, and Helander 2018; Sobczak 2019; Syed et al. 2020; Wewerka and Reichert 2021)
Modelling data extraction and transformation	(Brdjanin et al. 2021; Heravi, Lycett, and de Cesare 2014; Hofmann, Samp, and Urbach 2020; Huang and Vasarhelyi 2019; Leno et al. 2020, 2021; Madokam, Holmukke, and Jaiswal 2019; Mazilescu and Micu 2019; Syed et al. 2020)
Modelling choreography	(Anagnostou 2017; Gomes et al. 2022; Grossmann, Schrefl, and Stumptner 2013; Heravi, Lycett, and de Cesare 2014; Hofmann, Samp, and Urbach 2020; Lewicki, Tochowicz, and van Genuchten 2019; Mallek et al. 2015; Mu, Bénabena, and Pingaud 2015; Sobczak 2019; William and William 2019)
Modelling related systems	(Blahušiaková 2023; Cooper et al. 2019; Fung 2014; Gomes et al. 2022; Hofmann, Samp, and Urbach 2020; Leno et al. 2020; Mazilescu and Micu 2019; Ng et al. 2021; Syed et al. 2020)
Specification of compliance checking	(Cooper et al. 2019; Huang and Vasarhelyi 2019; Lacity and Willcocks 2016; Syed et al. 2020)
Adoption of modular system	(Hofmann, Samp, and Urbach 2020; Kedziora and Penttinen 2021; Syed et al. 2020)

Table 4. Description models in BPA.

Description model	Source
BPMN and extensions	(Grossmann, Schrefl, and Stumptner 2013; Heravi, Lycett, and de Cesare 2014; Keung et al. 2021; Leno et al. 2019, 2020; Mallek et al. 2015; Mu, Bénabena, and Pingaud 2015; Sobczak 2019; Svistunov and Lobachev, 2022; Syed et al. 2020; Wewerka and Reichert 2021)
Petri net	(Grossmann, Schrefl, and Stumptner 2013; Heravi, Lycett, and de Cesare 2014; Mu, Bénabena, and Pingaud 2015)
BPEL	(Heravi, Lycett, and de Cesare 2014; Mu, Bénabena, and Pingaud 2015)
Proprietary model	(Enriquez et al. 2020; Liu et al. 2020)
ebXML Business Process Specification Schema	(Heravi, Lycett, and de Cesare 2014)
Process map	(Phillips and Collins 2019)
Network of Timed Automata	(Mallek et al. 2015)

to be mitigated by the complementary contribution of automation experts from organisations with a highly mature level of business automation.

Case study

This section corresponds to steps 2, 3 and 4 of the methodology.

Due to the need for more relevant literature relating to the research topic, the case study's investigation methodology was chosen. Following the chosen methodology, this study is expected to provide initial insights into the research problem, casting a 'first stone' to further studies that may contribute to developing well-grounded and generalisable propositions (Eisenhardt and Graebner 2007). This study follows a single case design and uses a descriptive, exploratory, qualitative, and quantitative methodology (Yin 1994).

Case selection

The case selection was based on convenience and particular interest (Baškarada 2014). On the 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.

The case: a Portuguese bank

The case study took place in a Portuguese commercial Bank that is part of a larger group. The group provides banking services and financial activities in Portugal and foreign markets such as Poland, Mozambique, Angola, and China (Macao).

This Bank is Portugal's largest private-sector banking institution. It is focused on the retail and enterprise markets, providing its services through a modern branch network with comprehensive domestic coverage, several foreign offices and remote banking channels (banking service by telephone and online).

Successfully executing the 2018–2021 strategic plan, focused on five core priorities (talent mobilisation, mobile-centric digitisation, growth and leadership in Portugal, growth and international presence, and business model sustainability), was crucial for setting the Bank on a solid normalisation path and laid essential foundations for the future by a substantial acceleration in the Bank's level of digitisation (Banco Comercial Português 2022a).

The Bank 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 behaviour change, and still untapped potential for scaling the deployment of automation and artificial intelligence technologies. The Bank will further reinforce its efforts to reduce operational costs, acting on four fronts: simplification and automation, structure optimisation, distribution redesign, and internalised model scope. 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 to embed high levels of automation (Banco Comercial Português 2022b).

