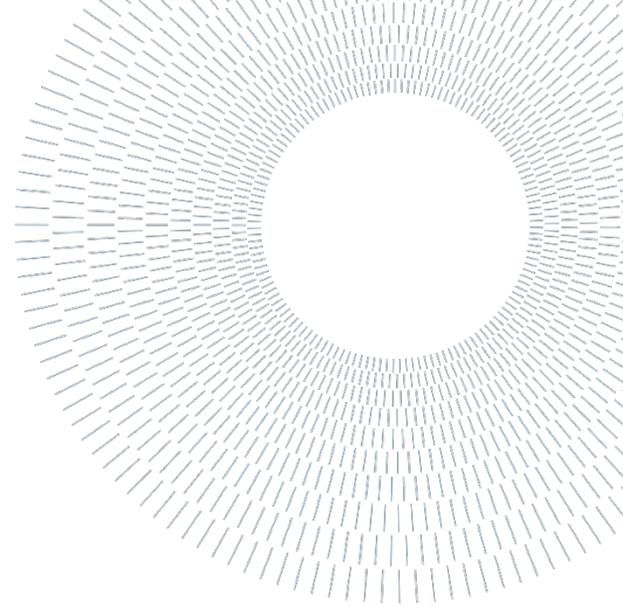




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EXECUTIVE SUMMARY OF THE THESIS

Process Selection & Economic Evaluation in IPA: A Comprehensive Framework for Implementation

TESI MAGISTRALE IN MANAGEMENT ENGINEERING – INGEGNERIA GESTIONALE

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1. Introduction

Artificial Intelligence's rapid advancements significantly reshaped how organizations operate. Advanced AI techniques, such as GPTs and unsupervised Machine Learning models, can now address considerably complex and diverse tasks, often outperforming human capabilities. As companies explore AI's ability to take over work traditionally handled by humans, its potential presents both opportunities and challenges for innovation.

Within the scope of AI progress, it is hence important to conduct detailed research on specific areas where its impact is immediately relevant and adds the most value to organizations' flows. For this reason, the study concentrates on the evolution of Robotic Process Automation (RPA) – a category of software tools used for the automation of digital processes – through the integration of AI.

RPA "bots" emerged in the content of Business Process Management (BPM), a discipline focused

on analyzing and optimizing companies' workflows, usually by rationalizing them into processes, activities, and tasks [1]. As business operations' complexity increased, digital automation tools such as RPA appeared as an efficient answer to streamline mainly digitalized, back-office processes [2]. However, RPA's "rudimentary" architecture limited the scope of possible automation activities only to repetitive and standardized ones. Its integration with advanced AI, commonly called Intelligent Process Automation (IPA), promises instead to significantly expand the scope of automation possibilities, automating end-to-end complex processes [3]. Amid the enthusiasm towards the transformative potential of the technology, it is crucial to establish a realistic outlook on what it can achieve, its limitations, and the necessary steps for organizations to adopt it.

Existing literature on the theme mostly remains at a high level, without detailed analyses on how AI potentially changes the processes to be automated, benefits and costs involved, and the ideal approach to the technology. This exploration is further

complicated by the lack of formalized methods for IPA implementation, since case studies and papers vary widely in their process selection and evaluation approaches.

Given the gaps identified, the objective of this research is to comprehensively collect and define best practices for IPA implementation, providing actionable recommendations to strategically incorporate digital automation into companies. In doing so, it aims also to critically assess the real impact of AI on IPA's adoption, benefits, and costs for organizations.

The objectives of the thesis can be translated into the following research questions:

RQ1: How can organizations identify the most suitable processes for automation with IPA?

RQ2: How should organizations evaluate the impact of IPA?

RQ3: What is the role of AI in digital automation technologies?

2. Methodology

The method followed to address the research questions integrated an extensive literature review with empirical findings, to explore IPA implementation practices both through literature and through the eyes of seven "Automation Experts". The literature review was used to establish a foundational understanding on digital automation technologies and identifying relevant gaps, while interviews provided real-world insights into challenges and strategies for IPA adoption.