In its current organisational model, the Bank counts on a distributed model of automation capabilities. Under the same Executive Committee Member, automation capabilities are allocated to three different departments: the IT Department (ITD), the Digital Transformation Office (DTO), and the BPM and Automation Centre of Competence of Operations Centre (BPMACC). This study focuses on these latter two.

Preparation for evidence collection

Data collection was performed using questionnaires and interviews with internal organisation automation experts as well as external organisation automation experts. The data collection protocol included survey tools. A combination of quantitative methods – questionnaire – and qualitative methods – interviews – was used, benefiting from the pros and bridging the cons of each method so that multiple sources and techniques could strengthen the case study method (Ng et al., 2021).

Questionnaire

The questionnaire, composed of 48 questions, reproduced in Table 6, was designed to be answered online, with no interaction between the investigator and the respondents. To ensure directivity and minimise the need for clarification from respondents, the questionnaire was carefully thought out to present a logical, organised, and coherent structure (Carmo and Ferreira 2018). To improve the quantitative data collection, closed-answer questions used three 5-point Likert scales dedicated to inquiring about frequency, importance, and agreement.

The sample size was significantly impacted by the investigator's ability to gain access to the study subjects. So, the Bank, as the first relevant unit of analysis, contributed with seven subjects. A second unit of analyses, an informal group of professionals in the automation field, contributed with nine subjects.

A pre-test was performed to guarantee the questionnaire's applicability in the field and to assess its alignment with the research objectives (Carmo and Ferreira 2018). A first version was administered to two professionals – a female senior automation developer and a male automation team manager – who were asked to answer the questionnaire and the questions shown in Table 5. Their answers helped improve the questionnaire's content and presentation and allowed us to estimate the filling time and information included in the invitation.

Table 5. Questionnaire validation.

#	Analysis Vector	Question
Q1	Relevance	To what extent do you consider the questions proposed to be relevant and/or important?
Q2	Utility	In your opinion, the proposed questionnaire will be useful for the research's purpose?
Q3	Completeness	In terms of completeness, how do you classify the questionnaire?
Q4	Use	Do you consider it simple to use the proposed questionnaire?
Q5	Improvements	What recommendations/suggestions would you propose so to improve the questionnaire?
Q6	(Generic)	Any other comments you can provide on the proposed questionnaire?

The questionnaire, presented in Table 6, aims to validate the respondents' experience concerning the research problem, evaluate and validate the relevance of the topic, and compile structured information to allow an objective assessment of best practices' alignment.

Interviews

Interviews are a qualitative methodology in which direct interaction is the critical factor (Carmo and Ferreira 2018) and were used in this study to gather additional in-depth information about the methods used by automation experts, along with more detailed insight into their opinions and past experiences and additional discussion about questionnaire results worthy of further exploration.

Sample selection fell on a set of qualified informants (Carmo and Ferreira 2018), listed in Table 7, from both units of analysis: one external automation expert and three internal automation experts, resulting in a convenience sample covering the entire spectrum of research.

The interviews, composed of 14 questions, reproduced in Table 8, followed a structured model consisting of predefined open and closed questions (Baškarada, 2014) designed to meet the objective.

Evidence collection and analysis

This section corresponds to step 5 of the methodology.

Questionnaire

The invitation to complete the questionnaire was sent by electronic mail on 7 October 2022, to a list of contacts. The questionnaire was available on Google Forms for completion between October 7th and 20th, 2022. Sixteen valid responses were collected, representing a theoretical sample, and ensuring an adequate precision degree (Glasow 2005). Subjects' competences and qualification, from either unit analyses, confer a high degree of confidence.

Demographic characterisation of the sample (Figures 4 and 5): the sample does not contain subjects over 50 years old, highlighting the age group of [30,40[(68.8%) and presented an underrepresentation of the female gender (18.8%).

The third section of the questionnaire aimed to characterise the sample in terms of professional activity and RPA/BPA experience. The sample proved to be diverse in terms of activity field (Figures 6 and 7), showing predominance of the financial area (50%). Although only 43.8% reported working at the Bank., an additional eight respondents

Table 6. Questionnaire layout, objectives, and variables.