The literature review started by examining the technological context of RPA and IPA, presenting the overall functioning, the use cases, and highlighting the capabilities and limitations introduced by AI. The following part was targeting IPA implementation practices, distinguishing between process selection and economic evaluation in automation projects. These two core steps of implementation were explored in detail by listing the ideal process characteristics for automation, the benefits and costs to be assessed, and six examples of structured frameworks for process selection and economic evaluation. Additionally, given the scarcity of IPA-focused research, frameworks built for the economic

evaluation of other AI technologies were incorporated to enrich the analysis.

To complement this theoretical base with practical insights, semi-structured interviews were conducted with seven "Automation Experts" from medium to large companies, including both Italian and multinational organizations across various sectors. These interviews, lasting each 30 to 60 minutes, were fundamental to capture a more grounded perspective concerning IPA capabilities and its impact on companies' operations. Interview questions, besides exploring the main topics of the RQs, addressed diverse organizational aspects like team composition and change management initiatives, concluding with discussions on future strategies and projects.

Each interview was transcribed and systematically analyzed through a mapping process, categorizing findings into four key themes aligned with the RQs: process suitability criteria, benefits and costs of IPA, approaches to process selection and evaluation, and the role of AI in digital automation. This enabled a more quantitative interpretation of qualitative data, facilitating comparisons with literature findings.

3. Literature Review

BPM has always been connected with the evolutions of Information Technology (IT), which transformed how organizations structure and execute their processes. Initially it relied solely on comprehensive IT systems like Enterprise Resource Planning (ERP) to unify data and coordinate tasks, but over time they were complemented by other lightweight IT solutions— simpler front-end tools that integrate with existing systems to automate standardized tasks, enhancing accuracy, speed, and efficiency [1].

In this context, RPA encompasses a range of software technologies designed to automate digital processes by replicating human actions. RPA "bots" interact with existing software applications as humans would do, by following a set of predefined instructions. They are used to automate repetitive workflows such as data entry, navigation, and extraction, that exist across multiple business functions. Its key technological advantage lies in its non-intrusive nature, enabling quick deployment without significant modifications to underlying systems. Even though

it can achieve impressive results in term of speed and accuracy, RPA is only capable to automate rule-based processes, extremely standardized activities that can be broken down in multiple simple tasks [2].

Building on top of traditional RPA, IPA integrates more advanced AI-driven capabilities such as natural language processing, machine learning, and unstructured data handling. These features extend the automation potential from rule-based tasks to more complex, high-value processes, enabling functionalities like decision making and contextual adaption. In academic research, IPA is seen as an intermediate step toward full AI automation, leading to AI-autonomous agents. These are solutions designed to automate all the steps in a process and even coordinate across multiple processes, dynamically responding to changes in the environment. However, their practical implementation remains limited due to the significant investments required and the challenges and limitations involved. A central complexity lies in the data infrastructure required to support these models, considerable both in terms of costs and governance. Additionally, AI's "black box reasoning", namely the difficulty in explaining what guides its responses, presents significant risks. Phenomena such as biases in the results or hallucinations, could prevent the automation of higher value – and typically higher risk – activities, where reliability is crucial [3] [4].

Having a clear picture of the technology, it becomes clear that effective IPA deployment requires thorough process analysis to identify the most suitable processes for automation. Few papers and case studies outline "Process Suitability Criteria", identifying characteristics of tasks that are most compatible with RPA [5]. Processes with repetitive, rule-based actions represent the base for RPA automation, and the bare essential for achieving positive automation outcomes. Processes with high transaction volumes are often prioritized, as frequent execution amplifies potential cost reductions and efficiency gains. Long-term stability of IT systems is another key factor; whenever an underlying software changes RPA tools stop functioning properly and need to be updated. Finally, structured data and limited human intervention are two significant required process aspects, that AI advancements could potentially overcome. The thesis proceeds to identify and analyze three structured frameworks

for RPA process selection, each contributing valuable insights into best practices for the first phase of implementation. These frameworks collectively stress the importance of adopting systematic methods to select and prioritize processes for automation. They vary significantly in the approach used and actually outline a trade-off between formalization and process data needed. When using a more qualitative approach, in which "process owners" (individuals overseeing the process) simply rate process characteristics during selection, no significant resources are needed, as it all relies on existing knowledge; but it can be very much subject to bias and individual considerations. Other methods instead try to make more quantitative considerations, for example conceptualizing process characteristics in mathematical formulas through historical data, resulting in an objective approach to process selection and prioritization, yet requiring significant resources and investments to collect and analyze correctly the data.