Question	Objective	Variable
Section 1 – Authorisation collection		
This section aims to obtain the respondent's authorisation 1. I authorise the use of my data for this study. Yes/No	Authorisation collection	Authorisation
Section 2 – Identification and characterisation of the respondent		
This section aims to contextualise the respondent demographic characterisation 2. What is your age? [20,30[/[30,40[/[40,50[/[50,60[/> 60	Contextualisation of age group	Age group
3. What is your gender? Male/Female/Prefer not to answer	Contextualisation of gender	Gender
Section 3 – Experience and materiality		
This section aims to contextualise the respondent professional and RPA/BPA experience. 4. What is your field of activity? Insurance/Finance/Telecommunications/Retail/Other (Please specify)	Contextualisation of activity	Activity field
5. Do you work at the Bank X? Yes/No	Contextualisation of activity	Employer
6. Have you worked in the finance industry in the past? Yes/No	Contextualisation of activity	Experience in finance industry
7. What is your professional experience? Nacional/International/Both	Contextualisation of professional experience	Professional experience
8. What is your actual occupation? Developer/Business Analyst/Team Manager/Project Manager/ Other (Specify)	Contextualisation of business role	Business role
9. What other role(s) did you play in RPA/BPA team/project? Developer/Business Analyst/Team Manager/Project Manager/ No other/Other (Specify)	Contextualisation 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	Contextualisation of activity	Company dimension
11. How many robots did the largest project you worked on have? < 5/[5, 10[/[10,50[/[50, 100[/≥ 100	Contextualisation of professional experience	Automation maturity level
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	Analysis of identified practices use	Formal description usage
13. Your team stakeholders' use formal description of RPA/ BPA? Very frequently/Frequently/Occasionally/Rarely/Never	Analysis 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	Analysis of identified practices perceived relevance	Formal description relevance
15. Your description of RPA/BPA specifies key performance indicators? Very frequently/Frequently/Occasionally/Rarely/Never	Analysis 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	Analysis of 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	Analysis 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 identified practices perceived relevance	AS IS-TO BE scenarios modelling relevance

(*Continued*)

Table 6. (Continued).

Question	Objective	Variable
19. Your description of RPA/BPA includes user interface objects modelling (e. g. screenshot and identification of which objects the robot should act and in what way)? Very frequently/Frequently/Occasionally/Rarely/Never	Analyses of identified practices use	User interface objects modelling usage
20. You model your user interface objects using: (Tick all applicable) Text description/Mock-ups/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	Analysis of 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	Analysis 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)	Analysis 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	Analysis of identified practices perceived relevance	Rules and decisions modelling relevance
25. Your description of RPA/BPA engages all stakeholders? Very frequently/Frequently/Occasionally/Rarely/Never	Analysis of identified practices use	Stakeholders' engagement
26. Stakeholders' engagement is: Extremely important/Very important/Moderately important/ Slightly important/Not important at all	Analysis of identified practices perceived relevance	Stakeholders' engagement relevance
27. Your description of RPA/BPA includes logs and exceptions modelling? Very frequently/Frequently/Occasionally/Rarely/Never	Analysis of identified practices use	Logs and exceptions modelling usage
28. Logs and exceptions modelling is: Extremely important/Very important/Moderately important/ Slightly important/Not important at all	Analysis of 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	Analysis of identified practices use	Data ETL modelling usage
30. You model ETL using: Information flow/Other (Please specify)	Analysis 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	Analysis of identified practices perceived relevance	Data ETL modelling relevance
32. Your description of RPA/BPA includes choreography modelling (e.g. detailed description of users' behaviour that automation is to replicate)? Very frequently/Frequently/Occasionally/Rarely/Never	Analysis of identified practices use	Choreography modelling usage
33. Choreography modelling is: Extremely important/Very important/Moderately important/ Slightly important/Not important at all	Analysis of the identified practices perceived relevance	Choreography modelling relevance
34. Your description of RPA/BPA includes related systems modelling (e. g. mapping of systems and applications interconnections)? Very frequently/Frequently/Occasionally/Rarely/Never	Analysis 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 (Specify)	Analysis of identified practices use	Related systems modelling usage
36. Related systems modelling is: Extremely important/Very important/Moderately important/ Slightly important/Not important at all	Analysis of identified practices perceived relevance	Related systems modelling 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	Analysis of identified practices use	Compliance checking specification usage

(*Continued*)

Table 6. (Continued).

Question	Objective	Variable
38. Compliance checking specification is: Extremely important/Very important/Moderately important/ Slightly important/Not important at all	Analysis of identified practices perceived relevance	Compliance checking specification relevance
39. Your description of RPA/BPA adopts a modular system (e. g. automation of sub-processes of the given process or even process building blocks)? Very frequently/Frequently/Occasionally/Rarely/Never	Analysis of identified practices use	Modular system usage
40. Modular system adoption is: Extremely important/Very important/Moderately important/ Slightly important/Not important at all	Analysis of 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	Analysis of description model	Formal description notation
42. Your team stakeholders' use the same description notation used by your team? Very frequently/Frequently/Occasionally/Rarely/Never	Analysis of description model	Formal description notation coverage
43. The description notation used by your team is: Petri net/BPMN Business Process Model and Notation/BPEL - Business Process Execution Language/ebXML/Other (Specify)	Analysis of description model	Formal description notation
44. The criteria for the description notation choice was: According to a best practice/Internally developed or adopted/ Comprehensible outside the team or company/Other (Specify)	Analysis of description model	Formal description notation 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	Analysis of interoperability adequacy	Interoperability relevance
46. Justify your answer to question 45.	Analysis of interoperability adequacy	Interoperability relevance
47. Your RPA/BPA description model is suitable to ensure interoperability. Strongly agree/Agree/Neutral/Disagree/Strongly disagree	Analysis of interoperability adequacy	Interoperability adequacy
48. Describe additional methods used/necessary to ensure interoperability.	Analysis of interoperability adequacy	Interoperability adequacy

Table 7. Characterisation of the interview sample.

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

revealed that they had previously worked in the financial area. Half (8) of the respondents classified their professional experience as exclusively national, but 37.5% of the sample (6) also revealed international experience.

Results revealed a diverse sample regarding the current business role of the subjects (Figure 8), with a slight preponderance of developers (37.5%), followed by project managers (25%). However, the majority (87.5%) have already played other roles in RPA/BPA teams or projects, and five have already assumed more than two different roles.

Table 8. Interview script, 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 contextualise the respondent's professional and RPA/BPA experience in its RPA/BPA context.		
2. How long have you been working in RPA/BPA?	Contextualisation of professional experience	RPA/BPA experience
3. What is your actual occupation? Developer/Business Analyst/Team Manager/Project Manager/Other (Specify)	Contextualisation of business role	Business role
4. Your RPA/BPA solution is: Inhouse developed/Inhouse developed with consultant's help/ Purchased solution from a provider	Contextualisation 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	Contextualisation of cooperation	Cooperation level
Section 2 – Usage and perceived value		
This section evaluates how respondents use the identified practices and rate their relevance.		
6. Your team uses the 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	Analysis 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	Analysis of identified practices perceived relevance	Formal description relevance
8. Why do you classify the relevance of the formal description in this way?	Analysis of identified practices' perceived relevance	Individual opinion
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 (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 KPIs 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

Most respondents (62.5%) revealed that the RPA/BPA they worked on were implemented in large companies, as shown in Figure 9. Almost the same percentage (68.8%) worked on projects that involved fifty or more robots.

Figure 10 represents the number of robots for the most significant projects.

Section 4 of the questionnaire 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

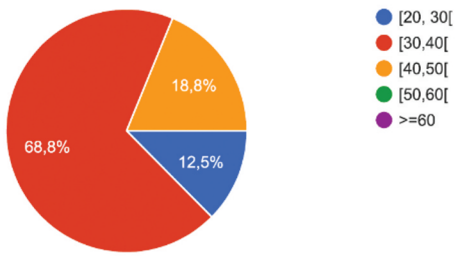

Figure 4. Sample characterisation by age group.

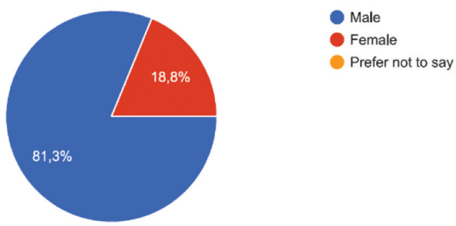

Figure 5. Sample characterisation by gender.

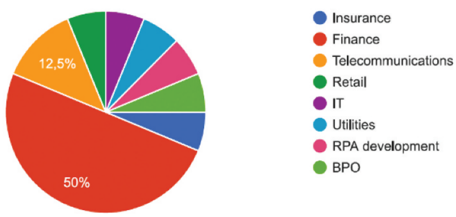

Figure 6. Sample characterisation by activity field.