Moving to the economic evaluation of projects, the first step was to collect the main benefits and costs associated with automation. Main benefits comprise increased efficiency, thanks to increased speed of execution, accuracy and saved FTEs (Full Time Equivalents), but include also broader gains related to employee satisfaction, and increased compliance to regulations. As for costs the main expenses come from software licenses and long-term maintenance, but also the required resources for training employees and change management can't be overlooked [6]. Three structured models for economic evaluation were then analyzed, one by one, to feed on the considerations on best practices for IPA economic assessment. Again, the models varied significantly in approach, but all proposed solutions to answer the difficulty of estimating automation benefits and costs with precision. By applying Return on Investment (ROI) scenario analysis to account for multiple estimates, grouping benefits and costs depending on their nature, or tracing in detail the calculation of AI training and running costs, all the models offered different approaches to use in economic evaluation, that enable companies to get more information about the project and align digital automation choices on a strategic level.

Overall, while the literature provides valuable insights into the technological capabilities of RPA and IPA, as well as criteria for identifying suitable

processes and benefits & costs to assess, it falls short in offering structured, and unified, methodologies for process selection and economic evaluation. This limitation highlights the importance of empirical exploration, to investigate how companies should practically implement IPA also based on a realistic perspective on its use, advancement, and importance inside the organizations.

4. Findings

Analyzing the interview findings on process selection, most companies demonstrated a reliance on well-established process criteria for the initial stages of automation implementation, favoring standardized, repetitive tasks with high transaction volumes, limited human intervention and few exceptions. A significant addition to literature criteria, is instead the use of IPA as a temporary solution; namely choosing processes to automate based on immediate needs or temporary inefficiencies, exploiting the technology's fast time-to-market and cost-effectiveness. However, most organizations lack consistent, structured methods for evaluating suitability criteria and objectively comparing processes for automation, as only two experts explicitly referenced a structured approach using process suitability criteria. Instead, they typically rely on bottom-up automation proposals, and then conduct a case-by-case analysis of each automation project, focusing on anticipated benefits and costs. Many rely heavily on "process owners" for selection and implementation, underscoring the absence of a formalized framework.

In terms of economic evaluation, interviewed experts largely agreed with literature on the key benefits to assess for IPA, citing primarily FTE savings, increased speed and improved accuracy. Employee satisfaction also appeared to be particularly significant for automation experts among the benefits of IPA. Even if not straightforward to quantify, most recognized the positive effect the technology has on employees' work routines, by automating low-value repetitive tasks in favor of more engaging activities. As for costs, interviewed companies exhibited slightly lower awareness, with fewer overall mentions. Employee-related costs, for training and upskilling programs, were the most cited. Other key ones, coherently with literature, included maintenance

and software licenses. Companies demonstrate a more structured approach to economic evaluation compared to process selection, but still rely on basic Benefit-Cost ratios (B/C) in contrast to the more sophisticated methods found in literature, such as sensitivity analyses and detailed ROI assessments.

When it comes to AI integration into automation processes, companies exhibited a relatively low maturity level, primarily leveraging AI through intelligent Optical Character Recognition (OCR) and LLMs for improving the input of documents and unstructured data. These uses align with what was defined as "AI-Assisted" automation, in which advanced AI is employed only on specific tasks and does not conduct the overall process. There were very limited mentions of ML models used for classification and prediction, hence automating higher-complexity tasks, but never close to the idea of Autonomous AI Agents. Moreover, many times AI was treated as a separate solution rather than a possible integration of RPA capabilities, missing on potential synergies.

Combining and interpreting literature and empirical insights, it was possible to answer individually to the RQs, by building a comprehensive framework that guides IPA implementation through process selection and economic evaluation, while simultaneously assessing the real impact AI has on digital automation technologies at the moment of writing.

RQ1: How can organizations identify the most suitable processes for automation with IPA?

First, a final list of eighteen ideal process characteristics was established (Table 1).