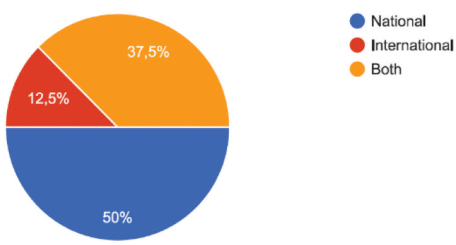

Figure 7. Sample professional experience characterisation.

perform the formal description of the RPA/BPA (Figure 11). The same analysis in relation to the team's stakeholders reveals a slightly lower (81.3%) adherence to the practice. In assessing its relevance (Figure 12), 81.3% recognise the practice as very or extremely important.

Concerning the questions (questions 12, 15, 17, 19, 22, 25, 27, 29, 32, 34, 37, 39) related to the usage of the twelve practices identified in the SLR (Table 9), they

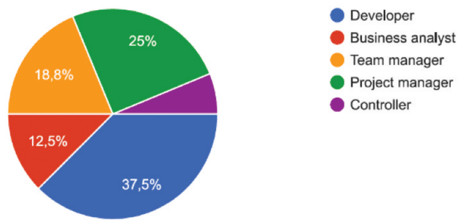

Figure 8. Sample characterisation by current business role.

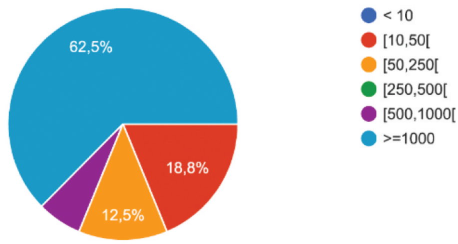

Figure 9. Number of employees of the company where RPA/BPA was implemented.

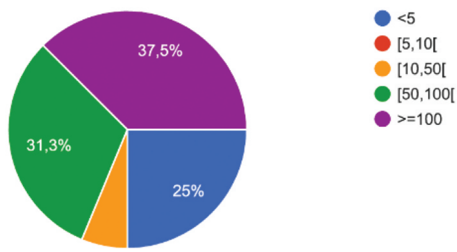

Figure 10. Number of robots of the most significant project.

show excellent adherence by the respondents. With a use classified as very frequent, the modelling of rules and decisions (13) is 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 the specification of key performance indicators (8) and modelling ETL (8). The least used was classified modelling ETL (7), seconded by modelling logs and exceptions (6), modelling choreography (6), and modelling-related systems (6).

Moreover, the identified practices are generally perceived as valuable (Table 10). Classified as extremely important, it stands out in 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). The least important was classified modelling choreography (8), seconded by modelling ETL (7).

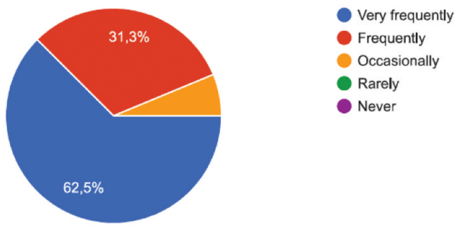

Figure 11. Usage of RPA/BPA formal description.

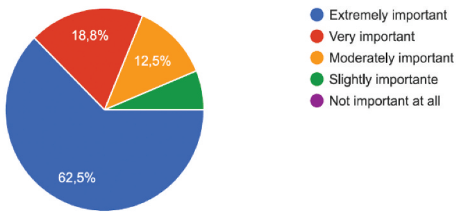

Figure 12. Relevance of RPA/BPA formal description.

Table 9. Results on identified practices usage (percentage and absolute values).

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)	–

Legend: Very frequently – VF, Frequently – FQ, Occasionally – OC, Rarely – RR, and Never – NR.

Evaluation of the description models used by the respondents revealed that 87.5% of respondents always use the same notation in the RPA/BPA description. However, the same cannot be said about its stakeholders (37.5%), as shown in Figure 13. Respondents refer to BPMN as the most used (81.3%) description notation, 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 illustrated in Figure 14.

Most respondents (93.8%) agreed that interoperability is relevant for RPA/BPA (Figure 15). One respondent said to disagree. However, only 62.6% consider their RPA/BPA description model suitable to ensure interoperability and nine additional methods were identified (Table 11).