Table 1: Final List of Process Suitability Criteria

Process Suitability Criterion	Importance by # of mentions	Proposed Weight (w_i)	Preferred Rating ($r_{i,p}$)
Limited Exceptions	Critical	0.161	High
Unambiguous Rules	Critical	0.161	High
Limited Human Intervention	Critical	0.161	High
Stable Environment	Critical	0.161	High
High Transactions Volume	Significant	0.048	High
Multiple Systems Access	Significant	0.048	High
Process Error Risk	Significant	0.048	Very Low
Temporary Solution	Significant	0.048	High
Aligned with Previous Projects	Minor	0.016	High
Structured Data	Minor	0.016	High
Data Quantity, Quality, Governance	Minor	0.016	High
High Human Intervention	Minor	0.016	Very Low
Prospected Utilization Rate	Minor	0.016	High
AI enabler	Minor	0.016	High
Compliance	Minor	0.016	High
Business Critical	Minor	0.016	High
Clear Costs	Minor	0.016	High
Prone to Human Error	Minor	0.016	High

Equation 1: Automation Suitability Value S_p of process p

$$S_p = \sum_{i=1}^{18} (w_i \cdot r_{i,p})$$

The list integrates both criteria found in literature and the ones mentioned only by automation experts (in grey) and ranks them on importance based on the number of overall mentions. It not only represents a collection of literature and empirical insights for ideal process characteristics, but it uses them to propose a structured process selection model that builds on the research of Riedl [5]. It proposes a weighted multi-criteria framework that can be used, together with qualitative ratings of process owners (e.g., using a 4-points scale ranging from *Very Low*, to *High*), to assign a suitability score and consequently compare multiple processes for automation. Even though the weights have been assigned based on the importance emerged in findings, they can be adapted based on the organizations' priorities, helping to streamline the process selection phase while still striking the balance between formalization and process data needed.

RQ2: How should organizations evaluate the impact of IPA?

Benefits and Costs to assess were formalized through Table 2 and they were ranked on importance based on number of mentions and distinguished between "Hard" and "Soft".

Table 2 : Final List of Benefits

Hard Benefits	Importance by # of mentions
FTE Savings	Critical
Execution Speed	Critical
Accuracy	Critical
Availability	Significant
Soft Benefits	Importance by # of mentions
Employee Satisfaction	Critical
Compliance	Significant
Customer Satisfaction	Minor
Increased Process Data	Minor
Innovation	Minor

Table 3: Final List of Costs

Hard Costs	Importance by # of mentions
Implementation - IT	Significant
Maintenance	Significant
Implementation - Labor	Minor
External Consultants	Minor
Running Costs	Minor
Soft Costs	Importance by # of mentions
Employee Training	Critical
Change Management	Significant
Coordination Costs	Minor
AI Data & Model	Minor
Digitalization Costs	Minor

Through the combination of literature and empirical findings, this final list aims to be a comprehensive overlook on the economic voices to be estimated during the economic evaluation phase, with varying degrees of precision required depending on their importance. The "Hard" and "Soft" categorization, drawing directly from PWC's model for calculating AI's Return on Investment (ROI) [6], is then proposed as a valuable framework for evaluation. Hard elements represent short-term, tangible outcomes, while Soft elements capture strategic, long-term impacts. This dual perspective enables companies to make more in-depth considerations on the economic value of automation projects, by calculating, together with the total ROI, Hard and Soft ROI individually. With these metrics, enterprises can better align automation choices with organizational objectives, prioritizing either short-term returns or long-term gains depending on factors such as capital availability, strategic importance of automation technologies or market status. To summarize, the framework offers a measure that is easily interpretable by multiple stakeholders while not requiring exhaustive data collection and estimation calculations.

RQ3: What is the role of AI in digital automation technologies?

The integration of interviews' empirical findings enabled a valuable analysis of AI's real impact on digital automation technologies. In contrast with literature, "Automation Experts" exposed a pragmatic perspective on AI, aligned with companies' practical uses and future implementations. Their answers were hence

formalized in Table 4 and Table 5 to evaluate AI's role in each aspect of IPA implementation.

Table 4 seeks to understand how AI changes the scope of automation possibilities by assessing its impact on Ideal Process Characteristics.

Table 4: AI Impact on Ideal Process Characteristics

Process Characteristic	AI Impact	Explanation
Structured Data	Reduces Dependence on Structured Data	Intelligent OCR and NLP allows processing of unstructured data
Human Intervention	Enables Automation of Human Judgement	AI automates decision-making through ML models
Error Risk	Increases Importance of Error Management	AI unpredictable results make error risk more significant in process selection.

What emerges is that it reduces RPA's reliance on structured data, enabling unstructured interactions through tools like Intelligent OCR and NLP. Additionally, it automates some decision-making tasks via Machine Learning, that would have previously required human judgment. However, it introduces complexities in error management, as biases and unforeseen variables can influence its outputs. For this reason, companies must undergo a "grounding phase" to ensure AI decisions are reliable, hence increasing the importance of error risk in process selection.

Table 5 aims to formalize how AI affects digital automation benefits and costs, and consequently the economic evaluation of such projects.

Table 5: AI Impact on Benefits & Costs

Benefit/Cost Aspect	AI Impact	Explanation
Implementation IT	Increases IT costs effectiveness	AI solutions enhance cost-effectiveness as expenses are shared among various projects.
AI Models & Data	Introduces Continuous Expenses	Advanced AI models require regular training and updates, leading to continuous costs

Thanks to its versatility, AI promises to increase cost-effectiveness during implementation by distributing expenses among multiple automation projects. Some solutions, such as Chatbots or ML classification models, can be in fact used across multiple processes and locations, distancing significantly from traditional RPA's process specificity. At the same time, AI entails its own set of expenses. These costs are related to model training, fine-tuning and refinement, and they come off not as one-time investments, but rather as continuous expenditures, driven by the models'

need of updated data to maintain relevance and accuracy.

Given the scarcity of literature on AI's role in IPA, and the limited use of AI tools in companies, integrating its assessment in structured methods for process selection and economic evaluation proved challenging. Nevertheless, drawing from AI-specific literature concepts such as soft ROI, or the mathematical calculation of model training costs, provided a novel perspective that signals a promising direction for future research. As organizations advance in their AI capabilities, their AI project assessment approach could integrate with RPA established frameworks and facilitate the development of comprehensive IPA models.

5. Conclusions

Overall, the thesis provides significant contributions to the research on Intelligent Process Automation adoption. It synthesizes existing literature on RPA and IPA, listing ideal process characteristics, automation benefits, and costs while explicitly assessing AI's influence on these factors. By aggregating and analyzing multiple structured frameworks for process selection and economic evaluation, it proposes different universally applicable models to guide IPA implementation in organizations. Moreover, to address the limited research on IPA, it incorporates insights from AI-specific literature and integrates them into traditional RPA models, a novel perspective compared to previous studies on the theme. These contributions are further enriched by empirical findings, capturing the concrete outlook of seven automation experts, that enabled a critical evaluation and reinterpretation of literature findings. Together, these elements form a comprehensive guide to IPA implementation, from process selection to economic evaluation, while emphasizing AI's present and future influence on digital automation.

Despite its contributions, the study presents some acknowledged limitations. The empirical research had to rely only on qualitative interviews, constrained by time and conducted through open-ended questions. While transcription mapping helped standardize responses, a degree of interpretation bias must be considered. The translations from Italian to English may have also influenced interview results, particularly when

trying to relate their insights to literature terms. Additionally, their qualitative nature excluded a deeper analysis of individual IPA case studies, which would have required extensive quantitative data on efficiency metrics, costs, and returns. Concerning the sample of companies included, they were all primarily based in the Italian market, and hence limited the scope of research, potentially overlooking the approach to innovations present in more technologically advanced markets. The same can be said for experts' job titles; as most held managerial roles, they provided strategic insights but possibly lacked detailed knowledge of technological challenges in implementing IPA solutions.

This work can hopefully serve as a valuable foundation for future studies on IPA implementation. Research could build on these findings by applying the method followed here to a diverse set of industries and markets. Studying organizations with greater technological maturity and different uses of the technology could provide deeper insights into advanced automation techniques. Another possibility is to expand the interview methodology to include close-ended questions and in-depth case studies, as it would enhance the empirical foundation and offer a detailed look at process data and cost-benefit metrics of automation projects. Finally, testing the proposed process selection and economic evaluation frameworks in real-world settings and case studies could validate their practicality, refine their applicability, and advance structured approaches to digital automation.

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