Responses to question 48 allowed us to obtain detailed information about additional methods respondents used to ensure interoperability. The results are gathered in Table 11.

Table 10. Results on identified practices value (percentage and absolute values).

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)	–

Legend: Extremely important – EI, Very important – VI, Moderately important – MI, Slightly important – SI and Not important at all - NI.

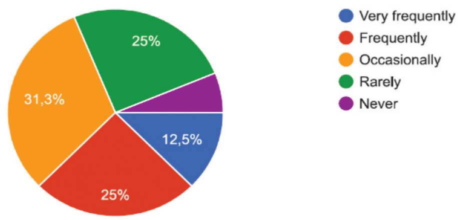

Figure 13. Stakeholders using the same description notation.

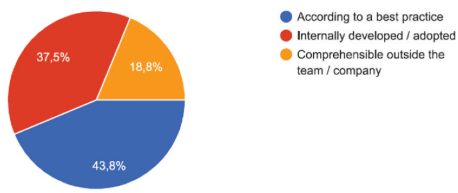

Figure 14. Criteria for description notation choice.

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 organisation (sections) and objectives. The interviews were conducted in person and online using Microsoft Teams. Both means of conduction made it possible to achieve the proposed objectives due to the observance of the recommended standards of action (Carmo and Ferreira 2018). The interviewees were relaxed, in a good mood, and maintained a collaborative attitude.

The results revealed that the four interviewees are experienced professionals who have played either multiple roles or management roles in the RPA context, so they can be considered reliable sources of information.

Regarding sourcing options, the Bank purchased RPA licences directly from RPA software providers, engaged consulting firms for help in its customisation, and then pursued in-house development. The external automation expert identified the use of a purchased

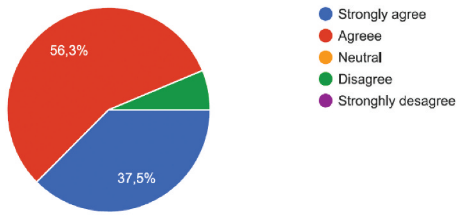

Figure 15. Interoperability relevance for RPA/BPA.

Table 11. Additional methods to ensure interoperability.

Additional methods
Common language, templates
Process standardisation, application interfaces
APIs. Web Services
1. XML forward and reverse engineering
2. PoC for software migration
3. Do not 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 and interpret that shared data. For two systems to be interoperable, they must be able to exchange data and present it so that a user can understand it".
Usage of report tools
We are saving data in documents to record the result of that process.
Standardised environment between our resources (i.e. every machine is equal with the same software and updates installed to ensure that every process runs the same in all our resources).

solution from a provider. The Bank applies RPA solutions exclusively to internal processes, whereas the external automation expert mentioned the RPA/BPA solution used in internal and inter-enterprise collaboration processes.

Section 2 of the interview's objective was to evaluate the usage of the practices identified through the SLR and its perceived value. It was found that the use of RPA/BPA formal description is widespread, and that internal automation experts and external automation experts share a unanimous opinion regarding the high relevance of the formal description for reasons such 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 backup.

Questions in section 3 focused on the identification of limiting factors to the usage of RPA/BPA formal description. Interviewees point out several reasons that may result in less usage of RPA/BPA formal description: a shortage of time and resources, the need to avoid lag time in a project context, and lack of awareness of its importance – moreover, they recognised that the formal description could suffer negative impacts in contexts with limited resources.

The interviewees listed a vast set of KPIs, defined to measure the performance of automation and 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 labour savings.

Answers reveal that interviewees are primarily satisfied with their RPA/BPA solution, although they recognise aspects that can be improved. Still, nothing so relevant that it leads them to ponder changing technology, especially as they do not perceive any substantial benefit from the change, although they clearly identify that it would involve high costs.

Results discussion

Resuming the focus of this research and the four research questions, from the results obtained in the questionnaires and 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, such as modelling of rules and decisions using a structured and systematic approach and description scripts, modelling the business process and modelling of As-Is and To-Be scenarios, modelling the user interface using text description, mock-ups, screenshot of applications and videos, engaging all stakeholders, specifying KPIs and modelling ETL using information flow, SSIS and text description.

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, as shown by the results gathered in Table 10 since both the questionnaire respondents and the interviewees recognised the use of practices identified in the literature review, as well as their relevance. Some are of quite general use. Others, although less used, are still considered quite relevant.

RQ3: Are the methods used sufficient to ensure interoperability?

The results of this study reveal that the use of formal descriptions of RPA/BPA is widespread. The automation experts interviewed share a unanimous opinion regarding the high relevance of the formal description for reasons such 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 backup. Although interoperability concerns justify some of the methods used, their use does not end there. Among the respondents, some expressed doubts about the sufficiency of their methods, listing additional methodologies.

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

Among the additional methods used to ensure interoperability, listed in Table 11, are the standardisation of processes, the use of automation standards, the standardisation of environments, and the use of reporting tools and application interfaces, among others. However, these clues must be deepened to assess which are effectively recommended.

The interviews with experienced professionals highlighted the relevance of BPA formal descriptions as essential for RPA functioning and development. The results also reveal that a technologically independent description of BPA is considered very important; nonetheless, its execution is only sometimes proportional to the importance attributed to it.

The results allowed the detection of relatively standardised forms of description, which stem from a particular application context, 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 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.

Conclusions

Enterprises demand new technological innovations (Mazilescu and Micu 2019) and an increasing degree of BPA to stay competitive in their markets (Wewerka and Reichert 2021) and explore new markets. And, evermore frequently, competitiveness means collaboration with external partners and transparency towards 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 organisations are implementing software products to automate at least some of the daily or regular activities (Mazilescu and Micu 2019), enterprises still have difficulties fully understanding the fundamental concepts of BPA to accurately estimate the effects of its introduction in the organisation (Wewerka and Reichert 2021) and to decide which model to implement assertively: the creation of Automation Centre's of Excellence 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 and Stanisławski 2021). Whatever model is chosen, from among many possible (e.g. insource, insource and consulting, outsourcing with a traditional business process outsourcing provider, outsourcing to RPA providers, cloud-sourced (Lacity and Willcocks 2016)), an enterprise should be able to change from one to another or select a different vendor, avoiding vendor's lock-in situations.

Each automation tool, either provided by an external supplier or developed inhouse, adopts a specific automation description. This lack of standardisation undermines communication due to ambiguity, lack of clarity and misunderstandings, prejudices quality because of misinterpretation, errors, and suboptimal results, and adversely affects performance due to uncertainty, conflict, and impact on productivity (Lewicki, Tochowicz, and van Genuchten 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).

The aim of this study was to assemble an encompassing set of best practices suitable for enterprises use in the technologically independent description of their business process automation and on the necessary elements to perform an alignment assessment, anticipating that the adoption of a commonly agreed best practices, on BPA description will provide benefits, acting as an enhancer of robustness, flexibility, efficiency, and competitiveness – the SLR methodology aimed to identify available research relevant to the problem.

The SLR execution confirmed the absence of a standardised framework for technological-independent BPA description. However, it made it possible to collate a set of best practices (Table 3) and models (Table 4) suitable for business process automation's description.

The subsequent case study provided an opportunity to assess a contemporary real-life situation. The relevance of the research topic was validated by the questionnaire respondents' and the additional in-depth information obtained in the interviews provided a detailed insight about the adherence to the practices identified in the SLR. Through a carefully planned, designed, and executed study, it is possible to render an alignment assessment and determine the value of the practices identified through the SLR as a starting point for defining an expanded set of best practices that enterprises can use to ensure interoperability.

The case study confirms the Bank's alignment with the best practices compiled from the literature review. However, assessing whether they will be adequate to ensure a technologically independent description is necessary.

Therefore, this study is a starting point for defining a set of best practices for a technologically independent description of business process automation to help companies avoid technological dependency and ensure interoperability. as factors of agility, collaboration, and competitiveness.

Limitations

The relative novelty of the BPA theme means a need for more academic research and, subsequently, a shortage of reliable scientific publications on its issues.

Despite the RPA maturity of the multinational enterprise used in this investigation, a single case study focused on one specific industry may not render a complete picture of the research problem.

Recommendations and future work

More single-case studies and multi-case studies within early BPA adopters' industries and across industries, as well as studies on multi-enterprise collaborative value chains, may provide enough evidence to construct a robust theoretical body of knowledge. Research work using different methodologies will be equally beneficial, 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. Further research will also helpfully focus on developing evaluation techniques to uncover interoperability problems and metrics for alignment assessment.

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Data availability statement

Data included in article/supp. material/referenced in the article.

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